Polytechnic University of Puerto Rico
San Juan, Puerto Rico

Outcomes Assessment
Planning Guide
Volume I
Appendixes

Prepared by
Office of Outcomes Assessment
February, 2003
Appendixes
Assessment Instruments

1- Appendix A- Civil Engineering
2- Appendix B- Industrial Engineering
3- Appendix C- Electrical Engineering
4- Appendix D- Mechanical Engineering
5- Appendix E- Environmental Engineering
6- Appendix F- Capstone Experience
7- Appendix G- Portfolio
8- Appendix H- Alumni Survey
9- Appendix I- Certification for Graduation
   A- School of Engineering
   B- School of Management
   C- School of Architecture

10-Appendix J- Classroom assessment User's Guide
   A- Introduction
   B- Principle of Good Practice for Assessing Student Learning
   C- The Program Evaluation Standards
   D- Course Goals and Performance Objectives
   E- TQM Tools and Techniques
   F- TQM in the Classroom

11-Appendix K- Evaluation Criteria
   A- Council of Higher Education
   B- Middle States Association of Colleges and Schools
   C- Accreditation Board for Engineering and Technology (ABET)
   D- National Architectural Accrediting Board (NAAB)

12-Appendix L
   A- Inventario de Inteligencia Emocional
   B- Evaluación de Lidres a 360 grados

13-Appendix M
   A- Financial Aid Process
   B- Mentoring and Enrollment Process
   C- Honor Program Process
   D- Budget Preparation Process
   E- Evaluation of the Learning Resources Center (Library)
   F- Learning Outcomes Assessment System
- Evaluation of the Course
- Evaluation of the Professor
- Evaluation of the Classroom and Environment
- Evaluation of the Student
- Evaluation of Component or Sequence
- Evaluation of Program
APPENDIX A
Civil Engineering

Some of the instruments used by the Civil Engineering Department to gather data for the assessment of the program
According to course content and objectives, what is the level of achievement that each of the following objectives attains in this course?

1: None  2: Low  3: Moderate  4: High

<table>
<thead>
<tr>
<th>Objective</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>The graduates of the Civil Engineering Program will be able to:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Provide service to the industry and government of their communities in</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>accordance to the standards of the profession.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Apply modern technologies and criteria throughout the planning, design,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and construction processes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Perform as effective leaders and team members, communicating comfortably</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in both Spanish and English.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Enhance their professional knowledge through a lifetime of continuing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>education.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: Underline the specific component of the objective that is addressed in this course. Indicate the activities (examinations, projects, assignments, portfolio, oral presentations, research, data analysis, etc) performed by the students that demonstrate the achievement of the objective.
According to course content and objectives, what is the level of achievement that each of the following outcomes attains in this course?

<p>| Remarks: Underline the specific component of the outcome that is addressed in this course. Indicate the activities (examinations, projects, assignments, portfolio, oral presentations, research, data analysis, etc) performed by the students that demonstrate the achievement of the outcome. |
|---|---|---|---|
| The graduates of the Civil Engineering Program will have: | 1 | 2 | 3 | 4 |
| 1. An ability to apply knowledge of mathematics, probability and statistics, science, and engineering. | | | | |
| 2. An ability to conduct laboratory experiments and to critically analyze and interpret data in one of the following areas: structural, geotechnical, environmental, and transportation engineering. | | | | |
| 3. Proficiency to analyze and design systems, components, or processes in one of the following areas: structural, geotechnical, water resources and environmental, highway and transportation, and construction engineering. | | | | |
| 4. An ability to work in teams and to interact with professionals of other disciplines. | | | | |</p>
<table>
<thead>
<tr>
<th>The graduates of the Civil Engineering Program will have:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. An ability to identify, formulate, and solve civil engineering problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. A comprehension of professional practice issues and ethical principles.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. An ability to communicate orally, in writing, and graphically in an effective way.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. An ability to evaluate the impact that design alternatives will have on society.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. An ability to learn independently and an awareness of the need to be engaged in continuing education.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. A knowledge of contemporary issues related to the civil engineering practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: Underline the specific component of the outcome that is addressed in this course. Indicate the activities (examinations, projects, assignments, portfolio, oral presentations, research, data analysis, etc.) performed by the students that demonstrate the achievement of the outcome.
<table>
<thead>
<tr>
<th>The graduates of the Civil Engineering Program will have:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Remarks: Underline the specific component of the outcome that is addressed in this course. Indicate the activities (examinations, projects, assignments, portfolio, oral presentations, research, data analysis, etc) performed by the students that demonstrate the achievement of the outcome.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. An ability to model civil engineering problems and to interpret results through the use of modern technologies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By: ____________________________  Date: ____________________________
Civil Engineering Program
Course Evaluation Survey
Course __________________________ Section __________ Quarter __________

For the Civil and Environmental Engineering Department it is important to know how well prepared do you feel to pursue the profession of engineering and to identify the stages of the program in which you developed certain skills and levels of understanding. Your answers to this survey will help the Department in identifying areas of the Civil Engineering Program that need improvement.

Please state your level of agreement to the following statements:

**RATING SCALE**
A = Totally Agree  B = Agree  C = Neutral  D = Disagree  E = Totally Disagree

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I was prepared to take this course.</td>
<td></td>
</tr>
<tr>
<td>2. This was an important course for my professional development.</td>
<td></td>
</tr>
<tr>
<td>3. This was an exciting and intellectually stimulating course.</td>
<td></td>
</tr>
<tr>
<td>4. I am satisfied with the course content.</td>
<td></td>
</tr>
</tbody>
</table>

Please indicate how well do you think this course prepared you in each of the following areas:

**RATING SCALE**
A = Excellent  B = Very Well  C = Well  D = Not Very Well  E = Not At All

<table>
<thead>
<tr>
<th>Ability</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. An ability to apply knowledge of mathematics, probability and statistics, science, and engineering.</td>
<td></td>
</tr>
<tr>
<td>6. An ability to design and conduct laboratory experiments and to critically analyze and interpret data.</td>
<td></td>
</tr>
<tr>
<td>7. Proficiency to analyze and design systems, components, or processes.</td>
<td></td>
</tr>
<tr>
<td>8. An ability to work in teams and to interact with professional of other disciplines.</td>
<td></td>
</tr>
<tr>
<td>9. An ability to identify, formulate and solve civil engineering problems.</td>
<td></td>
</tr>
<tr>
<td>10. A comprehension of professional practice issues and ethical principles.</td>
<td></td>
</tr>
<tr>
<td>11. An ability to communicate orally, in writing, and graphically in an effective way.</td>
<td></td>
</tr>
<tr>
<td>12. An ability to evaluate the impact that design alternatives will have on society.</td>
<td></td>
</tr>
<tr>
<td>13. An ability to learn independently and an awareness of the need to be engaged in continuing education.</td>
<td></td>
</tr>
<tr>
<td>14. A knowledge of contemporary issues related to the civil engineering practice.</td>
<td></td>
</tr>
<tr>
<td>15. An ability to model civil engineering problems and to interpret results through the use of modern technologies.</td>
<td></td>
</tr>
</tbody>
</table>

Comments:
## PORTFOLIO EVALUATION GUIDE (CIVIL)

### CIVIL AND ENVIRONMENTAL ENGINEERING DEPARTMENT
### POLYTECHNIC UNIVERSITY OF PUERTO RICO

**Student:**
**Course:**
**Professor:**

<table>
<thead>
<tr>
<th>PORTFOLIO SECTION</th>
<th>EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class summary and portfolio introduction</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Class notes are clearly taken and reflect understanding of the material</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Special assignments</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Exams</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Short tests</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Investigation projects required by the professor</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Investigation projects or additional investigations made by the student</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Written reports</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Laboratorie integration</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Additional material or information gathered for design projects</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Analysis of handouts provided by the professor</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Conclusion</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>

## 2.00 DESIGN PROJECT DOCUMENTATION

| Research | 1 2 3 4 | N/A | COMMENTS |
| Problem Definition | 1 2 3 4 | N/A | COMMENTS |
| Gathering of required information | 1 2 3 4 | N/A | COMMENTS |
| Design criteria definition | 1 2 3 4 | N/A | COMMENTS |
| Preliminary design alternatives | 1 2 3 4 | N/A | COMMENTS |
| Alternatives analysis and alternative selection | 1 2 3 4 | N/A | COMMENTS |
| Models documentation | 1 2 3 4 | N/A | COMMENTS |
| Graphical documentation | 1 2 3 4 | N/A | COMMENTS |
| Criteria analysis | 1 2 3 4 | N/A | COMMENTS |
| Alternative selected justification | 1 2 3 4 | N/A | COMMENTS |
| Design development | 1 2 3 4 | N/A | COMMENTS |
| Written specification | 1 2 3 4 | N/A | COMMENTS |
| Final model or prototype | 1 2 3 4 | N/A | COMMENTS |
| Construction drawings | 1 2 3 4 | N/A | COMMENTS |
| Materials Analysis | 1 2 3 4 | N/A | COMMENTS |
## 3.00 PORTFOLIO DOCUMENTATION, ORGANIZATION AND PRESENTATION

| Shows clearly communication of course content |  |  |
| Organization of topics according to professor's requirements |  |  |
| Reflects auto evaluation techniques |  |  |
| Relates course content with laboratory course contents |  |  |
| Shown adequate computers programs utilization |  |  |
| Shown adequate course assessment |  |  |
| Will serve as an instrument for other future courses and professional practice |  |  |

## 4.00 OUTCOMES ACHIEVEMENT

1. An ability to apply knowledge of mathematics, probability and statistics, science and engineering.
2. An ability to conduct laboratory experiments and to critically analyze and interpret data in one of the following areas; structural, geotechnical, environmental and transportation engineering.
3. Proficiency to analyze and design systems, components, or processes in one of the following areas; structural, geotechnical, water resources, and environmental, highway and transportation, and construction engineering.
4. An ability to work in teams and to interact with professionals of other disciplines.
5. An ability to identify, formulate, and solve civil engineering problems.
6. A comprehension of professional practice issues and ethical principles.
7. An ability to communicate orally, in writing, and graphically in an effective way.
8. An ability to evaluate the impact that design alternatives will have on society.
9. An ability to learn independently and awareness of the need to be engaged in continuing education.
10. A knowledge of contemporary issues related to civil engineering practice.
11. An ability to model civil engineering problems and to interpret results through the use of modern technologies.

**Legend:**

1. None
2. Low
3. Moderate
4. High
N/A Do not apply
<table>
<thead>
<tr>
<th>PORTFOLIO EVALUATION GUIDE (ENVIRONMENTAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVIL AND ENVIRONMENTAL ENGINEERING DEPARTMENT</td>
</tr>
<tr>
<td>POLYTECHNIC UNIVERSITY OF PUERTO RICO</td>
</tr>
<tr>
<td>Student:</td>
</tr>
<tr>
<td>Course:</td>
</tr>
<tr>
<td>Professor:</td>
</tr>
<tr>
<td>PORTFOLIO SECTION</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>1 2 3 4 N/A COMMENTS</td>
</tr>
</tbody>
</table>

### 1.00 COURSE CONTENT DOCUMENTATION

- Class summary and portfolio introduction
- Class notes are clearly taken and reflect understanding of the material
- Special assignments
- Exams
- Short tests
- Investigation projects required by the professor
- Investigation projects or additional investigations made by the student
- Written reports
- Laboratories integration
- Additional material or information gathered for design projects
- Analysis of handouts provided by the professor
- Conclusion

### 2.00 DESIGN PROJECT DOCUMENTATION

- Research
- Problem Definition
- Gathering of required information
- Design criteria definition
- Preliminary design alternatives
- Alternatives analysis and alternative selection
- Models documentation
- Graphical documentation
- Criteria analysis
- Alternative selected justification
- Design development
- Written specification
- Final model or prototype
- Construction drawings
- Materials Analysis

### 3.00 PORTFOLIO DOCUMENTATION, ORGANIZATION AND PRESENTATION

- Shows clearly communication of course content

8/5/2022
| Organization of topics according to professor's requirements |
| Reflected auto evaluation techniques |
| Relates course content with laboratory course contents |
| Shown adequate computer programs utilization |
| Shown adequate course assessment |
| Will serve as an instrument for other future courses and professional practice |

### 4.00 Outcomes Achievement

1. An ability to apply knowledge of mathematics, probability and statistics, science, and engineering.

2. An ability to design and conduct laboratory experiments and to critically analyze and interpret data in at least two of the following areas: water supply, wastewater management, air pollution control, and solid waste management.

3. Proficiency to analyze and design systems, components, or processes in a minimum of three of the following areas: water resources engineering, water supply engineering, wastewater engineering, air pollution and control, solid waste management, hazardous waste management, occupational safety and health, environmental toxicology, and environmental impact assessment.

4. An ability to work in teams and to interact with professionals of other disciplines.

5. An ability to identify, formulate, and solve environmental engineering problems.

6. A comprehension of ethical principles, professional practice issues, and the roles and responsibilities of public institutions and private organizations in environmental management.

7. An ability to communicate orally, in writing, and graphically in an effective way.

8. An ability to evaluate the impact that design alternatives will have on society.

9. An ability to learn independently and an awareness of the need to be engaged in continuing education.

10. A knowledge of contemporary issues related to the environmental engineering practice.

11. An ability to model environmental engineering problems and to interpret results through the use of modern technologies.

Legend:

1. None
2. Low
3. Moderate
4. High
N/A Do not apply
As part of the assessment of our educational process, we conduct surveys at various stages of development of our students. This process follows the student after graduation and into the job environment. To help us in this task, please complete this survey and return it to Dr. Noemi Rivera, Placement Office Director, in the self addressed envelope. In the following questions, please circle your best/closest choice.

1. What is your primary responsibility at your company?
   a) Engineering  b) Management  c) Human Resources
   d) Other (Please state) .................................................................

2. Nature of your company business:
   a) Manufacturing  b) Consulting  c) Government
   d) Distribution   e) Construction  f) Services
   g) Other (Please state).................................................................

3. How many Polytechnic University of Puerto Rico graduates have you supervised in the past 5 years?
   a) 1-2  b) 3-5  c) 5-10  d) More than 10

4. Please check the type(s) of functions Polytechnic University of Puerto Rico graduates perform at your company:
   _____ Administration
   _____ Design and analysis
   _____ Customer service
   _____ Manufacturing or process operations
   _____ Maintenance
   _____ Marketing and sales
   _____ Other (Please state).................................................................

5. On the average, how frequently do you have contact with the employee?
   a) Daily  b) Several times a week  c) Several times a month
   d) Rarely  e) Never

6. How long have you known the employee?
   a) Less than a year  b) 2-3 years  c) 3-5 years  d) More than 5 years

7. How do you rate Polytechnic University of Puerto Rico graduates in relation to engineers from other universities?
   a) Top 1% - 10%  b) Top 11% - 20%  c) Top 21% - 50%  d) Lower 50%
8. Please rate the strength of a typical Polytechnic University of Puerto Rico B.S. graduate in each of the following abilities. For each ability fill the box from 1 to 5 that most closely represents your own assessment.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very weak</td>
<td>Weak</td>
<td>About average</td>
<td>Strong</td>
<td>Very strong</td>
</tr>
</tbody>
</table>

a. Applying knowledge of mathematics, science, and engineering to solve engineering problems.

b. Designing and conducting experiments as well as to analyzing and interpreting data.

c. Designing a system, component, or process to meet desired needs.

d. Functioning well on multi-disciplinary teams.

e. Identifying, formulating, and solving engineering problems.

f. Understanding professional and ethical responsibilities.

g. Communicating effectively.

h. Understanding the impact of engineering solutions in a global and societal context.

i. Recognizing the need for and having the ability to engage in lifelong learning.

j. Understanding contemporary engineering issues.

k. Applying the techniques, skills, and modern engineering tools necessary for good engineering practice.

9. Please identify any areas of knowledge or skills that our graduates should have, but currently do not possess.

...........................................................................................................................................................................
...........................................................................................................................................................................
...........................................................................................................................................................................

10. What are the three most important things that you look for or your organization looks for when hiring new engineering graduates?

...........................................................................................................................................................................
...........................................................................................................................................................................
...........................................................................................................................................................................
Graduating Senior Exit Survey

Environmental Engineering

GRADUATING SENIORS: For multiple choice questions, please select the best answer. For other questions, provide your answers in the space provided. Use the reverse side of the page if you need more space.

1. How many years did you spend studying in the Environmental Engineering Program at PUPR?
   a. Less than five.   b. Five.   c. Six.   d. Seven   e. More than seven

2. What is your Cumulative Grade Point Average?
   a. Less than 2.00   b. 2.00 - 2.50   c. 2.51 - 3.00   d. 3.01 - 3.50   e. 3.51 - 4.00

3. Did you transfer to PUPR from another college of university?
   a. Yes   b. No
   If yes, indicate Institution: __________________________

4. If you transferred, approximately how many credit-hours did you transfer into PUPR?
   a. Less than 25   b. 25-50   c. More than 50

5. Sex:
   a. M   b. F

6. What is your current age?
   a. less than 25   b. 25-30   c. 31-35   d. 36-40   e. more than 40

7. Indicate if you held a job during your progress in the Environmental Engineering curriculum. For each academic year, check whether you held an Engineering related job, held a Non-Engineering related job, or did not have a job at all.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Held a Full-time Engineering related job</th>
<th>Held a Part-time Engineering related job</th>
<th>Held a Full-time Non-Engineering related job</th>
<th>Held a Part-time Non-Engineering related job</th>
<th>Did not have a job</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Please indicate your proficiency in the following subject areas using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electrical Circuits</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ethics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Material Science</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mechanics of Materials</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Statics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Water Resources Engineering</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Water Supply Engineering</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Wastewater Engineering</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Air Pollution and Control</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Solid Waste Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Hazardous Waste Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Occupational Safety and Health</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Toxicology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Impact Assessment</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
9. Please indicate your proficiency in conducting laboratory experiments using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th></th>
<th>Very</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weak</td>
<td>Average</td>
<td>Weak</td>
<td>Average</td>
<td>Strong</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

10. Please indicate your proficiency in analyzing and interpreting data obtained from laboratory experiments using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th></th>
<th>Very</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weak</td>
<td>Average</td>
<td>Weak</td>
<td>Average</td>
<td>Strong</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

11. Please indicate the level at which you considered the following constraints during the design process in your ENVE Capstone course using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic aspects</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Environmental issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Sustainability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Implementation/Construction feasibility</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ethical issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Health and Safety issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Social issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

12. Did your curriculum include in-depth instruction to develop effective design solution to problems in environmental engineering using appropriate analytical, computational and experimental practices? Indicate the level of depth using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th></th>
<th>Very</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weak</td>
<td>Average</td>
<td>Weak</td>
<td>Average</td>
<td>Strong</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
13. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong) your proficiency in identifying, formulating, and solving environmental engineering problems.

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

14. Please indicate your ability to function as a member of a team. Respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

15. Did your academic advisor (mentor) or any other faculty member discuss the Fundamentals of Engineering Examination with you?

a. Yes
b. No

16. Are you planning to take the Fundamentals of Engineering Examination?

a. Yes, before graduation  b. Yes, after graduation  c. No

17. Please indicate your understanding of professional issues using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

18. Please indicate your understanding of ethics in engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

19. Approximately how many technical reports have you presented orally as part of your course work?

a. 0  b. 1-5  c. 6-10  d. 11-15  e. more than 15
20. How would you rate your own oral communication ability in Spanish. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

21. How would you rate your own oral communication ability in English. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

22. Approximately how many technical reports have you written as part of course work?

a. 0       b. 1-5       c. 6-10      d. 11-15      e. more than 15

23. How would you rate your own written communication ability in Spanish. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

24. How would you rate your own written communication ability in English. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

25. How would you rate your understanding of the impact that design alternatives will have on society. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
26. Please indicate your level of agreement with the following statement: “my education will never end; my graduation just represents a milestone in my life-long journey”.

   a. Strongly Disagree  b. Disagree  c. Agree  d. Strongly Agree  e. Totally Agree

27. While at PUPR, how many workshops, seminars, short courses or conferences did you attend that you were not otherwise required to take?

   a. None  b. 1-5  c. 6-10  d. 11-15  e. more than 15

28. Please indicate your proficiency in the following computer tools of engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Engineering Tool</th>
<th>Very Weak</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Programming</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Computer graphics and drafting in AUTOCAD or similar software</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Word processing (i.e., Microsoft Word)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Presentations (i.e., Microsoft PowerPoint)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Spreadsheets (i.e., Microsoft Excel)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Electronic mail</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Internet research</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Water Resources Engineering Software (i.e., STORMCAD)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Water Supply Engineering Software (i.e., WATERCAD)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Wastewater Engineering Software (i.e., SEWERCAD)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Groundwater Pollution and Control Software (i.e., AQUA 3D)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Air Pollution and Control Software</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Solid and Hazardous Waste Management Software (i.e., SW PLAN)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Other Environmental Engineering Software</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
29. Please indicate your proficiency using the following codes and regulations using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Code/Regulations</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ley 9- Política Pública Ambiental</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The 40 Code of Federal Regulations (CFR), Part 1 through Part 799</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento de Estándares de Calidad de Agua de Puerto Rico (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento de la JCA para el Proceso de Presentación, Evaluación y Trámite de Documentos Ambientales</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Normas de Diseño de la Autoridad de Acueductos y Alcantarillados de Puerto Rico</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Normas de Diseño para Sistemas de Alcantarillado Pluvial (IP)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Guías para la asignación de cargas de contaminantes (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento para el Control de la Contaminación Atmosférica (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>OSHA Manuals on Safety, Health, and Industrial Hygiene</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento para el Control de los Desperdicios Sólidos Peligrosos (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento para el Manejo de los Desperdicios Sólidos no Peligrosos (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento para el Control de la Contaminación por Ruidos (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento para el Control de la Erosión y Prevención de la Sedimentación (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamentos de la Junta de Planificación de Puerto Rico</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>ACI 350-89. Environmental Engineering Concrete Structures</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
30. Are there any engineering tools you are aware of that you believe should be covered in your curriculum, but were ignored? If so, state these.

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

31. Please indicate at which level were contemporary issues of importance to civil engineers discussed in your courses using a scale of 1 (Very Weak) to 5 (Very Strong).


32. Which newspapers, periodicals, professional magazines or journals do you read regularly?

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

33. How would you rate your knowledge of contemporary issues of importance to an environmental engineer?


<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

34. Do you feel confident to practice as an environmental engineer? Please respond using a scale of 1 (Strongly disagree) to 5 (Strongly Agree):


<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

35. Do you have any recommendations to improve the Environmental Engineering Program?

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________
Graduating Senior Exit Survey

Civil Engineering

GRADUATING SENIORS: For multiple choice questions, please select the best answer. For other questions, provide your answers in the space provided. Use the reverse side of the page if you need more space.

1. How many years did you spend studying in the Civil Engineering Program at PUPR
   a. Less than five.  b. Five.  c. Six.  d. Seven  e. More than seven

2. What is your Cumulative Grade Point Average?
   a. Less than 2.00  b. 2.00 - 2.50  c. 2.51 - 3.00  d. 3.01 - 3.50  e. 3.51 - 4.00

3. Did you transfer to PUPR from another college of university?
   a. Yes  b. No  If yes, indicate Institution: 

4. If you transferred, approximately how many credit-hours did you transfer into PUPR?
   a. Less than 25  b. 25-50  c. More than 50

5. Sex:
   a. M  b. F

6. What is your current age?
   a. less than 25  b. 25-30  c. 31-35  d. 36-40  e. more than 40

7. Indicate if you held a job during your progress in the Civil Engineering curriculum. For each academic year, check whether you held an Engineering related job, held a Non-Engineering related job, or did not held a job at all.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Engineering related job</th>
<th>Part-time Engineering related job</th>
<th>Engineering related job</th>
<th>Non-Engineering related job</th>
<th>Did not have a job</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Please indicate your proficiency in the following subject areas using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electrical Circuits</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ethics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Material Science</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mechanics of Materials</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Statics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Numerical Methods</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Construction Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Engineering</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Hydraulic &amp; Hydrologic Systems</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Legal &amp; Professional Aspects</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Soil Mechanics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Foundations</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Structural Analysis</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Structural Design</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Surveying</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Highway and Transportation Engineering</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Water/Wastewater Treatment</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
9. Please indicate your proficiency in conducting laboratory experiments using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

10. Please indicate your proficiency in analyzing and interpreting data obtained from laboratory experiments using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

11. Please indicate the level at which you considered the following constraints during the design process in your CE Capstone course using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic aspects</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Environmental issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Sustainability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Implementation/Construction feasibility</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ethical issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Health and Safety issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Social issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

12. Did your curriculum include in-depth instruction to develop effective design solutions to problems in civil engineering using appropriate analytical, computational and experimental practices? Indicate the level of depth using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
13. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong) your proficiency in identifying, formulating, and solving civil engineering problems.

<table>
<thead>
<tr>
<th>Very</th>
<th>Weak</th>
<th>About</th>
<th>Strong</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

14. Please indicate your ability to function as a member of a team. Respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very</th>
<th>Weak</th>
<th>About</th>
<th>Strong</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

15. Did your academic advisor (mentor) or any other faculty member discuss the Fundamentals of Engineering Examination with you?

a. Yes  

b. No

16. Are you planning to take the Fundamentals of Engineering Examination?

a. Yes, before graduation  
b. Yes, after graduation  
c. No

17. Please indicate your understanding of professional issues using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very</th>
<th>Weak</th>
<th>About</th>
<th>Strong</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

18. Please indicate your understanding of ethics in engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very</th>
<th>Weak</th>
<th>About</th>
<th>Strong</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

19. Approximately how many technical reports have you presented orally as part of your course work?

a. 0  
b. 1-5  
c. 6-10  
d. 11-15  
e. more than 15
20. How would you rate your own oral communication ability in Spanish. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

21. How would you rate your own oral communication ability in English. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

22. Approximately how many technical reports have you written as part of course work?
   a. 0       b. 1-5   c. 6-10   d. 11-15   e. more than 15

23. How would you rate your own written communication ability in Spanish. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

24. How would you rate your own written communication ability in English. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

25. How would you rate your understanding of the impact that design alternatives will have on society. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

26. Please indicate your level of agreement with the following statement: "my education will never end, my graduation just represents a milestone in my life-long journey".
   a. Strongly Disagree   b. Disagree   c. Agree   d. Strongly Agree   e. Totally Agree

27. While at PUPR, how many workshops, seminars, short courses or conferences did you attend that you were not otherwise required to take?
   a. None   b. 1-5   c. 6-10   d. 11-15   e. more than 15
28. Please indicate your proficiency in the following computer tools of engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Computer Tool</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Programming</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computer graphics and drafting in AUTOCAD or similar software</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Word processing (i.e., Microsoft Word)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Presentations (i.e., Microsoft PowerPoint)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Spreadsheets (i.e., Microsoft Excel)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electronic mail</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Internet research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Structural Engineering Software</td>
<td>SAP 2000</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>ETABS</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Geotechnical Engineering Software</td>
<td>GEO-SLOPE</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>MARTAL</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Highway and Transportation Engineering Software (i.e., Highway Capacity Software 2000)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Water Resources/Water Supply/Wastewater Engineering Software</td>
<td>STORMCAD</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>WATERCAD</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>SEWERCAD</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Environmental Engineering Software</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Engineering and Management Software (i.e., MSProject)</td>
<td>L</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Other Software (i.e., MATHCAD)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
29. Please indicate your proficiency using the following codes and regulations using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Code/Regulations</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Code Requirements for Structural Concrete (ACI 318)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Manual of Steel Construction Load and Resistance Factor Design (AISC/LRFD)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Minimum Design Loads for Buildings and Other Structures (ASCE 7)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Uniform Building Code</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>ASTM Volume 04.08 &quot;Soil and Rock&quot;</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>A Policy on Geometric Design of Highways and Streets (AASHTO)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Highway Capacity Manual</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Manual of Uniform Traffic Control Devices</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Highway Design Manual of the Highway and Transportation Authority of Puerto Rico</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Normas de Diseño para Sistemas de Alcantarillado Pluvial (JP)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Normas de Diseño de la Autoridad de Acueductos y Alcantarillados de Puerto Rico</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento de Estándares de Calidad de Agua de Puerto Rico (JCA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reglamento de la JCA para el Proceso de Presentación, Evaluación y Trámite de Documentos Ambientales</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Project Management Book of Knowledge (PMBOK)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Documents and Divisions of the Construction Specifications Institute</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Contracts and Standards of the American Institute of Architects (AIA)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
30. Are there any engineering tools you are aware of that you believe should be covered in your curriculum, but were ignored? If so, state these.


31. Please indicate at which level were contemporary issues of importance to civil engineers discussed in your courses using a scale of 1 (Very Weak) to 5 (Very Strong).


32. Which newspapers, periodicals, professional magazines or journals do you read regularly?


33. How would you rate your knowledge of contemporary issues of importance to a civil engineer?

<table>
<thead>
<tr>
<th></th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

34. Do you feel confident to practice as a civil engineer? Please respond using a scale of 1 (Strongly disagree) to 5 (Strongly Agree):

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

35. Do you have any recommendations to improve the Civil Engineering Program?


APPENDIX B
Industrial Engineering

Some of the instruments used by the Industrial Engineering Department to gather data to conduct the assessment of the program
POLYTECHNIC UNIVERSITY OF PUERTO RICO
SCHOOL OF ENGINEERING

ALUMNI SURVEY

Employment Information:
1. Please indicate which of the following statements is applicable to your situation. Mark all that apply.
   - I am enrolled in graduate school
   - Employed part time (less than 30 hours a week)
   - Employed full time (30 or more hours a week)
   - Not employed

If you are NOT employed, skip to question 3.

2a. What is your present position?
2c. Where are you employed?
2d. What is your salary range? a.$20,000 or less b.$20,001 - $25,000 c.$25,001 - $30,000 d.$30,001 - $35,000
e.$35,001 - $40,000 f. $40,000 - $45,000 g.$45,000 - $50,000 h.$50,000 or more

First Time Employment
3. What was your first position after graduation?
4. How long after graduation did you obtain an engineering-related job?

Undergraduate Experience
5. How would you rate your overall satisfaction with your preparation to become an engineer? Please mark the box that best describes your opinion.
   Not Satisfied Satisfied Very Satisfied
   A Little Satisfied Satisfied Satisfied
   - - - -
6. How would you rate your preparation to obtain a job after graduation? Please mark the box that best describes your opinion.
   Not Satisfied Satisfied Very Satisfied
   A Little Satisfied Satisfied Satisfied
   - - - -
7. How would you rate your preparation to become a contributing member of society? Please mark the box that best describes your opinion.
   Not Satisfied Satisfied Very Satisfied
   A Little Satisfied Satisfied Satisfied
   - - - -
8. What do you consider to be the greatest strength of your undergraduate program?
9. What do you consider to be the greatest weakness of your undergraduate program?
10. What specific curriculum changes would you recommend? Why?

Graduate Studies & Professional Development
11. Are you currently enrolled or have you already completed a graduate program? Yes No
    If yes please indicate the Program and Institution:
    __________________________________________________________________________
12. After graduation, have you participated at least once a year in seminars, workshops or technical conferences? Yes No
    __________________________________________________________________________
13. Have you passed the Fundamentals of Engineering Examination? Yes No Haven't taken it
14. List your membership in professional organizations, if any. __________________________________________________________________________
GRADUATING SENIORS: For multiple choice questions, please select an answer that is closest/best. For other questions, provide your answers in the space provided. Use the reverse side of the page if you need more space.

1. When do you expect to graduate? Please indicate month and year ___________________________

2. When did you enter Polytechnic University's of Puerto Rico's engineering program? Please state month and year ____________________________

3. Did you transfer to PUPR from another college of university? a. Yes  b. No

4. Do you have a job offer? If so how many? If none, state "none" and skip the next question?

5. If you have accepted a job offer, please provide the following information:
   i. Company name ____________________________
   ii. Salary range?
      a. $20,000 or less  b. $20,001-$25,000  c. $25,001-$30,000
      d. $30,000-$35,000  e. $35,001-$40,000  f. > $40,000
   iii. Nature of the position?
      d. Other (Please state) ____________________________

6. Are you planning to attend graduate school? If no, please skip the next question. Yes  No

7. If you are planning to attend graduate school, please provide the following information?
   University/Department/Program/Degree Sought ____________________________

Mathematics, Science and Engineering Skills

8. Please indicate your proficiency in the following subject areas using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics-Calculus</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mathematics-Linear Algebra</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Probability and Statistics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Material Science</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electrical Circuits</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Statics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mechanics of Material</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Course</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ethics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Programming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Computations &amp; Modeling</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Design of Industrial Experiments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Engineering Statistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facility Design &amp; Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Cost Analysis</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industrial Ergonomics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industrial Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Information System Design</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Manufacturing Processes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Manufacturing Systems Design</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Material Handling System Design</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mathematical Optimization &amp; Modeling</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Production Planning &amp; Scheduling</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Productivity Measurement &amp; Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Queuing Theory &amp; Modeling</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Simulation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Statistical Quality Control</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total Quality Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Work Performance &amp; Methods</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**Scale:** 1 - Very Weak  2 - Weak  3 - Average  4 - Strong  5 - Very Strong

9. Were topics on data analysis and interpretation discussed in any of your required courses? Please state these courses; if none, state “none”.

10. Please indicate your proficiency in analyzing and interpreting data using a scale of 1 (Very Weak) to 5 (Very Strong):
    1 2 3 4 5
<table>
<thead>
<tr>
<th>Scale:</th>
<th>1- Very Weak</th>
<th>2- Weak</th>
<th>3- Average</th>
<th>4- Strong</th>
<th>5- Very Strong</th>
</tr>
</thead>
</table>

Designing and conducting experiments

11. Please mention courses in which you were introduced to experimental design. If none, state “none”.

12. Please indicate your proficiency in experimental design using a scale of 1 (Very Weak) to 5 (Very Strong):
   1 2 3 4 5

13. Please mention courses in which you conducted experiments. If none, state “none”.

14. Please indicate your proficiency in conducting experiments using a scale of 1 (Very Weak) to 5 (Very Strong):
   1 2 3 4 5

Design

15. Please mention courses in which you had any experience in designing systems, components, or processes. Include courses in which you were expected to address problems that were open-ended, required creativity to generate alternative solutions, and required you to select the best alternative in light of constraints and performance criteria.

16. Did your curriculum involve a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; and social? If so, state courses. If none, state “none”.

17. In your opinion, did your curriculum include in-depth instruction to develop effective design solutions to problems in engineering using appropriate analytical, computational and experimental practices?

Problem Solving

18. Please mention courses in which you learned how to identify, formulate, and solve industrial engineering problems.

19. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong) your proficiency in identifying, formulating, and solving industrial engineering problems.
   1 2 3 4 5

Teamwork

20. Please mention the courses in which worked in teams. If none state “none”.

21. Please indicate your ability to function as a member of a team. Respond using a scale of 1 (Very Weak) to 5 (Very Strong):
   1 2 3 4 5
Scale: 1 - Very Weak  2-Weak  3-Average  4-Strong  5-Very Strong

Professional and ethical responsibilities

22. List all professional societies of which you are a member; if none, state "none".

23. Did your advisor or any other faculty discuss the Fundamentals of Engineering Examination with you?
   Yes or No

24. Are you planning to take the Fundamental of Engineering Examination? If so, when will you take it? If no, why not?

25. Please indicate your understanding of professionalism using a scale of 1 (Very Weak) to 5 (Very Strong):
   1  2  3  4  5

26. Please mention courses in which ethics was discussed. If none, state "none".

27. Please indicate your understanding of ethics in engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):
   1  2  3  4  5

Communication Skills

28. Approximately how many technical reports have you presented orally as part of your course work?
   a. 0      b. 1-5     c. 6-10     d. more than 10

29. How would you rate your own oral communication ability. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):
   1  2  3  4  5

30. Approximately how many technical reports have you written as part of course work?
   a. 0      b. 1-5     c. 6-10     d. more than 10

31. How would you rate your own written communication ability. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):
   1  2  3  4  5

Global and societal context

32. List courses that helped you understand the impact of industrial engineering solutions in a global and societal context. If none, state "none".

33. How would you rate your understanding of the impact of industrial engineering solutions in a global and societal context. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):
   1  2  3  4  5

Life-Long Learning

34. Which of the following statements would you agree with:
   i.  I have reached the end of my education
   ii. My education will never end; my graduation just represents a milestone in my life-long educational journey.
### Table I.F.8
Faculty Survey Results
Level of Contribution per course to the achievement of the Program Outcomes

<table>
<thead>
<tr>
<th>IE Program Core Courses</th>
<th>Level of Contribution to Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L (1,2): Low, M (3): Moderate, H (4,5): High</td>
</tr>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>ENGI 1210 Computer Aided Design (R. Suarez)</td>
<td></td>
</tr>
<tr>
<td>ENGI 3210 Engineering Materials (J. Noriega)</td>
<td></td>
</tr>
<tr>
<td>ENGI 4210 Engineering Economics (J. Torres)</td>
<td></td>
</tr>
<tr>
<td>IE 1610 Introduction to Computer and Info. Technology (A. Rodriguez)</td>
<td></td>
</tr>
<tr>
<td>IE 2610 Computer Tools for IE’s (R. Suarez)</td>
<td></td>
</tr>
<tr>
<td>IE 3110 Financial and Cost Accounting (H. Soto)</td>
<td></td>
</tr>
<tr>
<td>IE 3210 Probability for Engineers (W. Fonseca)</td>
<td></td>
</tr>
<tr>
<td>IE 3220 Statistics for Engineers (W. Fonseca)</td>
<td></td>
</tr>
<tr>
<td>IE 3310 Work Design &amp; Human Factors (M. Pabón)</td>
<td></td>
</tr>
<tr>
<td>IE 3311 Work Design and Human Factors Lab.</td>
<td></td>
</tr>
<tr>
<td>IE 3610 Information Systems Design (M. Perez)</td>
<td></td>
</tr>
<tr>
<td>IE 4210 Design of Experiments (W. Fonseca)</td>
<td></td>
</tr>
<tr>
<td>IE 4220 Statistical Quality Control (R. Vega)</td>
<td></td>
</tr>
<tr>
<td>IE 4310 Job Design Work Measurement (M. Perez)</td>
<td></td>
</tr>
<tr>
<td>IE 4311 Job Design and Work Measurement Lab. (M Perez)</td>
<td></td>
</tr>
<tr>
<td>IE 4410 Material Management and Inventory Control (R. Cruz)</td>
<td></td>
</tr>
<tr>
<td>IE 4420 Operations Research I (W. Fonseca)</td>
<td></td>
</tr>
<tr>
<td>IE 4510 Production Planning and Control (R. Cruz)</td>
<td></td>
</tr>
<tr>
<td>IE 4520 Operations Research II (W. Fonseca)</td>
<td></td>
</tr>
<tr>
<td>IE 4610 Introduction to Database Systems (M Perez)</td>
<td></td>
</tr>
<tr>
<td>IE 4620 Computer Systems Networks (R. Suarez)</td>
<td></td>
</tr>
<tr>
<td>IE 4621 Computer Systems and Networks Lab.</td>
<td></td>
</tr>
<tr>
<td>IE 4630 Operating Systems (Suárez)</td>
<td></td>
</tr>
<tr>
<td>IE 4710 Ind. Manufacturing Processes (Miró)</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Name</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>IE 4720</td>
<td>Industrial Automation (J. F. López) *</td>
</tr>
<tr>
<td>IE 4721</td>
<td>Industrial Automation Lab. (J. F. López) *</td>
</tr>
<tr>
<td>IE 5410</td>
<td>Facilities Planning and Design (L.Olivares)</td>
</tr>
<tr>
<td>IE 5415</td>
<td>Facilities Planning Design Project (González)</td>
</tr>
<tr>
<td>IE 5610</td>
<td>Industrial Systems Simulation (W. Fonseca)</td>
</tr>
<tr>
<td>IE 5620</td>
<td>MIS &amp; Security (M. Perez) *</td>
</tr>
<tr>
<td>IE 5720</td>
<td>Industrial Robotics Applications (R. Cruz) *</td>
</tr>
<tr>
<td>IE 5721</td>
<td>Industrial Robotics Lab. (R. Cruz) *</td>
</tr>
<tr>
<td>IE 5730</td>
<td>Material Handling Automation (González)</td>
</tr>
<tr>
<td>IE 5900</td>
<td>Capstone Design Course (González)</td>
</tr>
</tbody>
</table>

*The values presented for these courses have been estimated by the Department Head, since the faculty member in charge of the course has not as of 06/29/01 completed the Faculty Survey.*
35. How many workshops, seminars, short courses or conferences did you attend that you were not otherwise required to take?

(a) None (b) 1-5 (c) 6-10 (d) more than 10

36. How would you rate your appreciation of the need for life-long learning. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

1 2 3 4 5

37. Please indicate your proficiency in the following tools of engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Engineering Tool</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Programming in FORTRAN, C, C++, Visual Basic, Matlab, Mathcad</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computer graphics and drafting in AUTOCAD or similar software</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Word processing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Presentation Software</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electronic mail</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Internet research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

38. Are there any engineering tools you are aware of that you believe should be covered in your curriculum, but were ignored? If so, state these.

Contemporary issues
39. Were contemporary issues of importance to engineering discussed in any of your courses? If yes, list courses. If no, state “none”.

40. Which newspapers, periodicals, professional magazines or journals do you read regularly?

41. Identify two contemporary issues of importance to industrial engineering?

42. How would you rate your knowledge of contemporary issues of importance to an industrial engineering?

1 2 3 4 5

Overall
43. Do you feel confident to practice as an industrial engineer? Please respond using a scale of 1 (Strongly disagree) to 5 (Strongly Agree):

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
### Table I.F.9

**Faculty Survey Results**

Faculty members appreciation of the actual level of achievement of the Program Outcomes based on students in class performance in recent academic terms

<table>
<thead>
<tr>
<th>IE Program Core Courses</th>
<th>Level of Program Outcome Attainment (Based on Course Contribution to Program Outcome)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Program Outcomes</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>ENGI 1210</td>
<td>Computer Aided Design (R. Suarez)</td>
</tr>
<tr>
<td>ENGI 3210</td>
<td>Engineering Materials (J. Noriega)</td>
</tr>
<tr>
<td>ENGI 4210</td>
<td>Engineering Economics (J. Torres)</td>
</tr>
<tr>
<td>IE 1610</td>
<td>Introduction to Computer and Info. Technology (A. Rodriguez)</td>
</tr>
<tr>
<td>IE 2610</td>
<td>Computer Tools for IE's (R. Suarez)</td>
</tr>
<tr>
<td>IE 3110</td>
<td>Financial and Cost Accounting (H. Soto)</td>
</tr>
<tr>
<td>IE 3210</td>
<td>Probability for Engineers (W. Fonseca)</td>
</tr>
<tr>
<td>IE 3220</td>
<td>Statistics for Engineers (W. Fonseca)</td>
</tr>
<tr>
<td>IE 3310</td>
<td>Work Design &amp; Human Factors (M. Pabón)</td>
</tr>
<tr>
<td>IE 3311</td>
<td>Work Design and Human Factors Lab.</td>
</tr>
<tr>
<td>IE 3610</td>
<td>Information Systems Design (M. Perez)</td>
</tr>
<tr>
<td>IE 4210</td>
<td>Design of Experiments (W. Fonseca)</td>
</tr>
<tr>
<td>IE 4220</td>
<td>Statistical Quality Control (R. Vega)</td>
</tr>
<tr>
<td>IE 4310</td>
<td>Job Design Work Measurement (M. Perez)</td>
</tr>
<tr>
<td>IE 4311</td>
<td>Job Design and Work Measurement Lab. (M Perez)</td>
</tr>
<tr>
<td>IE 4410</td>
<td>Material Management and Inventory Control (R. Cruz)</td>
</tr>
<tr>
<td>IE 4420</td>
<td>Operations Research I (W. Fonseca)</td>
</tr>
<tr>
<td>IE 4510</td>
<td>Production Planning and Control (R. Cruz)</td>
</tr>
<tr>
<td>IE 4520</td>
<td>Operations Research II (W. Fonseca)</td>
</tr>
<tr>
<td>IE 4610</td>
<td>Introduction to Database Systems (M. Perez)</td>
</tr>
<tr>
<td>IE 4620</td>
<td>Computer Systems Networks (R. Suarez)</td>
</tr>
<tr>
<td>IE 4621</td>
<td>Computer Systems and Networks Lab.</td>
</tr>
<tr>
<td>IE 4630  *</td>
<td>Operating Systems (R. Suarez)</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>IE 4710</td>
<td>Ind. Manufacturing Processes (C. Miró)</td>
</tr>
<tr>
<td>IE 4720</td>
<td>Industrial Automation (A. Colón)</td>
</tr>
<tr>
<td>IE 4721</td>
<td>Industrial Automation Lab. (A. Colén)</td>
</tr>
<tr>
<td>IE 5410</td>
<td>Facilities Planning and Design (González)</td>
</tr>
<tr>
<td>IE 5415</td>
<td>Facilities Planning Design Project (González)</td>
</tr>
<tr>
<td>IE 5610</td>
<td>Industrial Systems Simulation (W. Fonseca)</td>
</tr>
<tr>
<td>IE 5620</td>
<td>MIS &amp; Security (M. Perez)</td>
</tr>
<tr>
<td>IE 5710</td>
<td>Process Instrumentation Control (A. Colón)</td>
</tr>
<tr>
<td>IE 5711</td>
<td>Process Instrumentation and Control Lab. (A. Colón)</td>
</tr>
<tr>
<td>IE 5720</td>
<td>Industrial Robotics Applications (A. Colón)</td>
</tr>
<tr>
<td>IE 5721</td>
<td>Industrial Robotics Lab. (A. Colón)</td>
</tr>
<tr>
<td>IE 5730</td>
<td>Material Handling Automation (González)</td>
</tr>
<tr>
<td>IE 5900</td>
<td>Capstone Design Course (González)</td>
</tr>
</tbody>
</table>

F:/godeoy/ABET IE 2001 Reports/Program relation of Curriculum outcomes (Tabla B)
APPENDIX C
Electrical Engineering

Some of the instruments used by the Electrical Engineering Department to gather data for the assessment of its program
Graduating Senior Exit Survey
Department of Electrical Engineering

GRADUATING SENIORS: For multiple choice questions, please indicate with a ✓ an answer that is closest/best. For other questions, provide your answers in the space provided. Use the reverse side of the page if you need more space.

1.- When do you expect to graduate? Please indicate month and year ________________________.

2.- When did you enter Polytechnic University of Puerto Rico's engineering program? Please state month and year ________________________.

3.- Did you transfer to PUPR from another college or university? Yes ____ No ____

4.- If you transferred, approximately how many credit-hours did you transfer into PUPR?
   a.  <25  
   b.  25<50  
   c.  >50

5.- Do you have an engineering job offer? If so how many? If none, state "none" and skip the next question.

6.- If you have accepted an engineering job offer, please provide the following information:
   a.  Company name: ____________________________
   b.  Salary range?
      - $30,000 or less ✓
      - $30,001-$40,000 ✓
      - $40,001-$50,000 ✓
      - $50,001-$60,000 ✓
      - $60,001-$70,000 ✓
      - >$70,000
   c.  Nature of the position?
      - Engineering/Technical ✓
      - Management ✓
      - Research and Development ✓
      - Other (please state) ____________________________

7.- Are you planning to attend graduate school? If NO, please skip the next question
   Yes ____ No ____

8.- If you are planning to attend graduate school, please provide the following information?
   University name ____________________________________________
   Department/Program _________________________________________
   Degree Sought ______________________________________________

Mathematics, science and engineering skills

9.- Please indicate with ✓ your proficiency in the following subject areas using a scale of 1 (Very weak) to 5 (Very strong):

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Very weak</th>
<th>Weak</th>
<th>Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics- Calculus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics-Linear, Matrix and Algebra</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability and Statistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Circuits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subject Area</td>
<td>Very weak 1</td>
<td>Weak 2</td>
<td>Average 3</td>
<td>Strong 4</td>
<td>Very Strong 5</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------</td>
<td>--------</td>
<td>-----------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>Computer Hardware</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermodynamics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Economics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Programming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numerical Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic Circuits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electromagnetic Theory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signals and Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Machinery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic Controls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microprocessors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algorithm Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysing and Interpreting data**

10.- Were topics on data analysis and interpretation discussed in any of your required courses? Please state these courses: If none, state "none".

11.- Please indicate with a ✓ your proficiency in analyzing and interpreting data using a scale of 1 (Very weak) to 5 (Very Strong):

- Very Weak
- Weak
- Average
- Strong
- Very Strong

**Designing and Conducting Experiments**

12.- Please mention courses in which you were introduced to experimental design. If none, state "none".

13.- Please indicate with a ✓ your proficiency in experimental design using a scale of 1 (Very weak) to 5 (Very Strong):

- Very Weak
- Weak
- Average
- Strong
- Very Strong

14.- Please mention courses in which you conducted experiments. If none, state "none".

15.- Please indicate with a ✓ your proficiency in conducting experiments using a scale of 1 (Very weak) to 5 (Very Strong):

- Very Weak
- Weak
- Average
- Strong
- Very Strong

**Design**

16.- Please mention courses in which you had any experience in designing systems, components, or processes. Include courses in which you were expected to address problems that were open-ended, required creativity to generate alternate solutions, and required you to select the best alternative in light of constraints and performance criteria.
17. Did your curriculum involve a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic, environmental, sustainability, manufacturability, ethical, health and safety, social and political? If so, state courses. If none, state "none".

18. In your opinion, did your curriculum include in-depth instruction to develop effective design solutions to problems in Electrical Engineering using appropriate analytical, computational and experimental practices?

**Problem Solving**

19. Please mention courses in which you learned how to identify, formulate, and solve engineering problems.

20. Please respond with a ✓ using a scale of 1 (Very weak) to 5 (Very Strong) your proficiency in identifying, formulating, and solving engineering problems.

- Very Weak
- Weak
- Average
- Strong
- Very Strong

**Team work**

21. Please mention courses in which you worked in teams. If none, state "none".

22. Please indicate with a ✓ your ability to function as a member of a team. Respond using a scale of 1 (Very Weak) to 5 (Very Strong):

- Very Weak
- Weak
- Average
- Strong
- Very Strong

**Professional and ethical responsibilities**

23. List all professional organizations and societies of which you are a member of. If none, state "none".

24. Did your mentor or any other faculty discuss the Fundamentals of Engineering Examination with you?

25. Are you planning to take the Fundamental of Engineering Examination? If so, when will you take it? If no, why not?

26. Please indicate with a ✓ your understanding of professionalism using a scale of 1 (Very weak) to 5 (Very Strong):

- Very Weak
- Weak
- Average
- Strong
- Very Strong

27. Please mention course numbers in which ethics were discussed. If none, state "none".

28. Please indicate with a ✓ your understanding of ethics in engineering practice using a scale of 1 (Very weak) to 5 (Very strong):

- Very Weak
- Weak
- Average
- Strong
- Very Strong

29. Approximately how many technical reports have you presented orally as part of your course work?

   a. 0
   b. 1-5
   c. 5-10
   d. More than 10

Page 3 of 3
30.- How would you rate your own oral communication ability. Please indicate with a ✓ using a scale of 1 (Very Weak) to 5 (Very Strong):

☐ Very Weak  ☐ Weak  ☐ Average  ☐ Strong  ☐ Very Strong

31.- Approximately how many technical reports have you written as part of course work?

a. 0  b. 1-5  c. 6-10  d. More than 10

32.- How would you rate your own written communication ability. Please indicate with a ✓ using a scale of 1 (Very weak) to 5 (Very Strong):

☐ Very Weak  ☐ Weak  ☐ Average  ☐ Strong  ☐ Very Strong

Global and Societal context

33.- List courses that helped you understand the impact of engineering solutions in a global context. If none, state “none”.

34.- How would you rate your understanding of the impact of engineering solution in a global context. Please indicate with a ✓ using a scale of 1 (Very weak) to 5 (Very strong):

☐ Very Weak  ☐ Weak  ☐ Average  ☐ Strong  ☐ Very Strong

35.- List courses you took that shaped your thinking of societal impact of engineering solutions. If none, state “none”.

36.- How would you rate your understanding of the impact of engineering solution in a societal context. Please indicate with a ✓ using a scale of 1 (Very weak) to 5 (Very strong):

☐ Very Weak  ☐ Weak  ☐ Average  ☐ Strong  ☐ Very Strong

Life-long Learning

37.- Which of the following statements would you agree with:

☐ I have reached the end of my education.
☐ My education will never end; my graduation just represents a milestone in my life-long educational journey.

38.- While at PUPR how many workshops, seminars, short courses or conferences did you attend that you were not otherwise required to take?

a. None  b. 1-5  c. 6-10  d. More than 10

39.- How would you rate your appreciation of the need for life-long learning. Please indicate with a ✓ using a scale of 1 (Very weak) to 5 (Very strong):

☐ Very Weak  ☐ Weak  ☐ Average  ☐ Strong  ☐ Very Strong

40.- How would you rate your ability to engage in life-long learning. Please indicate with a ✓ using a scale of 1 (Very weak) to 5 (Very strong):

☐ Very Weak  ☐ Weak  ☐ Average  ☐ Strong  ☐ Very Strong
### Engineering tools

41.- Please indicate your proficiency in the following tools of engineering practice using a scale of 1 (Very weak) to 5 (Very strong):

<table>
<thead>
<tr>
<th>Engineering Tools</th>
<th>Very weak</th>
<th>Weak</th>
<th>Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Programming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Graphics and drafting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software for Electrical element analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation Software</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spreadsheets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic mail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

42.- Are there any engineering tools you are aware of that you believe should be covered in your curriculum, but were ignored? If so, state these.

### Contemporary issues

43.- Were contemporary issues of importance to engineering discussed in any of your courses? If yes, list course numbers. If none, state "none".

44.- Which newspapers, periodicals, professional magazines or journals do you regularly read?

45.- Identify two contemporary issues of importance to the electrical engineer?

46.- How would you rate your knowledge of contemporary issues of importance to an engineer? Please indicate with a ✓ using a scale of 1 (Very weak) to 5 (Very strong):

- [ ] Very Weak
- [ ] Weak
- [ ] Average
- [ ] Strong
- [ ] Very Strong

### Overall

47.- Do you feel confident to practice as an engineer? Please indicate with a ✓ using a scale of 1 (Strongly disagree) to 5 (Strongly agree):

- [ ] Strongly Disagree
- [ ] Disagree
- [ ] Neutral
- [ ] Agree
- [ ] Strongly Agree

FPB/lrd/graduating senior exit survey

Page 5 of 5
EMPLOYER FEEDBACK SURVEY

Polytechnic University of Puerto Rico
Electrical Engineering Department

To be completed by the PUPR graduate(s) supervisor.

Please respond to the following questions. Please circle your best/closest choice.

1.- What is your primary responsibility at your company?
   a. Engineering  b. Management
   c. Human Resources
   d. Other (Please state): ____________________________

2.- Nature of your company's business:
   a. Manufacturing  b. Consulting
   c. Government  d. Distribution
   e. Construction  f. Service Organization
   g. Other (Please state): ____________________________

3.- How many Polytechnic University of Puerto Rico, Electrical Engineering graduates have you supervised in the past 5 years?
   a. 1-2  b. 3-5
   c. 5-10  d. More than 10

4.- Please check the type(s) of functions the Polytechnic University of Puerto Rico, Electrical Engineering graduates perform at your company:

   □ Administration  □ Manufacturing or process Operations
   □ Design and Analysis  □ Maintenance
   □ Customer Service  □ Marketing and Sales
   □ Other (Please state): ____________________________

5.- On average, how frequently do you have contact with employee?
   a. Daily  b. Several times a week
   c. Several times a month  d. Rarely
   e. Never
6.- How long have you known the employee?
   a. Less than a year  
   b. 2-3 years  
   c. 3-5 years  
   d. More than 5 years

7.- How do you rate Polytechnic University of Puerto Rico, Electrical Engineering graduates in relation to electrical engineers from other universities?
   a. Top 1% - 10%  
   b. Top 11% - 20%  
   c. Top 21% - 50%  
   d. Lower 50%

8.- Please rate the strength of a typical Polytechnic University of Puerto Rico, Electrical Engineering B.S. graduate in each of the following abilities. For each ability fill the box from 1 to 5 that most closely represents your own assessment.

<table>
<thead>
<tr>
<th>Ability</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to apply knowledge of mathematics, science, and engineering</td>
<td></td>
</tr>
<tr>
<td>to solve electrical engineering problems</td>
<td>(1)(2)(3)(4)(5)</td>
</tr>
<tr>
<td>Ability to design and conduct experiments, as well as analyze and</td>
<td></td>
</tr>
<tr>
<td>interpret data</td>
<td></td>
</tr>
<tr>
<td>Ability to design a system, component, or process to meet desired needs.</td>
<td></td>
</tr>
<tr>
<td>Ability to function on multi-disciplinary teams</td>
<td></td>
</tr>
<tr>
<td>Ability to identify, formulate, and solve engineering problems</td>
<td></td>
</tr>
<tr>
<td>Understanding professional and ethical responsibilities</td>
<td></td>
</tr>
<tr>
<td>Ability to communicate effectively</td>
<td></td>
</tr>
<tr>
<td>Broad education necessary to understand impact of engineering solutions in a global and societal context</td>
<td></td>
</tr>
<tr>
<td>Knowledge of Contemporary Issues</td>
<td></td>
</tr>
<tr>
<td>Recognition of need for and ability to engage in lifelong learning</td>
<td></td>
</tr>
<tr>
<td>Ability to use techniques, skills, and modern engineering tools</td>
<td></td>
</tr>
<tr>
<td>necessary for engineering practice</td>
<td></td>
</tr>
<tr>
<td>Capability to occupy positions as electrical engineers in Power,</td>
<td></td>
</tr>
<tr>
<td>Communication, Controls, Electronics or Computer Engineering.</td>
<td></td>
</tr>
<tr>
<td>Capability to pursue graduate studies in Electrical Engineering</td>
<td></td>
</tr>
</tbody>
</table>
 Approved Credits __________ Years of Study __________

Your feedback is important to our continuous improvement efforts. Please take a few minutes to complete this survey. Thank You.
Rate your agreement with the following Program Educational Objectives. Use the “Comments” section to provide additional information you understand could be useful for us. Feel free to specify if you think there are other objectives that should be included.

<table>
<thead>
<tr>
<th>Educational Objective</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>N/A or Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Educate electrical engineering students with a sense of timeliness, responsibility, ethical behavior, social awareness, and knowledge of current technological trends.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Provide electrical engineering students with experiences leading to the development of analytical thinking, problem solving capacity and desire for improvement in the short term and over their life long careers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Graduate engineers with background in electrical engineering fundamentals, advanced topics, and practical knowledge acquired through hands-on laboratory experience and industrial work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Provide engineering design experiences by means of open-ended projects worked in teams that include an information search, analysis of alternatives, proposal preparation, synthesis, socioeconomic and environmental evaluation, and long-term impact.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Provide electrical engineering students with the skills necessary in applying mathematics, physics, computers, fundamental and specialized engineering courses to enable them to work as electrical engineers or continue graduate studies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Improve the written and oral communications skills in English and/or Spanish so that upon graduation the student is able to communicate in a professionally acceptable manner.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Provide the electrical engineering students with the background necessary to pursue the fundamentals of engineering and professional exams.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. To sponsor academic organizations and extracurricular activities and to encourage and support innovation and creativity for the participation and benefit of the students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STUDENTS

Electrical Engineering Students are expected to have the following abilities/skills by the time they graduate. These skills are obtained through the whole electrical engineering curriculum. We are in the process of identifying if all these skills are well supported by our program. Please, take a few minutes to fill out the following matrix for the course you are currently enrolled. For every outcome, specify if you understand it is covered in the course and to what extent (S = Strong, M = Medium, W = Weak or NA = Outcome not significantly covered). Also, use the last column to comment on how the outcome is covered from your specific point of view, and provide examples if possible (i.e. if you say that the course applies knowledge of mathematics, specify in which topics, the type of problems and/or required mathematical background). Feel free to add comments you understand can enhance the quality of the education you are receiving at the end and/or back page of this questionnaire. Thanks.

<table>
<thead>
<tr>
<th>Course:</th>
<th>Student No:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome</th>
<th>S / M / W / NA</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.- Ability to apply knowledge of mathematics, science, and engineering.</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>b.- Ability to design and conduct experiments, as well as analyze and interpret data.</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

S = Strongly Covered / M = Well Covered / W = Weakly Covered / NA = Non Applicable or Non Significantly Covered
<table>
<thead>
<tr>
<th>Outcome</th>
<th>S / M / W / NA</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>c. - Ability to design a system, component, or process to meet desired needs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. - Ability to function on multidisciplinary teams.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. - Ability to identify, formulate, and solve engineering problems.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S = Strongly Covered / M = Well Covered / W = Weakly Covered / NA = Non Applicable or Non Significantly Covered
<table>
<thead>
<tr>
<th>Outcome</th>
<th>S / M / W / NA</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>f. Understanding of professional and ethical responsibility.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Ability to communicate effectively.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Broad education necessary to understand impact of engineering solutions in a global/societal context.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*S = Strongly Covered / M = Well Covered / W = Weakly Covered / NA = Non Applicable or Non Significantly Covered*
<table>
<thead>
<tr>
<th>Outcome</th>
<th>S / M / W / NA</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. - Knowledge of Contemporary Issues.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. - Recognition of need for and ability to engage in lifelong learning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k. - Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*S = Strongly Covered / M = Well Covered / W = Weakly Covered / NA = Non Applicable or Non Significantly Covered*
<table>
<thead>
<tr>
<th>Outcome</th>
<th>S / M / W / NA</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Capability to occupy positions as electrical engineers or pursue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>graduate studies.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional Comments:

S = Strongly Covered / M = Well Covered / W = Weakly Covered / NA = Non Applicable or Non Significantly Covered
**UNIVERSIDAD POLITÉCNICA DE PUERTO RICO**

**CUESTIONARIO PARA LA EVALUACIÓN FORMATIVA DE UN CURSO**

(Para ser completado por los estudiantes al final del curso)

<table>
<thead>
<tr>
<th>Significado de las puntuaciones:</th>
<th>Curso: ___________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - Completamente de acuerdo</td>
<td>Sección: ____________________</td>
</tr>
<tr>
<td>3 - Bastante de acuerdo</td>
<td>Profesor: ____________________</td>
</tr>
<tr>
<td>2 - Bastante en desacuerdo</td>
<td>Fecha: _______________________</td>
</tr>
<tr>
<td>1 - Completamente en desacuerdo</td>
<td></td>
</tr>
<tr>
<td>N/C - No puedo contestar; (no cuenta para puntos)</td>
<td></td>
</tr>
</tbody>
</table>

**Instrucciones:** Favor de marcar la columna que se acerca a cómo usted se siente

<table>
<thead>
<tr>
<th>Nro.</th>
<th>Descripción</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>N/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Al comenzar el curso, el (la) profesor (a) entregó y discutió un prontuario del curso y orientó a los estudiantes sobre los objetivos, contenido, métodos de enseñanza y los criterios de evaluación.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>La compra del libro de texto y de otros materiales requeridos estuvo ampliamente justificada por el uso que se le dio en el curso.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Los materiales utilizados en el curso están bien diseñados y ayudan a la comprensión de los temas del curso.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>El (La) profesor (a) utilizó el prontuario como guía para desarrollar el curso.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>El (La) profesor (a) asistió a la clase puntualmente.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>El (La) profesor (a) provee alternativas para cubrir el material de clase cuando no puede estar presente.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>El (La) profesor (a) domina el material del curso.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>El (La) profesor (a) prepara bien sus clases.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>El (La) profesor (a) explica claramente el material del curso.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>El (La) profesor (a) enfatiza los puntos importantes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>El (La) profesor (a) provee regularmente ejemplos apropiados para ayudar a los estudiantes a entender el material del curso.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>El trabajo fue distribuido adecuadamente a través del curso.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>El (La) profesor (a) ofrece exámenes y asigna trabajos a tono con el material cubierto en el curso y enfatizando los puntos importantes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>El (La) profesor (a) informa los resultados de los exámenes y otros trabajos realizados dentro de un período de tiempo razonable (2 semanas).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>El (La) profesor (a) discute los exámenes y trabajos con los estudiantes para aclarar las dudas y dificultades.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>El (La) profesor (a) utiliza variedad de métodos y técnicas de enseñanza.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>El (La) profesor (a) se expresa con claridad, propiedad y corrección.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>El (La) profesor (a) usa el pizarrón en forma legible y ordenada.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Polytechnic University of Puerto Rico
Electrical Engineering Department

Program Educational Objectives Evaluation - Industry Advisory Board

Your Feedback is important to our continuous improvement efforts, please take a few minutes to complete this survey. Thank you.

Rate your agreement with the following Program Educational Objectives:

<table>
<thead>
<tr>
<th>Educational Objective</th>
<th>Totally Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Totally Disagree</th>
<th>N/A or Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.- Educate electrical engineering students with a sense of timeliness, responsibility, ethical behavior, social awareness, and knowledge of current technological trends.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.- Provide electrical engineering students with experiences leading to the development of analytical thinking, problem solving capacity and desire for improvement in the short term and over their life long careers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.- Graduate engineers with background in electrical engineering fundamentals, advanced topics, and practical knowledge acquired through hands-on laboratory experience and industrial work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.- Provide engineering design experiences by means of open-ended projects worked in teams that include an information search, analysis of alternatives, proposal preparation, synthesis, socioeconomic and environmental evaluation and long-term impact.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.- Provide electrical engineering students with the skills necessary in applying mathematics, physics, computers, fundamental and specialized engineering courses to enable them to work as electrical engineers or continue graduate studies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.- Improve the written and oral communications skills in English and/or Spanish so that upon graduation the student is able to communicate in a professionally acceptable manner.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.- Provide the electrical engineering students with the background necessary to pursue the fundamentals of engineering and professional exams.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.- To sponsor academic organizations and extracurricular activities and to encourage and support innovation and creativity for the participation and benefit of the students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D
Mechanical Engineering

Some of the instruments used by the Mechanical Engineering Department to gather data for the assessment of its program
ALUMNI SURVEY

Employment Information:
1. Please indicate which of the following statements is applicable to your situation. Mark all that apply.
   ___ Employed full time (30 or more hours a week)    ___ Employed part time (less than 30 hours a week)
   ___ I am enrolled in graduate school          ___ Not employed

If you are NOT employed, skip to question 3.

2a. What is your present position?
2c. Where are you employed?
2d. What is your salary range? a. $20,000 or less    b. $20,001 - $25,000    c. $25,001 - $30,000    d. $30,001 - $35,000
   e. $35,001 - $40,000    f. $40,001 - $45,000    g. $45,001 - $50,000    h. >$50,000

First Time Employment
3. What was your first position after graduation?
4. How long after graduation did you obtain an engineering-related job?

Undergraduate Experience
5. How would you rate your overall satisfaction with your preparation to become an engineer? Please mark the box that best describes your opinion.
   Not                  A Little               Satisfied    Satisfied    Very
   Not                  A Little               Satisfied    Satisfied    Very
   □                    □                     □           □           □

6. How would you rate your preparation to obtain a job after graduation? Please mark the box that best describes your opinion.
   Not                  A Little               Satisfied    Satisfied    Very
   Not                  A Little               Satisfied    Satisfied    Very
   □                    □                     □           □           □

7. How would you rate your preparation to become a contributing member of society? Please mark the box that best describes your opinion.
   Not                  A Little               Satisfied    Satisfied    Very
   Not                  A Little               Satisfied    Satisfied    Very
   □                    □                     □           □           □

8. What do you consider to be the greatest strength of your undergraduate program?

9. What do you consider to be the greatest weakness of your undergraduate program?

10. What specific curriculum changes would you recommend? Why?

Graduate Studies & Professional Development
11. Are you currently enrolled or have you already completed a graduate program?        Yes        No
    If yes please indicate the Program and Institution:

12. After graduation, have you participated at least once a year in seminars, workshops or technical conferences?        Yes        No

13. Have you passed the Fundamentals of Engineering Examination? Yes No Haven't taken it

14. List your membership in professional organizations, if any.
EMPLOYER FEEDBACK SURVEY

As part of the assessment of our educational process, we conduct surveys at various stages of development of our students. This process follows the student after graduation and into the job environment. To help us in this task, please complete this survey and return it to Dr. Noemi Rivera, Placement Office Director, in the self addressed envelope. In the following questions, please circle your best/closest choice.

1. What is your primary responsibility at your company?
   a) Engineering 
   b) Management 
   c) Human Resources 
   d) Other (Please state)

2. Nature of your company business:
   a) Manufacturing 
   b) Consulting 
   c) Government 
   d) Distribution 
   e) Construction 
   f) Services 
   g) Other (Please state)

3. How many Polytechnic University of Puerto Rico graduates have you supervised in the past 5 years?
   a) 1-2 
   b) 3-5 
   c) 5-10 
   d) More than 10

4. Please check the type(s) of functions Polytechnic University of Puerto Rico graduates perform at your company:
   ____ Administration
   ____ Design and analysis
   ____ Customer service
   ____ Manufacturing or process operations
   ____ Maintenance
   ____ Marketing and sales
   ____ Other (Please state)

5. On the average, how frequently do you have contact with the employee?
   a) Daily 
   b) Several times a week 
   c) Several times a month 
   d) Rarely 
   e) Never

6. How long have you known the employee?
   a) Less than a year 
   b) 2-3 years 
   c) 3-5 years 
   d) More than 5 years

7. How do you rate Polytechnic University of Puerto Rico graduates in relation to engineers from other universities?
   a) Top 1% - 10% 
   b) Top 11% - 20% 
   c) Top 21% - 50% 
   d) Lower 50%
GRADUATING SENIORS: For multiple choice questions, please select an answer that is closest/best. For other questions, provide your answers in the space provided. Use the reverse side of the page if you need more space.

1. When do you expect to graduate? Please indicate month and year

2. When did you enter Polytechnic University of Puerto Rico's engineering program? Please state month and year

3. What is your Cumulative Grade Point Average?
   a. 2.00 - 2.50  b. 2.51 - 3.00  c. 3.01 - 3.50  d. 3.51 - 4.00

4. Did you transfer to PUPR from another college or university? a. Yes  b. No

5. If you transferred, approximately how many credit-hours did you transfer into PUPR?
   a. <10  b. 11-20  c. 21-30  d. 31-40
   e. 41-50  f. >50

6. What is your current age?
   a. <25  b. 25-30  c. 31-35  d. 36-40
   e. 41-45  f. 46-50  g. >50

7. Do you hold any certifications of professional registration?
   a. Professional Engineer  b. Engineering in Training
   c. Other (Please state)

8. Do you have a job offer? If so how many? If none, state "none" and skip the next question.
8. Please rate the strength of a typical Polytechnic University of Puerto Rico B.S. graduate in each of the following abilities. For each ability fill the box from 1 to 5 that most closely represents your own assessment.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very weak</td>
<td>Weak</td>
<td>About average</td>
<td>Strong</td>
<td>Very strong</td>
</tr>
<tr>
<td>a.</td>
<td>Applying knowledge of mathematics, science, and engineering to solve engineering problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Designing and conducting experiments as well as analyzing and interpreting data.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Designing a system, component, or process to meet desired needs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Functioning well on multi-disciplinary teams.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Identifying, formulating, and solving engineering problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Understanding professional and ethical responsibilities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td>Communicating effectively.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td>Understanding the impact of engineering solutions in a global and societal context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Recognizing the need for and having the ability to engage in lifelong learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td>Understanding contemporary engineering issues.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k.</td>
<td>Applying the techniques, skills, and modern engineering tools necessary for good engineering practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Please identify any areas of knowledge or skills that our graduates should have, but currently do not possess.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

10. What are the three most important things that you look for or your organization looks for when hiring new engineering graduates?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
9. If you have accepted a job offer, please provide the following information:
   
   i. Company name ________________________________

   ii. Salary range?
       a. $30,000 or less  b. $30,001-$40,000  c. $40,001-$50,000
       d. $50,000-$60,000 e. $60,001-$70,000  f. > $70,000

   iii. Nature of the position?
       d. Other (Please state) ________________________________

10. Are you planning to attend graduate school? If no, please skip the next question.

11. If you are planning to attend graduate school, please provide the following information?

   University name ________________________________
   Department/Program ________________________________
   Degree Sought ________________________________
   Type and amount of financial support ________________________________

12. Think about the best teacher you had at PUPR. What were the qualities of that teacher that you think should be emulated by other teachers?

13. Think about the worst teacher you had at PUPR. Please mention some characteristics of this teacher and his/her teaching style that should be improved by this teacher, and possibly other teachers?
Mathematics, science and engineering skills

14. Please indicate your proficiency in the following subject areas using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics-Calculus</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mathematics-Linear Algebra</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Probability and Statistics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Material Science</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electrical Circuits</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Statics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Strength of Materials</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ethics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computer Programming</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Manufacturing Processes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Stress Analysis</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mechanism Design</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Design of Machine Elements</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Measurements</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>System Dynamics and Mechtronics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mechatronics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Thermal Design</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Turbomachinery</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CAD/CAM</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Analyzing and interpreting data

15. Were topics on data analysis and interpretation discussed in any of your required courses? Please state these courses: if none, state "none".

16. Please indicate your proficiency in analyzing and interpreting data using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Designing and conducting experiments

17. Please mention courses in which you were introduced to experimental design. If none, state "none".

18. Please indicate your proficiency in experimental design using a scale of 1 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

19. Please mention courses in which you were introduced to designing, and setting up experimental apparatus. If none, state "none".

20. Please indicate your proficiency in designing, and setting up experimental apparatus using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

21. Please mention courses in which you actually conducted experiments to test a hypothesis. If none, state "none".
22. Please indicate your proficiency in conducting experiments using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Design

23. Please mention courses in which you had any experience in designing systems, components, or processes. Include courses in which you were expected to address problems that were open-ended, required creativity to generate alternate solutions, and required you select the best alternative in light of constraints and performance criteria.

24. Did your curriculum involve a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; social; and political? If so, state course number(s). If none, state “none”.

25. In your opinion, did your BSME curriculum include in-depth instruction to develop effective design solution to problems in mechanical engineering using appropriate analytical, computational and experimental practices?

26. Please mention courses in which you learned how to identify, formulate, and solve mechanical engineering problems focused on both thermal and mechanical systems.

27. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong) your proficiency in identifying, formulating, and solving mechanical engineering problems focused on both thermal and mechanical systems.

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
28. Please indicate your ability to function as a member of a team. Respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Problem solving

29. Please indicate your proficiency in solving problems using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Professional and ethical responsibilities

30. Are you a member of any professional society? Name all society memberships; if none, state "none".

31. Did your mentor or any other faculty discuss the Fundamentals of Engineering Examination with you?

32. Have you signed up to take the Fundamentals of Engineering Examination? If so, when will you take it? If no, why not?

33. Please indicate your understanding of professionalism using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

34. Please mention course numbers in which ethics was discussed. If none, state "none".
35. Please indicate your understanding of ethics in engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Communication skills

36. Approximately how many technical reports have you presented orally as part of your course work?
   a. 0  b. 1-5  c. 6-10  d. more than 10

37. How would you rate your own oral communication ability. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

38. Approximately how many technical reports have you written as part of course work?
   a. 0  b. 1-5  c. 6-10  d. more than 10

39. How would you rate your own written communication ability. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Global and societal context

40. List courses that helped you to understanding the impact of engineering solutions in a global context. If none, state "none".
41. How would you rate your understanding of the impact of engineering solution in a global context. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

42. List courses you took that shaped your thinking of societal impact of engineering solutions. If none, state “none”

43. How would you rate your understanding of the impact of engineering solution in a societal context. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**Life-Long Learning**

44. Which of the following statements would you agree with:

i. I have reached the end of my education

ii. My education will never end; my graduation just represents a milestone in my life-long educational journey.

45. How many workshops, seminars, short courses did you attend that you were not otherwise required to take?

(a) None  (b) 1-5  (c) 6-10  (d) more than 10

46. How would you rate your appreciation of the need for life-long learning. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
47. How would you rate your ability to engage in life-long learning. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Engineering Tools

48. Please indicate your proficiency in the following tools of engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Engineering Tools</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming in FORTRAN, C, C++, Visual Basic, MATLAB, MATHCAD</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computer graphics and drafting in AUTOCAD or similar software</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Software for mechanism and finite element analysis</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Word Processing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electronic mail</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Internet research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

49. Are there any engineering tools you are aware of that you believe should be covered in your curriculum, but were ignored? If so, state these.
Contemporary issues

50. Were contemporary issues of importance to mechanical engineers discussed in any of your courses? If yes, list course numbers. If no, state “none”.

51. Which newspapers, periodicals, professional magazines or journals do you read regularly?

52. Can you identify two contemporary issues of importance to the mechanical engineer?

53. How would you rate your knowledge of contemporary issues of importance to a mechanical engineer?

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Overall

54. Do you feel confident to practice as a mechanical engineer? Please respond using a scale of 1 (Strongly disagree) to 5 (Strongly Agree):

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Student Survey
Mechanical Engineering Capstone Experience
Spring 2000

Please respond to each of the following statements by filling the box from 1 to 5 corresponding to your degree of agreement with the statement using the scale given below. Note: Your responses will not affect your grade in this course and are anonymous. Items 27-33 are program-specific.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>totally disagree</td>
<td>disagree</td>
<td>neither</td>
<td>agree</td>
<td>totally disagree</td>
</tr>
<tr>
<td>nor agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on my experience in this course and in preceding courses:

1. I am confident in my abilities to apply my knowledge of mathematics to solve mechanical engineering problems
   
2. I am confident in my abilities to apply my knowledge of science to solve mechanical engineering problems
   
3. I am confident in my abilities to apply my knowledge of engineering to solve mechanical engineering problems
   
4. I am confident in my abilities to design and conduct statistically valid experiments and to interpret the data
   
5. I am confident in my abilities to function on multidisciplinary teams
   
6. I am constantly aware of team process and dynamics for good team performance
   
7. I am able to reinforce and support ideas from team members
   
8. I am able to negotiate agreements and handle conflict
   
9. I am able to encourage open discussion of ideas
   
10. I am able to work for and accept consensus or compromise
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>I am able to plan work and set goals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>I am able to stay on task toward a timely completion of goals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>I am able to define and apply a systematic approach to tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I am able to communicate effectively with persons from other disciplines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>I am confident of my ability to identify, formulate, and solve engineering problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>I am able to define an engineering problem in succinct terms which express its essential elements and needed context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>I am able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>I am able to use organized methods of comparing alternative solutions to problems to evaluate and evolve progressively better solutions before final selection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>I am able to &quot;sell&quot; my ideas or design solutions by effective technical presentations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>I am able to &quot;sell&quot; my ideas or design solutions by effective written reports</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>I am confident in my abilities to be aware of the issues I will likely face in my career and to make ethical decisions and to behave responsibly in all aspects of my occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>I am confident in my understanding of the impact of engineering solutions in a global and societal context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>I have begun a plan for remaining current in my field</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>I have acquired a knowledge of contemporary issues relevant to my field, including energy conservation and the environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
25. I have demonstrated an ability to use effectively techniques, skills, and modern engineering tools necessary for engineering practice

26. I am confident in my abilities to apply knowledge of chemistry

27. I am confident in my abilities to apply knowledge of calculus-based physics

28. I am confident in my abilities to apply knowledge of statistics

29. I am confident in my abilities to apply knowledge of linear algebra

30. I am confident in my abilities to apply knowledge of advanced mathematics through multivariate calculus and differential equations

31. I am confident in my abilities to work professionally in both thermal and mechanical systems areas

32. I am able to design and perform the realization of thermal and mechanical systems

33. I am confident in my abilities to apply knowledge of contemporary analytical, computational, and experimental practices to solve mechanical engineering problems focused on both thermal and mechanical systems areas
Capstone Course Faculty Rating Survey
Department of Mechanical Engineering
Spring 2000

Course No. ____________  Section ______  Number of students ______

Course Title ____________________________

Number of students working in team ____  Team sizes ____  ____  ____  ____

Number of students working individually ____

Number of defined projects ____

Please respond to each of the following statements by filling the box from 1 to 5 corresponding to your degree of agreement with the statement using the scale below.

NOTE: your responses will be used for outcomes assessment of this program, which includes a number of courses and experiences leading to this capstone experience. It is expressly not for assessment of your performance as an instructor in this course.


<table>
<thead>
<tr>
<th></th>
<th>1 totally disagree</th>
<th>2 disagree</th>
<th>3 neither disagree nor agree</th>
<th>4 agree</th>
<th>5 totally agree</th>
</tr>
</thead>
</table>

Based on my observation of student work in this course:

1. These students were able to apply their knowledge of mathematics to solve mechanical engineering problems.  
   
2. These students were able to apply their knowledge of science to solve mechanical engineering problems.  
   
3. These students were able to apply their knowledge of engineering to solve engineering problems.  
   
4. These students were able to design and conduct statistically valid experiments and to interpret the data.  
   
5. These students were able to function on multi-disciplinary teams.  
   

6. These students realized the importance of being constantly aware of team process and dynamics for good team performance.

7. These students were able to reinforce and support ideas from various team members.

8. These students were able to negotiate agreements and handle conflict constructively.

9. These students practiced encouraging open discussion of ideas.

10. These students worked for and accepted consensus or compromise.

11. These students were able to plan work and set goals effectively.

12. These students were able to stay on task toward a timely completion of goals.

13. These students were able to define and apply a systematic approach to tasks.

14. These students were able to communicate effectively with persons from other disciplines.

15. These students were able to identify, formulate, and solve engineering problems.

16. These students were able to define an engineering problem in succinct terms that expressed its essential elements and needed context.

17. These students were able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem.
18. These students demonstrated abilities to use organized methods of comparing alternative solutions to problems to evaluate and evolve progressively better solutions before final selection.

19. These students were able to "sell" their ideas or design solutions by effective technical presentations.

20. These students were able to "sell" their ideas or design solutions by effective written reports.

21. These students exhibited awareness of issues that they will likely face in their careers and seemed able and ready to make ethical decisions and to behave responsibly in all aspects of their occupations.

22. These students exhibited a good understanding of the impact of engineering solutions in a global and societal context.

23. These students showed commitment to life-long learning in their profession and have begun plans for remaining current in their fields.

24. These students demonstrated knowledge of contemporary issues relevant to their fields, including energy conservation and the environment.

25. These students demonstrated an ability to use effectively techniques, skills, and modern engineering tools necessary for engineering practice.

26. These students were able to apply knowledge of chemistry.

27. These students were able to apply knowledge of calculus-based physics.

28. These students were able to apply knowledge of statistics.

29. These students were able to apply knowledge of linear algebra.
30. These students were able to apply knowledge of advanced mathematics through multivariate calculus and differential equations.

31. These students were able to work professionally in both thermal and mechanical systems areas.

32. These students were able to design and perform the realization of thermal and mechanical systems.

33. These students were able to apply knowledge of contemporary analytical, computational, and experimental practices to solve mechanical engineering problems focused on both thermal and mechanical systems areas.
GRADUATING SENIORS: For multiple choice questions, please select an answer that is closest/best. For other questions, provide your answers in the space provided. Use the reverse side of the page if you need more space.

1. When do you expect to graduate? Please indicate month and year

2. When did you enter Polytechnic University of Puerto Rico's engineering program? Please state month and year

3. What is your Cumulative Grade Point Average?
   a. Less than 2.00   b. 2.00 - 2.50   c. 2.51 - 3.00   d. 3.01 - 3.50   e. 3.51 - 4.00

4. Did you transfer to PUPR from another college of university? a. Yes   b. No
   If yes, indicate Institution:

5. If you transferred, approximately how many credit-hours did you transfer into PUPR?
   a. Less than 25   b. 25-50   c. More than 50

6. What is your current age?
   a. <25   b. 25-30   c. 31-35   d. 36-40
   e. 41-45   f. 46-50   g. >50

7. Do you have an engineering job offer? If so, how many? If none, state “none” and skip the next question?
Environmental Engineering Program
Course Evaluation Survey

For the Civil and Environmental Engineering Department it is important to know how well prepared do you feel to pursue the profession of engineering and to identify the stages of the program in which you developed certain skills and levels of understanding. Your answers to this survey will help the Department in identifying areas of the Environmental Engineering Program that need improvement.

Please state your level of agreement to the following statements:

**RATING SCALE**
A = Totally Agree  B = Agree  C = Neutral  D = Disagree  E = Totally Disagree

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I was prepared to take this course.</td>
<td></td>
</tr>
<tr>
<td>2. This was an important course for my professional development.</td>
<td></td>
</tr>
<tr>
<td>3. This was an exciting and intellectually stimulating course.</td>
<td></td>
</tr>
<tr>
<td>4. I am satisfied with the course content.</td>
<td></td>
</tr>
</tbody>
</table>

Please indicate how well you think this course prepared you in each of the following areas:

**RATING SCALE**
A = Excellent  B = Very Well  C = Well  D = Not Very well  E = Not At All

<table>
<thead>
<tr>
<th>Ability</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. An ability to apply knowledge of mathematics, probability and statistics, science, and engineering to solve environmental engineering related problems.</td>
<td></td>
</tr>
<tr>
<td>6. An ability to design and perform experiments, to gather, analyze, and interpret data.</td>
<td></td>
</tr>
<tr>
<td>7. An ability to apply process modeling techniques and to design environmental control systems, components, or processes to meet desired needs.</td>
<td></td>
</tr>
<tr>
<td>8. An ability to work in groups and to interact with other disciplines.</td>
<td></td>
</tr>
<tr>
<td>9. An ability to develop an engineering judgement in order to identify, formulate, and solve fundamental engineering problems.</td>
<td></td>
</tr>
<tr>
<td>10. A comprehension of professional and ethical principles.</td>
<td></td>
</tr>
<tr>
<td>11. An ability to communicate orally, in writing, and graphically in an effective way.</td>
<td></td>
</tr>
<tr>
<td>12. The broad education necessary to understand the impact of engineering solutions in a global and societal context.</td>
<td></td>
</tr>
<tr>
<td>13. An awareness of the need for, and an ability to learn independently and to engage in life-long learning.</td>
<td></td>
</tr>
<tr>
<td>14. A knowledge of contemporary issues related to environmental engineering.</td>
<td></td>
</tr>
<tr>
<td>15. An ability to use the techniques, skills, and modern engineering tools necessary or practicing environmental engineering.</td>
<td></td>
</tr>
<tr>
<td>16. Proficiency in analysis and design in any of the following areas: water supply engineering, wastewater engineering, air pollution and control, solid waste management, hazardous waste management, occupational safety and health, environmental toxicology, and environmental impact assessment.</td>
<td></td>
</tr>
<tr>
<td>17. An understanding of the roles and the responsibilities of public institutions and private organizations in environmental management.</td>
<td></td>
</tr>
<tr>
<td>18. An understanding of the safety and environmental consequences of their work as environmental engineers.</td>
<td></td>
</tr>
<tr>
<td>19. A knowledge of waste minimization and pollution prevention concepts.</td>
<td></td>
</tr>
</tbody>
</table>

Comments:
APPENDIX E
Environmental Engineering

Some of the instruments used by the Civil and Environmental Department to gather data for the assessment of this program
Project Scoring Rubric for Final Project Presentations
Department of Mechanical Engineering
Fall 2000

This instrument can be used by teams of faculty and industrial observers present for final presentations of the Capstone project. The results of the ratings will be compiled for assessment of the course progress and of certain program goals.

Date ___________________ Scorer Name: _______________________________________

Scorer Title: _________________________________________________________________

Scorer Company or Affiliation: _________________________________________________

Team Name or identifier: _______________________________________________________

Project Title: _________________________________________________________________

Please respond to each of the following statements by filling the box from 1 to 5 corresponding to your degree of agreement with the statement using the scale below.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>totally disagree</td>
<td>disagree</td>
<td>neither disagree nor agree</td>
<td>agree</td>
<td>totally agree</td>
</tr>
</tbody>
</table>

Based on my observation of the team's final oral presentation: 1 2 3 4 5

1. These students were able to apply knowledge of mathematics, science, and engineering to solve engineering problems. □ □ □ □ □

2. These students were able to function effectively on multidisciplinary teams. □ □ □ □ □

3. These students were able to plan work and set and meet goals effectively. □ □ □ □ □

4. These students were able to identify, formulate, and solve engineering problems. □ □ □ □ □

5. These students were able to "sell" their ideas or design solutions by effective technical presentations. □ □ □ □ □

6. These students exhibited a good understanding of the impact of engineering solutions in a global and societal context. □ □ □ □ □
23. These students showed commitment to life-long learning in their profession, and have begun plans for remaining current in their fields.

24. These students demonstrated knowledge of contemporary issues relevant to their fields, including energy conservation and the environment.

25. These students demonstrated an ability to use effectively techniques, skills, and modern engineering tools necessary for engineering practice.

26. These students were able to apply knowledge of chemistry.

27. These students were able to apply knowledge of calculus-based physics.

28. These students were able to apply knowledge of statistics.

29. These students were able to apply knowledge of linear algebra.

30. These students were able to apply knowledge of advanced mathematics through multivariate calculus and differential equations.

31. These students were able to work professionally in both thermal and mechanical systems areas.

32. These students were able to design and perform the realization of thermal and mechanical systems.

33. These students were able to apply knowledge of contemporary analytical, computational, and experimental practices to solve mechanical engineering problems focused on both thermal and mechanical systems areas.
Please respond to each of the following statements by filling the box from 1 to 5 corresponding to your degree of agreement with the statement using the scale below. Note: Your responses will not affect your grade in this course and are anonymous. Items 27-33 are program-specific.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>totally disagree</td>
<td>disagree</td>
<td>neither disagree</td>
<td>agree</td>
<td>totally disagree</td>
</tr>
<tr>
<td></td>
<td>disagree</td>
<td>disagree</td>
<td>disagree</td>
<td>agree</td>
<td>disagree</td>
</tr>
</tbody>
</table>

Based on my observation of student work on this course:

1. These students were able to apply their knowledge of mathematics to solve mechanical engineering problems.

2. These students were able to apply their knowledge of science to solve mechanical engineering problems.

3. These students were able to apply their knowledge of engineering to solve mechanical engineering problems.

4. These students were able to design and conduct statistically valid experiments and to interpret the data.

5. These students were able to function on multi-disciplinary teams.

6. These students realized the importance of being constantly aware of team process and dynamics for good team performance.

7. These students were able to reinforce and support ideas from various team members.

8. These students were able to negotiate agreements and handle conflict constructively.

9. These students practiced encouraging open discussion of ideas.

10. These students worked for and accepted consensus or compromise.
How well defined was the project to the students?

To what degree do you feel that the goals of the project were achieved?

Please identify any stumbling blocks to successful project completion which were encountered by the student team, but not necessarily of their own responsibility:

Did you review the final written report? _____ If so, please comment on the final written report quality:

Did you attend the final project presentation? _____ If so, please comment on the quality of the final oral presentation:
Industrial Coach or Project Contact/Sponsor Survey
Mechanical Engineering Capstone Design Course

This survey is to be filled out for each project sponsored by an industrial partner by the company contact person responsible for the project.

CONFIDENTIAL - This survey will be used to assess the outcomes of various courses and experiences up to and including this capstone experience. It will affect neither the grade of students in this course nor the evaluation of the instructor's performance in the course.

Dear (industrial sponsor or project coach):

We appreciate the time you contribute to our engineering program by filling out this survey. Please be assured that your responses will help us in assessing our degree of success in meeting our strategic goals and in meeting the requirements of ABET criteria. We want your honest and thoughtful feedback that only you can give on the project in which you were involved.

Project Title: ________________________________

Date project completed: ________________________________

Company Sponsoring project: ________________________________

Person completing survey: ________________________________

Title: ________________________________

Number of students in project team: ________________________________

Disciplines of students: ________________________________

Approximately how often did you meet with the student team or with its representatives? ________________________________

Approximately how often did you have other forms of communication (identify) with the students? ________________________________

______________________________

______________________________
27. This student was able to apply knowledge of calculus-based physics.

28. This student was able to apply knowledge of statistics.

29. This student was able to apply knowledge of linear algebra.

30. This student was able to apply knowledge of advanced mathematics through multivariate calculus and differential equations.

31. This student was able to work professionally in both thermal and mechanical systems areas.

32. This student was able to design and perform the realization of thermal and mechanical systems.

33. This student was able to apply knowledge of contemporary analytical, computational, and experimental practices to solve mechanical engineering problems focused on both thermal and mechanical systems areas.
16. This student was able to define an engineering problem in succinct terms that expressed its essential elements and needed context.

17. This student was able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem.

18. This student demonstrated abilities to use organized methods of comparing alternative solutions to problems to evaluate and evolve progressively better solutions before final selection.

19. This student was able to "sell" their ideas or design solutions by effective technical presentations.

20. This student was able to "sell" their ideas or design solutions by effective written reports.

21. This student exhibited awareness of the issues which they will likely face in the career and seemed able and ready to make ethical decisions and to behave responsibly in all aspects of their occupations.

22. This student exhibited a good understanding of the impact of engineering solutions in a global and societal context.

23. This student showed commitment to life-long learning in their profession, and has begun plans for remaining current in the field.

24. This student demonstrated knowledge of contemporary issues relevant to the field, including energy conservation and the environment.

25. This student demonstrated an ability to use effectively techniques, skills, and modern engineering tools necessary for engineering practice.

26. This student was able to apply knowledge of chemistry.
Based on my observation of this team member's work on this project:

1. This student was able to apply knowledge of mathematics to solve mechanical engineering problems.

2. This student was able to apply knowledge of science to solve mechanical engineering problems.

3. This student was able to apply knowledge of engineering to solve mechanical engineering problems.

4. This student was able to design and conduct statistically valid experiments and to interpret the data.

5. This student was able to function effectively on our multidisciplinary team.

6. This student realized the importance of being constantly aware of team process and dynamics for good team performance.

7. This student was able to reinforce and support ideas from various team members.

8. This student was able to negotiate agreements and handle conflict constructively.

9. This student practiced encouraging open discussion of ideas.

10. This student worked for and accepted consensus or compromise.

11. This student was able to plan work and set goals effectively.

12. This student was able to stay on task toward a timely completion of goals.

13. This student was able to define and apply a systematic approach to tasks.

14. This student was able to communicate effectively with persons from other disciplines.

15. This student was able to identify, formulate, and solve engineering problems.
CONFIDENTIAL Student Peer Survey
Mechanical Engineering Capstone Experience
Spring 2000

To the student:

Please take the time to provide feedback to the members of your project team in this course by filling out this survey form. You may be asked to complete this survey several times for each team member during the course term. Your ratings and comments will be relayed anonymously to each team member along with those of other team members for the purpose of improvement and program assessment.

This particular survey will be used only for the purpose of getting anonymous information back to your team members for their personal development plan and for overall outcome assessment of the success of the capstone experience in this engineering program. It will not be used as a part of any student's grade unless explicitly so stated in place of this paragraph. Also, any feedback you receive on your performance will be treated confidentially as well.

Please respond truthfully and constructively. If you rate a student particularly high or particularly low, then you should feel obligated to mention in the comments section some specific example of behavior which illustrates the basis for your opinion.

Team name or team identifier: ______________________________________

Team member being rated: ______________________________________

Please rate this team member on each of the following statements by filling the box from 1 to 5 corresponding to your degree of agreement with the statement for that team member using the scale below.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>totally disagree</td>
<td>disagree</td>
<td>neither agree</td>
<td>disagree nor agree</td>
<td>totally disagree</td>
</tr>
</tbody>
</table>
8. If you have accepted a job offer, please provide the following information:
   i. Company name _____________________________
   ii. Salary range?
      a. $30,000 or less    b. $30,001-$40,000    c. $40,001-$50,000
      d. $50,000-$60,000  e. $60,001-$70,000  f. > $70,000
   iii. Nature of the position?
        d. Other (Please state) _____________________________

9. Are you planning to attend graduate school? If no, please skip the next question.

10. If your are planning to attend graduate school, please provide the following information?

    University name _____________________________

    Department/Program _____________________________

    Degree Sought _____________________________

11. Think about the best teacher you had at PUPR. What were the qualities of that teacher that you think should be emulated by other teachers?

12. Think about the worst teacher you had at PUPR. Please mention some characteristics of this teacher and his/her teaching style that should be improved by this teacher, and possibly other teachers?
Mathematics, science and engineering skills

13. Please indicate your proficiency in the following subject areas using a scale of 1 (Very Weak) to 5 (Very Strong): 

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electrical Circuits</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ethics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fluid Mechanics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Material Science</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Mechanics of Materials</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Statics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Numerical Methods</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Water Supply Engineering</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Wastewater Engineering</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Air Pollution</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Solid Waste Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Hazardous Waste Management</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Occupational Safety and Health</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Toxicology</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Impact Assessment</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Analyzing and interpreting data

14. Were topics on data analysis and interpretation discussed in any of your required courses? Please state these courses: if none, state "none".

15. Please indicate your proficiency in analyzing and interpreting data using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Designing and conducting experiments

16. Please mention courses in which you were introduced to designing and conducting experimental design. If none, state "none".

17. Please indicate your proficiency in experimental design using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

18. Please mention courses in which you conducted experiments. If none, state "none".

19. Please indicate your proficiency in conducting experiments using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
20. Please mention courses in which you had any experience in designing systems, components, or processes. Include courses in which you were expected to address problems that were open-ended, required creativity to generate alternate solutions, and required you to select the best alternative in light of constraints and performance criteria.

21. Did your curriculum involve a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustain ability; manufacturability; ethical; health and safety; and social? If so, state course. If none, state "none".

22. In your opinion, did your curriculum include in-depth instruction to develop effective design solution to problems in engineering using appropriate analytical, computational and experimental practices?

Problem Solving

23. Please mention courses in which you learned how to identify, formulate, and solve mechanical engineering problems.

24. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong) your proficiency in identifying, formulating, and solving engineering problems.

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Teamwork

25. Please mention courses in which you worked in teams? If none, state "none".

26. Please indicate your ability to function as a member of a team. Respond using a scale of 1 (Very Weak) to 5 (Very Strong):
Professional and ethical responsibilities

27. List all professional societies of which you are a member. If none, state “none”.

28. Did your advisor or any other faculty discuss the Fundamentals of Engineering Examination with you?

29. Are you planning to take the Fundamental of Engineering Examination? If so, when will you take it? If no, why not?

30. Please indicate your understanding of professionalism using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

31. Please mention courses in which ethics was discussed. If none, state “none”.

32. Please indicate your understanding of ethics in engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

33. Approximately how many technical reports have you presented orally as part of your course work?
34. How would you rate your own oral communication ability. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

35. Approximately how many technical reports have you written as part of course work?

| a. 0 | b. 1-5 | c. 6-10 | d. more than 10 |

36. How would you rate your own written communication ability. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

37. List courses that helped you understand the impact of engineering solutions in a global and societal context. If none, state "none".

38. How would you rate your understanding of the impact of engineering solution in a global context. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

39. Which of the following statements would you agree with:

i. I have reached the end of my education
ii. My education will never end; my graduation just represents a milestone in my life-long educational journey.

40. While at PUPR, how many workshops, seminars, short courses or conferences did you attend that
you were not otherwise required to take?

(a) None    (b) 1-5    (c) 6-10    (d) more than 10

41. How would you rate your appreciation of the need for life-long learning. Please respond using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Engineering Tools

42. Please indicate your proficiency in the following tools of engineering practice using a scale of 1 (Very Weak) to 5 (Very Strong):

<table>
<thead>
<tr>
<th>Engineering Tool</th>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Programming</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Computer graphics and drafting in AUTOCAD or similar software</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Wordprocessing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electronic mail</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Internet research</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

43. Are there any engineering tools you are aware of that you believe should be covered in your curriculum, but were ignored? If so, state these.

Contemporary issues

44. Were contemporary issues of importance to civil engineers discussed in any of your courses? If yes, list course numbers. If no, state "none".
45. Which newspapers, periodicals, professional magazines or journals do you read regularly?

46. Identify two contemporary issues of importance to the environmental engineering.

47. How would you rate your knowledge of contemporary issues of importance to an engineer?

<table>
<thead>
<tr>
<th>Very Weak</th>
<th>Weak</th>
<th>About Average</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Overall

48. Do you feel confident to practice as an engineer? Please respond using a scale of 1 (Strongly disagree) to 5 (Strongly Agree):

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
APPENDIX F
Capstone Experience Assessment Instruments
Instruments A to E

This is a comprehensive set of instruments developed by the Southeastern University and College Coalition for Engineering Education (SUCCEED) to gather data for the assessment of the Capstone Design Project. PUPR recommends its use in each program.
INSTRUMENT A
Capstone Experience
Student Survey

Please respond to each of the following statement by writing a number (at left) from 1 to 5 corresponding to your degree of agreement with the statement using the scale below.

(NOTE: YOUR RESPONSES WILL NOT AFFECT YOUR GRADE IN THIS COURSE AND ARE ANONYMOUS).

Asterisked (*) items indicate program-specific goal questions.)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>totally disagree</td>
<td>disagree</td>
<td>neither agree</td>
<td>agree nor disagree</td>
<td>totally agree</td>
</tr>
</tbody>
</table>

Based on my experience in this course and in preceding courses:

_____ 1. I am confident in my abilities to apply my knowledge of mathematics to solve engineering problems.

_____ 2. I am confident in my abilities to apply my knowledge of science to solve engineering problems.

_____ 3. I am confident in my abilities to apply knowledge of engineering to solve engineering problems.

_____ 4. I am confident in my abilities to design and conduct statistically valid experiments and to interpret the data.

_____ 5. I am confident in my abilities to design full and fractional factorial experiments, conduct them, and to interpret the results.

_____ 6. I am confident in my abilities to function on multi-disciplinary teams.

_____ 7. I am constantly aware of team process and dynamics for good team performance.

_____ 8. I am able to reinforce and support ideas from team members.

_____ 9. I am able to negotiate agreements and handle conflict.

_____ 10. I am able to encourage open discussion of ideas.

_____ 11. I am able to work for and accept consensus or compromise.
12. I am able to plan work and set goals.

13. I am able to stay on task toward a timely completion of goals.

14. I am able to define and apply a systematic approach to tasks.

15. I am able to communicate effectively with persons from other disciplines.

16. I am confident of my ability to identify, formulate, and solve engineering problems.

17. I am able to define an engineering problem in succinct terms which express its essential elements and needed context.

18. I am able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solution to a problem.

19. I am able to use organized methods of comparing alternative solutions to problems (such as the Pugh method) to evaluate and evolve progressively better solution before final selection.

20. I am able to "sell" my ideas or design solutions by effective technical presentations.

21. I am able to "sell" my ideas or design solutions by effective written reports.

22. I am confident in my abilities to be aware of the issues I will likely face in my career and to make ethical decisions and to behave responsibly in all aspects of my occupation.

23. I am confident in my understanding of the impact of engineering solutions in a global and societal context.

24. I have begun a plan for remaining current in my field.

25. I have acquired a knowledge of contemporary issues relevant to my field, including energy conservation and the environment.

26. I have demonstrated an ability to use effectively tools of 3D modeling including Pro-engineer software.

27. I have demonstrated an ability to use effectively tools of finite element modeling including IDEAS software.

28. I have demonstrated an ability to use effectively tools of project planning including Microsoft Project.

29. I have demonstrated an ability to use effectively tools of business process re-engineering including Process Mapping using Benchmark software.
INSTRUMENT B
Capstone Course or Experience
Faculty Course Instructor or Coach Survey

Course No. ______ Section ______ Number of students ______

Course Title ____________________________________________________________

Number of students working in teams ______ team sizes ______, ______, ______
Number of students working individually ______

Number of industrially defined projects ______

Other faculty working on this course section with you:

_____________________________________________________________________

_____________________________________________________________________

Please respond to each of the following statements by writing a number (at left) from 1 to 5 corresponding to your degree of agreement with the statement using the scale below.

(NOTE: your responses will be used for outcomes assessment of this program, which includes a number of courses and experiences leading to this capstone experience. It is expressly not for assessment of your performance as an instructor in this course.)

Asterisked (*) items indicate program-specific

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>totally disagree (or untrue of most students)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>neither agree nor agree (or true of about half of most students)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>totally agree (or true of virtually every student)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Based on my observation of student work in this course,

1. These students were able to apply their knowledge of mathematics to solve engineering problems.

2. These students were able to apply their knowledge of science to solve engineering problems.

3. These students were able to apply their knowledge of engineering to solve engineering problems.

4. These students were able to design and conduct statistically valid experiments and to interpret the data.

5. These students were able to design full and fractional factorial experiments. Conduct them, and to interpret the results.

6. These students were able to function on multi-disciplinary teams.
7. These students realized the importance of being constantly aware of team process and dynamics for good team performance.

8. These students were able to reinforce and support ideas from various team members.

9. These students were able to negotiate agreements and handle conflict constructively.

10. These students practiced encouraging open discussion of ideas.

11. These students worked for and accepted consensus or compromise.

12. These students were able to plan work and set goals effectively.

13. These students were able to stay on task toward a timely completion of goals.

14. These students were able to define and apply a systematic approach to tasks.

15. These students were able to communicate effectively with persons from other disciplines.

16. These students were able to identify, formulate, and solve engineering problems.

17. These students were able to define an engineering problem in succinct terms which expressed its essential elements and needed context.

18. These students were able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem.

19. These students demonstrated abilities to use organized methods of comparing alternatives solutions to problems (such as the Pugs method) to evaluate and evolve progressively better solutions before final selection.

20. These students were able to “sell” their ideas or design solutions by effective technical presentations.

21. These students were able to “sell” their ideas or design solutions by effective written reports.

22. These students exhibited awareness of the issues which they will likely face in their careers and seemed able and ready to make ethical decisions and to behave responsibly in all aspects of their occupations.

23. These students exhibited a good understanding of the impact of engineering solutions in a global and societal context.

24. These students showed commitment to life-long learning in their profession, and have begun plans for remaining current in their fields.
25. These students demonstrated a knowledge of contemporary issues relevant to their fields, including energy conservation and the environment.

26. These students demonstrated an ability to use effectively tools of 3D modeling including Pro-engineer software.

27. These students demonstrated an ability to use effectively tools of finite element modeling including IDEAS software.

28. These students demonstrated an ability to use effectively tools of project planning including Microsoft Project.

29. These students demonstrated an ability to use effectively tools of business process re-engineering including Process Mapping use Benchmarking software.
INSTRUMENT C
Capstone Course or Experience
Industrial Coach or Projects Contact/Sponsor Survey

(To be filled out for each project sponsored by industrial partner by the company contact person responsible for the project.)

CONFIDENTIAL – THIS SURVEY WILL BE USED TO ASSESS THE OUTCOMES OF VARIOUS COURSES AND EXPERIENCES UP TO AND INCLUDING THIS CAPSTONE EXPERIENCE. IT WILL NOT AFFECT THE GRADE OF STUDENTS IN THIS COURSE NOR THE EVALUATION OF THE INSTRUCTOR’S PERFORMANCE IN THIS COURSE.

Dear (industrial sponsor or project coach):

We appreciate the time you contribute to our engineering program by filling out this survey. Please be assured that your responses will help as in assessing our degree of success in meeting our strategic goals and in meeting the requirements of ABET criteria. We want your honest and thoughtful feedback which only you can on the project in which you were involved.

Project Title

________________________________________

Date project completed

________________________________________

Company Sponsoring project

________________________________________

Person completing survey

________________________________________

Title

________________________________________

Number of students in project team:

________________________________________

Disciplines of students (if known)

________________________________________

Approximately how often did you have other forms of communication (identify) with the students?

________________________________________

How well defined was the projects to the students?

________________________________________

To what degree do you feel that the goals of the project were achieved?

________________________________________

________________________________________

________________________________________
Please identify any stumbling blocks to successful project completion which were encountered by the student team, but not necessarily of their own responsibility:

____________________________________________________

____________________________________________________

Did you review the final written report? ______ If so, please comment on

____________________________________________________

____________________________________________________

Please respond to each of the following statement by writing a number (at left) From 1 to 5 corresponding to your degree agreement with the statement Using the scale below.

Asterisked (*) items indicate program-specific goal questions.)

<table>
<thead>
<tr>
<th>1 totally disagree</th>
<th>2 neither</th>
<th>3 agree</th>
<th>4 (or true of students)</th>
<th>5 (or true of virtually all students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(or untrue of most)</td>
<td>(or true of about half)</td>
<td>(or true agree of most)</td>
<td>of virtually every student)</td>
<td></td>
</tr>
</tbody>
</table>

(Please enter NA in the blank if you have no basis for any observation or opinion for that statement)

Based on my observation of student work on this project:

______ 1. These students were able to apply their knowledge of mathematics to solve engineering problems.

______ 2. These students were able to apply their knowledge of science to solve engineering problems.

______ 3. These students were able to apply their knowledge of engineering to solve engineering problems.

______ 4. These students were able to design and conduct statistically valid experiments and to interpret the data.

______ 5. These students were able to design full and fractional factorial experiments. Conduct them, and to interpret the results.

______ 6. These students were able to function on multi-disciplinary teams.

______ 7. These students realized the importance of being constantly aware of team process and dynamics for good team performance.
8. These students were able to reinforce and support ideas from various team members.

9. These students were able to negotiate agreements and handle conflict constructively.

10. These students practiced encouraging open discussion of ideas.

11. These students worked for and accepted consensus or compromise.

12. These students were able to plan work and set goals effectively.

13. These students were able to stay on task toward a timely completion of goals.

14. These students were able to define and apply a systematic approach to tasks.

15. These students were able to communicate effectively with persons from other disciplines.

16. These students were able to identify, formulate, and solve engineering problems.

17. These students were able to define an engineering problem in succinct terms which expressed its essential elements and needed context.

18. These students were able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem.

19. These students demonstrated abilities to use organized methods of comparing alternatives solutions to problems (such as the Push method) to evaluate and evolve progressively better solutions before final selection.

20. These students were able to "sell" their ideas or design solutions by effective technical presentations.

21. These students were able to "sell" their ideas or design solutions by effective written reports.

22. These students exhibited awareness of the issues which they will likely face in their careers and seemed able and ready to make ethical decisions and to behave responsibly in all aspects of their occupations.

23. These students exhibited a good understanding of the impact of engineering solutions in a global and societal context.

24. These students showed commitment to life-long learning in their profession, and have begun plans for remaining current in their fields.

25. These students demonstrated a knowledge of contemporary issues relevant to their fields, including energy conservation and the
*26. These students demonstrated an ability to use effectively tools of 3D modeling including Pro-engineer software.

*27. These students demonstrated an ability to use effectively tools of finite element modeling including IDEAS software.

*28. These students demonstrated an ability to use effectively tools of project planning including Microsoft Project.

*29. These students demonstrated an ability to use effectively tools of business process re-engineering including Process Mapping use Benchmarker software.
INSTRUMENT D
Capstone Experience
CONFIDENTIAL Student Peer Survey

(NOTE: this survey may be administered on the WWW if appropriate security measures are taken, providing advantages of easy and timely response back to the team members after perusal by a faculty member to disallow flaming of any team member).

To the student:

Please take the time to provide feedback to the members of your project team in this course By filling out this survey form. You may be asked to complete this survey several times for Each team member during the course term. Your ratings and comments will be relayed Anonymously to each team member along with those of other team members for the purpose Of improvement and program assessment.

This particular survey will be used only for the purpose of getting anonymous information Back to your team members for their personal development plan and for overall outcome Assessment of the success of the capstone experience in this engineering program. It will not Be used as a part of any student's grade unless explicitly so stated in place of this paragraph. Also, any feedback you receive on your performance will be treated confidentially as well.

Please respond truthfully and constructively. If you rate a student particularly high or Particularly low, then you should feel obligate to mention in the comments section some Specific example of behavior which illustrate the basis for your opinion.

Anonymous Peer feedback on Team Member's performance on team project.

Team member completing this rating (not reported to person being rated):

________________________________________

Team name or team identifier: ___________________________________________________

Team member being rated: _______________________________________________________

Please rate this team member on each of the following statements by writing a Number (at left) from 1 to 5 corresponding to your degree of agreement with the Statement for that member using the scale below.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>totally disagree</td>
<td>disagree</td>
<td>neither agree nor agree</td>
<td>agree</td>
<td>totally agree</td>
<td></td>
</tr>
</tbody>
</table>

(Please enter NA in the blank if you have no basis for any observation or opinion for that statement)

Based on my observation of this team member's work on this project:

_____ 1. This student was able to apply their knowledge of mathematics to solve engineering problems.

_____ 2. This student was able to apply their knowledge of
science to solve engineering problems.

3. This student was able to apply their knowledge of engineering to solve engineering problems.

4. This student was able to design and conduct statistically valid experiments and to interpret the data.

5. This student was able to design full and fractional factorial experiments. Conduct them, and to interpret the results.

6. This student was able to function on multi-disciplinary teams.

7. This student realized the importance of being constantly aware of team process and dynamics for good team performance.

8. This student was able to reinforce and support ideas from various team members.

9. This student was able to negotiate agreements and handle conflict constructively.

10. This student practiced encouraging open discussion of ideas.

11. This student worked for and accepted consensus or compromise.

12. This student was able to plan work and set goals effectively.

13. This student was able to stay on task toward a timely completion of goals.

14. This student was able to define and apply a systematic approach to tasks.

15. This student was able to communicate effectively with persons from other disciplines.

16. This student was able to identify, formulate, and solve engineering problems.

17. This student was able to define an engineering problem in succinct terms which expressed its essential elements and needed context.

18. This student was able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem.

19. This student demonstrated abilities to use organized methods of comparing alternatives solutions to problems (such as the Pugh method) to evaluate and evolve progressively better solutions before final selection.

20. This student was able to "sell" their ideas or design
solutions by effective technical presentations.

21. This student was able to "sell" their ideas or design solutions by effective written reports.

22. This student exhibited awareness of the issues which they will likely face in their careers and seemed able and ready to make ethical decisions and to behave responsibly in all aspects of their occupations.

23. This student exhibited a good understanding of the impact of engineering solutions in a global and societal context.

24. This student showed commitment to life-long learning in their profession, and have begun plans for remaining current in their fields.

25. This student demonstrated a knowledge of contemporary issues relevant to their fields, including energy conservation and the environment.

26. This student demonstrated an ability to use effectively tools of 3D modeling including Pro-engineer software.

27. This student demonstrated an ability to use effectively tools of finite element modeling including IDEAS software.

28. This student demonstrated an ability to use effectively tools of project planning including Microsoft Project.

29. This student demonstrated an ability to use effectively tools of business process re-engineering including Process Mapping use Benchmarker software.
INSTRUMENT E
Project Scoring Rubric for Final Project Presentation

This instrument can be used by teams of faculty and industrial observers present for final presentations of the Capstone project. It is deliberately concise in order to be scored in two minutes or so, once that is a reasonable amount of time in which to ask scores of such presentations to do their evaluations. Typically two or three teams may present per hour, and the results of the ratings compiled for assessment of the course progress and certain program goals.

Date __________________ Score Name: ________________________________

Score Title ________________________________________________________

Score Company or Affiliation __________________________________________

Team Name or identifier: _____________________________________________

Project Title _________________________________________________________

Please respond to each of the following statements by writing a number (at left) from 1 to 5 corresponding to your degree of agreement with the statement using the scale below.

Asterisked (*) items indicate program-specific

1. These students were able to apply to function effectively on mathematics, science, and engineering to solve engineering problems.

6. These students were able to function effectively on multi-disciplinary team.

12. These students were able to plan work and set meet goals effectively.

16. These students were able to identify, formulate, and solve engineering problems.

20. These students were able to “sell” their ideas or design solutions by effective technical presentations.

(Please enter NA in the blank if you have no basis for any observation or opinion for that statement)
23. These students exhibited a good understanding of the impact of engineering solutions in a global and societal context.

*29. These students demonstrated an ability to use effectively tools of business process re-engineering including Process Mapping using Bechmarker software.
APPENDIX G
Portfolio Assessment Instruments

This is a comprehensive set of instruments developed by the Southeastern University and College Coalition for Engineering Education (SUCCEED). The purpose is to gather data for the assessment of the student portfolios. These may be required at any or all course. PUPR recommends the extensive use of portfolios in every course, particularly the engineering ones.
Portfolio Guidelines for Engineering Problems Solving and Design Courses

This instrument was developed by the Foundation Coalition: Integrated Engineering Program Maricopa County Community College District (MCCCD)
Portfolio Guidelines

Why use portfolios?
We will be learning many new concepts and acquiring many new skills in our engineering courses and other courses as we pursue the academic career. Although test scores do provide us, the student, and the faculty member with information on how the students are doing and what they are learning, this information gives a limited view of what they know and how they can perform.

In the Engineering Problem Solving and Design courses the student will be introduced to the problem solving and design process while they are applying the use of the technology tools that were presented in previous courses. They will also be taught more in depth about how to work together effectively in teams. Throughout the courses they will be learning and applying communication and social skills that are necessary to work successfully in teams.

A portfolio will help them demonstrate their knowledge and skills in:
- computer modeling
- solving equations
- using communication skills
- social skills in the context of work groups or teams
- practicing effective group roles
- problem solving
- giving presentations
- self-evaluation abilities
Directions

Please follow these directions carefully. Your completed portfolio will be a unique product. No two will be alike. In addition to being a self-assessment measure for you, it will be used in assessing your progress and work in the course.

Begin organizing now by collecting of your work or activities done in or outside of class. You may also include examples of work from your course as evidence when you are showing your growth in a particular area. Use expandable folders to help you collect and organize your work and your thoughts. These folders can contain divider sheets that identify each of the student performance goals you are expected to demonstrate in your class portfolio.

These goals are:

Goal I: Students will demonstrate increased appreciation and motivation for lifelong learning.

Goal II: Students will demonstrate increased ability to be an effective team member.

Goal III: Students will demonstrate increased oral, written, and graphical communication skills.

Goal IV: Students will demonstrate increased ability to appropriately integrate knowledge from different disciplines to define problems, develop and evaluate alternative solutions, and specify appropriate solutions.

We will meet several times during the quarter to exchange ideas and suggestions on how you can “show what you know” most effectively. Faculty members and peer tutors will be available to assist you in this project. You will have a product at the end of the course which you can be proud of.
Section I

Goal I: Students will demonstrate increased appreciation and motivation for Lifelong learning.

Include in this section:

A. A cover sheet. Be creative.
B. A reflective essay (one to three pages in length) that includes:
   1. Your definition of lifelong learning and how you project for yourself a life of learning activities.
   2. A description of any activities or events that you may have participated as a student or outside of school that have contributed to your personal or professional growth.
   3. A discussion of how you acquire new knowledge (in and out of school) and how you approach new experiences.
   4. At least three pieces of evidence or proof that support your involvement in lifelong learning experiences or events. This might include:
      - Learning journal entries;
      - Self-reports of extracurricular activities;
      - Reports of attendance seminars with guest;
      - Speakers, attendance at special concerts or presentations;
      - Things you have done on your own to develop personally or professionally.
Section II

Goal II: Students will demonstrate increased ability to be an effective team member.

Include in this section:

___ A. A cover sheet. Be creative.
___ B. A reflective essay (one to three pages in length) that includes.
   1. How you see yourself participating in groups. Discuss how you keep a group on-task, work to resolve conflict, strive for group consensus, support other team members, and participate in group activities or the development of ideas.
   2. A discussion of your speaking and listening skills when working in teams or groups. Do you avoid interruptions or speak in turn? Do you ask appropriate question, offer suggestions, options, or ideas? Do you start, join, maintain, or finish conversations?
   3. A description of some your relevant experiences with groups or teams you may have worked with during the year. Where you challenged? How did your skills change?
   4. A description of any areas where you feel you need to improve in order to be an effective team member.
   5. Included at least three pieces of evidence or proof that support you involvement and growth in this area. This might include:
      • Team or Partner Assessment check sheets;
      • Self-reports of listening, speaking, or participation skills;
      • Focused learning journal entries related to being an effective team member.
Section III

Goal III: Students will demonstrate increased oral, written, and Graphical communication skills.

Include in this section:

    A. A cover sheet. Be creative.
    B. A reflective essay (one to three pages in length) that includes.
        1. A description of the manner in which you communicate and present
           Your ideas to others verbally. Discuss your ability to respond to questions and
           comments, use audience-appropriate language, vocal clarity, professional
           demeanor, and content presentation.
        2. A discussion of the manner in which you communicate present your ideas to
           Others in writing. Discuss the changes in your ability to present information
           clearly, use correct grammar, spelling, and punctuation, and incorporate
           research material to support your concepts.
        3. A summary of the manner in which you communicate and present your ideas
           to others graphically. Discuss the changes in your ability to use graphic
           methods to present data, concepts, and equations, solve problems using
           graphical representations, and express ideas in two and three dimensions.
        4. Some reflective comments on how you see yourself as a communicator.
           Discuss how you think your communication skills have improved this year,
           where you would like to see more growth, and any steps you have taken or
           want to take to make those improvements.
        5. Include at least three pieces of evidence or proof that support your
           involvement and growth in this area. This might include:
           • Design projects;
           • Videos of you and your team;
           • Faculty gratings or rating;
           • Assignments that required use of graphics;
           • Peered/or faculty check sheets;
           • Learning journal entries;
           • Assignments is that show the use of any of the communication skills;
Section IV

Goal IV: Students will demonstrate increased ability to appropriately integrate knowledge from different disciplines to define problems, develop and evaluate alternative solutions, and specify appropriate solutions.

Include in this section:

A. A cover sheet. Be creative.

B. A reflective essay (one to three pages in length) that includes:
   1. A description of what you have learned in English, communications, math physics,
   2. A discussion of how knowledge of communication and team skill have been useful in engineering problem solving and design.
   3. Explanations of instances when you have integrated what you have learned in class to solve problems outside of the classroom in your everyday life.
   4. A description of how your growth in communication skills and social skills have affected your relationship at work outside of school.
   5. Include at least pieces of evidence or proof that support your involvement and growth in this area. This might include:
      • Design projects that required you to use several knowledge areas;
      • Examples of course assignments where concepts or problems from two or more different disciplines were integrated into a particular lesson;
      • A self report about how you have integrated different pieces of knowledge from your course work outside of class.
Show what you know!

Remember, we will meet several times during the quarter to exchange ideas and suggestions on how you can "show what you know" most effectively. Faculty members and peer tutors will be available to assist you in this project.

Grading your portfolio

You can earn up to 100 points on your portfolio; 39/100 points will be for general presentation. This includes items such as appearance, organization, elements of good writing, originality and creativity, cover page, table of contents, introduction, and summary.

Section I is worth a total of 13 points; Sections II, III, and IV are worth a total of 16 points each. All these sections combined total points. In a few weeks you will be given a detailed handout which describes the breakdown of those points fully and clearly. The scoring of your portfolio closely follows these guidelines.
Portfolio Scoring Rubrics

This instrument was developed by the Foundation Coalition: Integrated Engineering Program Maricopa County Community College District (MCCCD)

Polytechnic University of Puerto Rico
San Juan, Puerto Rico
Rubrics

Items with a maximum of 1 point are scored:

1 = Yes
0 = No

Items with a maximum of 3 points are scored using the following scale:

3 = Exhaustive, complete, and well-developed response. Student draws on examples from personal experience to provide elaboration and richness to key points. Shows a high degree of self-reflection and self-assessment. Response shows evidence that the student has transferred or generalized knowledge or conceptual understanding and is indicative of an exceptional level of student progress and development.

2 = Satisfactory response. Student explains through example and provides some elaboration of key points. Some self-reflection and self-assessment. Some transfer and generalization. Response shows evidence of good student progress and development.

1 = Marginally acceptable response. May be missing some components; ideas and/or examples are generally underdeveloped. Weak evidence of self-reflection and self-assessment. Student does not transfer or generalize knowledge or understanding. Indicative of marginal student progress and development.

0 = No response or response shows no evidence of understanding of the area. Little or no self-reflection, self-assessment, transfer, or generalization. Indicative of poor student progress and development.
<table>
<thead>
<tr>
<th>Appearance</th>
<th>General Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1</td>
<td>Is the portfolio neat and visually attractive?</td>
</tr>
<tr>
<td></td>
<td>Is the material in the portfolio presented in a logical</td>
</tr>
<tr>
<td></td>
<td>Sequence/arrangement?</td>
</tr>
<tr>
<td>0 1</td>
<td>Elements of Good Writing</td>
</tr>
<tr>
<td>0 1</td>
<td>Is the writing free from grammar and spelling errors?</td>
</tr>
<tr>
<td></td>
<td>Does the text flow and is the writing clear?</td>
</tr>
<tr>
<td></td>
<td>Does the cover page include:</td>
</tr>
<tr>
<td>0 1</td>
<td>a title</td>
</tr>
<tr>
<td>0 1</td>
<td>student's name</td>
</tr>
<tr>
<td>0 1</td>
<td>the names and codes of the courses and the quarter</td>
</tr>
<tr>
<td>0 1</td>
<td>college name</td>
</tr>
<tr>
<td>0 1</td>
<td>instructors' names</td>
</tr>
<tr>
<td>0 1</td>
<td>date</td>
</tr>
<tr>
<td></td>
<td>Table of Contents</td>
</tr>
<tr>
<td>0 1</td>
<td>Does the table contents include:</td>
</tr>
<tr>
<td>0 1</td>
<td>Page numbers</td>
</tr>
<tr>
<td>0 1</td>
<td>titles or descriptions of content pages</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
</tr>
<tr>
<td></td>
<td>Does the introduction essay include:</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>reflective statements about the course (what the student learned, how</td>
</tr>
<tr>
<td></td>
<td>the student feels he/she improved, likes/dislikes, etc.)</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>description about the learning process experience when</td>
</tr>
<tr>
<td></td>
<td>putting together the portfolio</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>an introduction to the student</td>
</tr>
<tr>
<td></td>
<td>Originality/Creativity</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>Does the portfolio contain unusual or interesting pieces of</td>
</tr>
<tr>
<td></td>
<td>evidence?</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>Are the reflection portions particularly insightful?</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>Is the presentation of the portfolio in general exceptionally attractive,</td>
</tr>
<tr>
<td></td>
<td>interesting, or unique?</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>Does the summary essay include:</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>highlights of what the student enjoyed and learned the most about</td>
</tr>
<tr>
<td></td>
<td>during the year</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>highlights of what the student would like to pursue</td>
</tr>
<tr>
<td></td>
<td>further study in</td>
</tr>
<tr>
<td>0 1 2 3</td>
<td>statements about what the student might like to see changed or</td>
</tr>
<tr>
<td></td>
<td>improved</td>
</tr>
</tbody>
</table>

*Total points for general presentation __________ of 39 possible*
Section I

Goal I: Students will demonstrate increased appreciation and motivation for lifelong learning.

Does Section I include:

- A cover sheet: 1

A reflection essay that includes:

1. A definition of lifelong learning and what this means.
2. A description of any activities or events that the student may have participated in at school or outside of school that have contributed to personal and professional growth.

3. A discussion of how the student acquires new knowledge (in and out of school) and how he or she approaches new experiences.

4. At least three pieces of evidence or proof that supports the student’s involvement in lifelong learning experiences or events. This might include:
   - Learning journal entries;
   - Self-reports of extracurricular activities
   - Reports of attendance at seminars with guest
   - Speakers, attendance at special concerts or presentations
   - Things you have done on your own to develop personally or professionally

Total points for Section I _______ of 13 possible
Section II

Goal II:  Students will demonstrate increased ability to be an effective team member.

Does Section II include:

1. A cover sheet
2. A reflective essay that includes:

   1. A description of how the student participates in groups by keeping a group on-task, working to resolve conflicts, striving for group consensus, supporting other team members, and developing ideas.

   2. A discussion of the student's speaking and listening skills when leading in items or groups. Does the student describe how to pay attention/avoid interruptions, paraphrase thoughts, feelings, and emotions, or how others use body language to communicate? Does the student avoid interruptions, speak in turn, ask appropriate questions, offer suggestions, options, or ideas? Does the student start, join, maintain, or finish conversations?

   3. A description of some relevant experiences with groups or teams during the year. Were challenges and areas of growth identified?

   4. A description of any areas that needed improvement in order to be a more effective team member.

   5. At least three pieces of evidence or proof that supports involvement and growth in this area. This might include:
      - Team or Partner Assessment check, sheets;
      - Self-reports of listening, speaking, or participation skills;
      - Learning journal entries related to being an effective team member.

---

Total points for Section II _______ of 16 possible
Section III

Goal III: Students will demonstrate increased oral, written, and graphical communication skills.

- Does Section II include:
  - A cover sheet
  - A reflective essay that includes:
    1. A description of how the student communicates and presents ideas to others verbally. Does the discussion talk about ability to respond to questions and comments, use audience-appropriate language, vocal clarity, professional demeanor, and content presentation.
    2. A description of how the student communicates and presents ideas to others in writing. Does the student present information clearly, use correct grammar, spelling, and punctuation, and incorporate research material to support his/her concepts?
    3. A summary of the manner in which the student communicates and presents ideas to others graphically does the student discuss ability to use graphic methods to present data, concepts, and equations, solve problems using graphical representations, and express ideas in two and three dimensions?
    4. Reflective comments on how the students sees himself/herself as a communicator. Is there a discussion about how the student thinks communication skills have improved this year, where the student would like to see more growth, and how to make improvement?
    5. At least three pieces of evidence or proof that supports involvement and growth in this area. This might include:
       - Peer and/or faculty check sheets
       - Videos of the student and his/her team
       - Faculty gratings of ratings
       - Design projects
       - Learning journal entries
       - Assignments that show the use of any communication skills
       - Assignments that required use of graphics

Total points for Section III _______ of 16 possible
Section IV

Goal IV: Students will demonstrate increased ability to appropriately integrate knowledge from different disciplines to define problems, develop and evaluate alternative solutions, and specify appropriate solutions.

Does Section IV include:

0 1 1
A cover sheet
A reflective essay that includes:

0 1 2 3
1. A description of what the student learned in English, communications, math, physics, chemistry, or any other courses and how this helped in the engineering course work.

0 1 2 3
2. A discussion of how knowledge of communication and team skills have been useful in engineering problem solving and design.

0 1 2 3
3. Examples of instances when the student has integrated what was learned in class to solve problems outside of the classroom in everyday life.

0 1 2 3
4. A description of growth in communication skills and social skills and how this affected the student’s relationships at work or outside of school.

0 1 2 3
5. Include at least three pieces of evidence or proof that supports involvement and growth in this area. This might include:

- Design projects where the student used several knowledge areas to complete design
- Examples of course assignments where concepts or problems from two or more different disciplines were integrated into a particular lesson (Math, physics, chemistry, engineering, communications, English)
- A self-report about how the student has integrated different pieces of knowledge from his/her course work outside of class

Total points for Section III _____ of 16 possible
Totals

/39 | Total points for general presentation

/13 | Total points for Section I

/16 | Total points for Section II

/16 | Total points for Section III

/16 | Total points for Section IV

/100 | GRAND TOTAL

Faculty/Reader Comments:
APPENDIX H
Alumni Survey

This is a comprehensive and well thought instruments developed by the North Carolina State University (NCSU), a member of the South eastern University and College Coalition for Engineering Education (SUCCEED), to gather data from the alumni for the assessment of outcomes.
Polytechnic University of Puerto Rico
ALUMNI SURVEY

Directions to complete each question: Use a No. 2 pencil only • Do not use ink, ball-point, or felt-tip pens • Make heavy black marks that fill in the bubbles completely • Erase clearly any marks you wish to change • Do not make stray marks on this form • Do not fold, tear, or mutilate this form.

Section I
Professional Preparation
In the first column, please fill in the appropriate bubble to indicate how important each area is in your current professional position, including graduate studies. Next, in the second column, indicate how well you think you were prepared in each area through your program of study at PUPR.

<table>
<thead>
<tr>
<th>Importance to your current work?</th>
<th>How well were you prepared by PUPR?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Important</td>
<td>Important</td>
</tr>
<tr>
<td>Excellent Preparation</td>
<td>Good Preparation</td>
</tr>
</tbody>
</table>

1. Communication skills overall
   a. Written communications skills
   b. Public speaking and presentation skills
   c. Reading skills
   d. Listening skills

2. Overall technical knowledge

3. Overall knowledge of computer applications
   a. Basic computer skills (word processing, etc.)
   b. Technical computer skills (programming, etc.)

4. Ability to apply scientific principles

5. Ability to apply mathematical skills

6. Foreign language skills

7. Ability to work in teams

8. Leadership and management skills

9. Using knowledge to solve problems overall
   a. Planning projects
   b. Defining problems
   c. Solving problems
   d. Thinking creatively
   e. Bringing information/ideas together from different areas

10. Skills gained through research or internship experience

11. Traits overall
   a. Professionalism
   b. Conducting work activities in an ethical manner
   c. Resourcefulness
   d. Confidence in your ability to perform well

12. Work attitudes and skills overall


Section II
Goals of Undergraduate Education
This group of items consists of a set of goals developed at PUPR for undergraduate education.
In the first column, please indicate how important these are to you now as goals for an undergraduate education. Use the scale provided.
In the second column, please indicate how satisfied you are that your undergraduate education at PUPR met each goal listed below. Use the scale provided.

<table>
<thead>
<tr>
<th>Importance</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Important</td>
<td></td>
</tr>
<tr>
<td>Important</td>
<td></td>
</tr>
<tr>
<td>Moderately Important</td>
<td></td>
</tr>
<tr>
<td>Of Limited Importance</td>
<td></td>
</tr>
<tr>
<td>Not Important</td>
<td></td>
</tr>
<tr>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Excellent Preparation</td>
<td></td>
</tr>
<tr>
<td>Good Preparation</td>
<td></td>
</tr>
<tr>
<td>Average Preparation</td>
<td></td>
</tr>
<tr>
<td>Fair Preparation</td>
<td></td>
</tr>
<tr>
<td>Poor Preparation</td>
<td></td>
</tr>
<tr>
<td>Not Applicable</td>
<td></td>
</tr>
</tbody>
</table>

14. Acquiring a broad general education
15. Ability to critically analyze events, information, and ideas
16. Ability to understand current literature in my field
17. Awareness of new scientific knowledge and discoveries
18. Having tolerance for different points of view
19. Understanding how science and technology influence everyday life
20. Recognizing and acting upon ethical principles
21. Being involved in public and community affairs
22. Understanding issues and problems facing the world
23. Understanding the present as it relates to historical events/processes
24. Valuing racial equity
25. Valuing gender equity
26. Developing a commitment to personal health and fitness
27. Viewing learning as a lifelong process
28. Advancing my appreciation of the arts, music, and literature ......................................................... O O O O O O O O O O
29. Understanding my own abilities and interests ................................................................. O O O O O O O O O O
30. Preparing for a career .................................................................................................................. O O O O O O O O O O

Section III
General Education Preparation
Please share your opinions on the general education preparation you gained at PUPR. For items 31-37, please indicate the extent to which you agree or disagree with each statement by filling in the bubble which best describes your opinion.

31. Through my experiences at PUPR, I know how to access and use the information I need in my professional positions ................................................................. O O O O O O O O O O
32. While at PUPR, I made new friends with people from different countries background than mine ........................................................................................................... O O O O O O O O O O
33. My social science courses at PUPR have provided knowledge and insights useful to my professional activities .................................................................................. O O O O O O O O O O
34. My undergraduate experiences and courses at PUPR encouraged me to think creatively and innovatively ................................................................................................. O O O O O O O O O O
35. My education at PUPR has prepared me to be competitive with graduates from other institutions .................................................................................................................. O O O O O O O O O O
36. Foreign language courses at PUPR have helped me gain an appreciation of other cultures .......................................................................................................................... O O O O O O O O O O
37. To keep in touch with current events, I frequently read newspapers and magazines ......................................................................................................................... O O O O O O O O O O

38. On average, how frequently do you read for leisure? (excluding newspaper and magazines)
   O a. More than 3 times per week
   O b. 1-3 times per week
   O c. 1-3 times per month
   O d. Less than once a month
   O e. Seldom
   O f. Not at all
39. What three recommendations would you make to the PUPR for ways to improve undergraduates experiences at PUPR

a. 

b. 

c. 

40. What services would you value from PUPR (Mark all that apply.)
O a. Alumni seminars and short courses in your discipline
O b. Career Planning and Placement assistance
O c. Getting El Politécnico
O d. Hearing about events in your area
O e. Reunions
O f. Other (please specify): ____________________________

Section IV
Further Education Plans

41. What is your current status with regard to graduate/professional study?
O a. Have not applied
O b. Have applied
O c. Have been accepted
O d. Am currently enrolled (please skip to item 43)
O e. Have already completed (please skip to item 43)

42. If you are not currently enrolled or have not already completed a graduate/professional degree, what is your level of interest in continuing your education through graduate/professional school?
O a. High interest
O b. Moderate interest
O c. Low interest
O d. Not interested at all

43. If you have been accepted, are currently enrolled, or have already completed a graduate/professional degree, please indicate the name of that institution:
Institution name and location:

______________________________

Academic discipline and degree sought or completed:

______________________________
Section V
Employment

44. While at PUPR did you participate in any of the following work-related experiences? (Mark all that apply.)
   O a. Cooperative Education Program
   O b. Research
   O c. Internship
   O d. Summer employment or part-time job in major
   O e. Did not participate in any of these experiences

45. If so, was that experience helpful in securing your present position of employment?
   O a. Yes
   O b. No
   O c. Not applicable

46. In your search for a job, which one resource did you find most useful? (fill in only one bubble.)
   O a. PUPR faculty member(s)
   O b. Family, friends, or acquaintances
   O c. Direct contact with employer
   O d. Professional associations
   O e. Employment Security Commission
   O f. College career fair
   O g. Career Planning and Placement Center
   O h. Private employment agency
   O i. Computer search service
   O k. Other (please specify): ________________

47. How long did it take you to get your first full-time permanent job after completing your bachelor’s degree?
   O a. Had same job before completing degree
   O b. Accepted position upon graduation
   O c. 1-6 months
   O d. 7-12 months
   O e. Over 1 year
   O f. Have not yet obtained a full-time permanent job
   O g. Not applicable (student or other reasons)

48. What is your current employment status? (Fill in the one most applicable bubble.)
   O a. Employment full-time (35+ hours per week)
   O b. Employment part-time (34 hours per week or less)
   O c. Unemployed, but seeking employment
   O d. Unemployed, not seeking employment
   O e. Student not seeking employment

If you are presently employed, please complete items 49-56. If you are not presently employed, this

49. a. If you are employed outside your major field of study, is this by choice?
   O a. Directly relate
   O b. Somewhat relate
   O c. Not relate

   b. If you are employed outside your major field of study, is this by choice?
   O a. Yes
   O b. No
   O. Not applicable

50. If you are currently employed, what are the minimum educational requirements for that position?
   O a. High School Diploma or less
   O b. Certificate Program or one year of college
   O c. Associate Degree or two years of college
   O d. Bachelor’s Degree
   O e. Graduate Degree

51. Within what general range is your income per year? (Note: this information will remain confidential.)
   O a. Under $20,000
   O b. $20,000-29,999
   O c. $30,000-39,999
   O d. $40,000-49,999
   O e. $50,000-59,999
   O f. $60,000-69,999
   O g. $70,000 or over
   O h. Not applicable: not presently employed

52. Please provide the name of the firm you work for, your current job title, and a brief description of your current responsibilities.

______________________________________________________________

Comletes your questionnaire. Thank you for participating in this important survey.
53. If you are self employed, please tell us about your work or business, including the name of your firm.


54. What type of service or product is provided by your firm?


55. In what state is your firm located?


Section VI
Employer Assessment
As part of our continuous improvement efforts, we would like to contact the supervisors of our alumni (if employed), or graduate program supervisors (if in graduate school). All responses will be kept in strict professional confidence and no individual will be identified in the report of the survey results. The items of interest to us are similar to items 1-13 on this survey. If you are willing for us to contact your supervisor, please provide us with information on how to contact him/her:

56. Supervisor name: ____________________________
Firm name: ____________________________
Address: ____________________________

City, State, Zip: ____________________________
Telephone number: ( ) ____________________________

Thanks for your time and assistance!
Please return this survey in the postage-paid envelope provided.
APPENDIX I

Certification for Graduation

A- School Engineering
   a- BS Civil Engineering
   b- BS Industrial Engineering
   c- BS Electrical Engineering
   d- BS Mechanical Engineering
   e- BS Chemical Engineering
   f- BS Environmental Engineering
   g- BS Land Surveying and Mapping

B- School of Management
   a- BBA Industrial
   b- BBA Construction Management
   c- BBA Accounting
   d- BBA Marketing
   e- BBA Management of Information Systems
   f- BBA Management

C- School of Architecture

This is a set of instruments used by the respective Directors or Academic Department Heads to certify the graduation candidates at the undergraduate level.
## Preparatory Studies

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR.</th>
<th>GRADES</th>
<th>DATE</th>
<th>INIT.</th>
<th>EQUIV.</th>
<th>+/-</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 0100</td>
<td>PREPARATORY MATHEMATICS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 0110</td>
<td>ALGEBRA</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 0110</td>
<td>INTRODUCTION TO PHYSICS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATUL 0100</td>
<td>ADJUSTMENT TO UNIVERSITY LIFE</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 0100</td>
<td>PREPARATORY ENGLISH</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 0110</td>
<td>ENGLISH GRAMMAR</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 0100</td>
<td>PREPARATORY SPANISH</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 0110</td>
<td>SPANISH GRAMMAR</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Civil Engineering Curriculum

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR.</th>
<th>GRADES</th>
<th>DATE</th>
<th>INIT.</th>
<th>EQUIV.</th>
<th>+/-</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1330</td>
<td>PRECALCULUS I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 1340</td>
<td>PRECALCULUS II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2310</td>
<td>CALCULUS I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2320</td>
<td>CALCULUS II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2330</td>
<td>CALCULUS III</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2340</td>
<td>CALCULUS IV</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 3310</td>
<td>DIFFERENTIAL EQUATIONS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 1210</td>
<td>GENERAL CHEMISTRY I</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 1211</td>
<td>GENERAL CHEMISTRY I</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LABORATORY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2430</td>
<td>PHYSICS I, MECHANICS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COURSE</td>
<td>COURSE TITLE</td>
<td>CR.</td>
<td>GRADES</td>
<td>DATE</td>
<td>INIT.</td>
<td>EQUIV.</td>
<td>+/-</td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------------</td>
<td>-----</td>
<td>--------</td>
<td>------</td>
<td>-------</td>
<td>--------</td>
<td>-----</td>
</tr>
<tr>
<td>ENGI 3410</td>
<td>ENGINEERING MECHANICS, DYNAMICS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 3420</td>
<td>FLUID MECHANICS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 3421</td>
<td>FLUID MECHANICS LABORATORY</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 4210</td>
<td>ENGINEERING ECONOMICS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 3800</td>
<td>PRINCIPLES OF ELECTRICAL ENGINEERING</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SURV 2091</td>
<td>SURVEYING INSTRUMENTS LABORATORY FOR ENGINEERS</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 3002</td>
<td>APPLIED SOFTWARE FOR CIVIL ENGINEERING</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 3004</td>
<td>APPLIED NUMERICAL ANALYSIS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 3402</td>
<td>WATER RESOURCES AND HYDRAULIC ENGINEERING</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 3502</td>
<td>CONSTRUCTION MATERIALS</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 3503</td>
<td>CONSTRUCTION MATERIALS LABORATORY</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4102</td>
<td>THEORY OF STRUCTURES I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4104</td>
<td>THEORY OF STRUCTURES II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4106</td>
<td>STEEL STRUCTURES DESIGN</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4108</td>
<td>CONCRETE STRUCTURES DESIGN</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4202</td>
<td>GEOTECHNICAL ENGINEERING I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4203</td>
<td>GEOTECHNICAL ENGINEERING I LABORATORY</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4204</td>
<td>GEOTECHNICAL ENGINEERING II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4205</td>
<td>GEOTECHNICAL ENGINEERING II LABORATORY</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4302</td>
<td>HIGHWAY DESIGN I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE 4304</td>
<td>HIGHWAY DESIGN II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course No.</td>
<td>Course Title</td>
<td>Cr.</td>
<td>Grades</td>
<td>Date</td>
<td>Int.</td>
<td>Equiv.</td>
<td>(+/-)</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------</td>
<td>-----</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>DEVELOPMENT STUDIES (24 CREDITS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1010</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1100</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1120</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1130</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1140</td>
<td>Preparatory Mathemat</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1150</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1160</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>THEMATICS (24 CREDITS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1310</td>
<td>Precalculus I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1320</td>
<td>Precalculus II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1330</td>
<td>Calculus I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1340</td>
<td>Calculus II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1350</td>
<td>Calculus III</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1360</td>
<td>Calculus IV</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1370</td>
<td>Differential Equations</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1380</td>
<td>Linear Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SOCIO HUMANISTIC (24 CREDITS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1010</td>
<td>Linguistic Analysis of Literary Genres</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1020</td>
<td>Hispanic Literature</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1030</td>
<td>The Study of the Essay as a Literary G</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 1040</td>
<td>Literary Analysis of Fiction, Poetry and Drama</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 2010</td>
<td>Socio-Humanistics Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 2020</td>
<td>Socio-Humanistics Studies II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 3040</td>
<td>Ethics in Engineering</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IUG 3050</td>
<td>Socio-Humanistic Elective</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>Course Title</td>
<td>Cr</td>
<td>Grades</td>
<td>Date</td>
<td>Int.</td>
<td>Equiv.</td>
<td>(+/-)</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------</td>
<td>----</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>1610</td>
<td>Introduction to Computer and Information Technology</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2610</td>
<td>Computer Tools for IE's</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3110</td>
<td>Financial and Cost Accounting</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3210</td>
<td>Probability for Engineers</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3220</td>
<td>Statistics for Engineers</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3310</td>
<td>Work Design and Human Factors</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3311</td>
<td>Work Design and Human Factors Lab.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3610</td>
<td>Information Systems Design</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4210</td>
<td>Design of Experiments</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4220</td>
<td>Statistical Quality Control</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4310</td>
<td>Job Design and Work Measurement</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4311</td>
<td>Job Design and Work Measurement Lab.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4410</td>
<td>Material Management and Inventory Cont</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4420</td>
<td>Operations Research I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4510</td>
<td>Production Planning and Control</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4520</td>
<td>Operations Research II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4610</td>
<td>Introduction To Database Systems</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4620</td>
<td>Computer Systems and Networks</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4621</td>
<td>Computer Systems and Networks Lab.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>710</td>
<td>Industrial Manufacturing Processes</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>720</td>
<td>Industrial Automation</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>721</td>
<td>Industrial Automation Lab.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COURSE</td>
<td>COURSE TITLE</td>
<td>CRD</td>
<td>GRADES</td>
<td>DATE</td>
<td>INIT</td>
<td>EQUIV</td>
<td>CEEB SCORES</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------</td>
<td>-----</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>*SPAN 100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>300-549</td>
</tr>
<tr>
<td>*ENGL 100</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>300-599</td>
</tr>
<tr>
<td>*SPAN 110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>550-749</td>
</tr>
<tr>
<td>*ENGL 110</td>
<td>English as a Second Language</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>600-749</td>
</tr>
<tr>
<td>*MATH 100</td>
<td>Preparatory Mathematics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>400-649</td>
</tr>
<tr>
<td>*MATH 110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>650-699</td>
</tr>
<tr>
<td>*SCIE 110</td>
<td>General Physics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*ATUL 100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If required, these courses are in addition to the minimum graduation requirements of the degree.*

REV. NOV. 1994
### Mathematics Component (21 credit-hours)

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Crd</th>
<th>Des. crds.</th>
<th>Grades</th>
<th>Date</th>
<th>Init.</th>
<th>Equiv.</th>
<th>DSN (+) (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1330</td>
<td>Precalculus I</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 1340</td>
<td>Precalculus II</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2310</td>
<td>Calculus I</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2320</td>
<td>Calculus II</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2330</td>
<td>Calculus III</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2340</td>
<td>Calculus IV</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 3310</td>
<td>Differential Equations</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Basic Sciences Component (19 credit-hours)

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Crd</th>
<th>Des. crds.</th>
<th>Grades</th>
<th>Date</th>
<th>Init.</th>
<th>Equiv.</th>
<th>DSN (+) (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCIE 1210</td>
<td>General Chemistry I</td>
<td>4</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 1211</td>
<td>General Chemistry I Lab.</td>
<td>0</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2430</td>
<td>Physics I, Mechanics</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2431</td>
<td>Physics I, Laboratory</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2440</td>
<td>Phys. II, Heat, Light and Sound</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2441</td>
<td>Physics II, Laboratory</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2450</td>
<td>Physics III, Elect. and Magnet.</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2451</td>
<td>Physics III, Laboratory</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2470</td>
<td>Principles of Mat. Science</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SocioHumanistics/Studies and Languages Component (24 credit-hours)

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Crd</th>
<th>Des. crds.</th>
<th>Grades</th>
<th>Date</th>
<th>Init.</th>
<th>Equiv.</th>
<th>DSN (+) (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOHU 2010</td>
<td>Socio-Humanistic Studies I</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOHU 2020</td>
<td>Socio-Humanistic Studies II</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 1010</td>
<td>Ling. Analysis of Lit. Genre</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 2010</td>
<td>Hispanic Literature</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 1010</td>
<td>Study of the Essay as Lit.Genre</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 2010</td>
<td>Lit. An. of Fict., Poet. and Dram.</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>** ****</td>
<td>Socio-Hum. and Lang. Elect.</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHIL 3040</td>
<td>Ethics in Engineering</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Engineering Sciences Component (22 credit-hours)

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Crd</th>
<th>Des. crds.</th>
<th>Grades</th>
<th>Date</th>
<th>Init.</th>
<th>Equiv.</th>
<th>DSN (+) (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 1110</td>
<td>Engineering Graphics</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 1130</td>
<td>Freshman Engineering Design</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 2110</td>
<td>Engineering Mechanics, Statics</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 2210</td>
<td>Eng. Probability and Statistics</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 2300</td>
<td>Computer Engineering Literacy</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 3410</td>
<td>Eng. Mechanics, Dynamics</td>
<td>3</td>
<td>0.5</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 3420</td>
<td>Fluid Mechanics</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGI 4210</td>
<td>Engineering Economics</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>Course Title</td>
<td>rds</td>
<td>Deg.</td>
<td>Grades</td>
<td>Date</td>
<td>Init. Equiv.</td>
<td>DSN</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------</td>
<td>-----</td>
<td>------</td>
<td>--------</td>
<td>------</td>
<td>--------------</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>EE 5340</td>
<td>Microcomputer Interfacing</td>
<td>4</td>
<td>4</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5341v</td>
<td>Microcomputer Interfacing Lab.</td>
<td>0</td>
<td>0</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5500</td>
<td>Power Electronics</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5510</td>
<td>Solid State Electronics</td>
<td>3</td>
<td>0</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5600</td>
<td>Process Control and Inst. Lab.</td>
<td>3</td>
<td>1.5</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5601</td>
<td>Process Control and Inst. Lab.</td>
<td>1</td>
<td>0.5</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5610</td>
<td>Control System Design</td>
<td>3</td>
<td>2.5</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5620</td>
<td>Modern Control Engineering</td>
<td>3</td>
<td>1</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5630</td>
<td>Robotic Engineering Design</td>
<td>4</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5631</td>
<td>Robotic Eng. Design Lab.</td>
<td>0</td>
<td>0</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5700</td>
<td>Fiber Optics Systems Design</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5710</td>
<td>Microwaves and Satellites</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5720</td>
<td>Digital Signal Processing</td>
<td>3</td>
<td>0.5</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5721</td>
<td>Real Time DSP Laboratory</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5729</td>
<td>Digital Signal Proc. Fund. Lab.</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5730</td>
<td>Radio Frequency Design</td>
<td>3</td>
<td>2</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5740</td>
<td>Image Processing</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5990</td>
<td>Special Topics in Electrical Eng.</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COOP 3010</td>
<td>Professional Practice</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Electric/Power**

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>rds</th>
<th>Deg.</th>
<th>Grades</th>
<th>Date</th>
<th>Init. Equiv.</th>
<th>DSN</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 3220</td>
<td>Software Applications for EE</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 3410</td>
<td>Electromech. Energy Conv. II</td>
<td>3</td>
<td>0.5</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 3411</td>
<td>Electrom. Energy Conv. II Lab.</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 3420</td>
<td>Power System Analysis I</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 4400</td>
<td>Power System Analysis II</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 4401</td>
<td>Power System Analysis Lab.</td>
<td>1</td>
<td>0</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 4430</td>
<td>Power Plant Eng.</td>
<td>3</td>
<td>0</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 4440</td>
<td>Princ. of Electric Sys. Design</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 4900</td>
<td>Research in Electrical Eng.</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5400</td>
<td>Electrom. Energy Conv. III</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5430</td>
<td>Power System Protection</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5431</td>
<td>Power System Protection Lab.</td>
<td>1</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5432</td>
<td>Power System Stability</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5436</td>
<td>Distribution System Design</td>
<td>3</td>
<td>2</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5444</td>
<td>Adv. Electric System Design</td>
<td>3</td>
<td>2</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5460</td>
<td>Electric Power Dispatch</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5500</td>
<td>Power Electronics</td>
<td>3</td>
<td>1</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5420</td>
<td>Electric Power Quality</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 5990</td>
<td>Special Topics in Electrical Eng.</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 4110</td>
<td>Thermodynamics II</td>
<td>3</td>
<td>0.5</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COOP 3010</td>
<td>Professional Practice</td>
<td>3</td>
<td>0</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COURSE NO.</td>
<td>COURSE TITLE</td>
<td>CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------</td>
<td>----</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 0100</td>
<td>Preparatory Mathematics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATUL 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 0100</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 0110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Socio-Humanistic Studies and Languages (24 Credits)**

<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 1010</td>
<td>The Study of the Essay as a Literary Genre</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 1010</td>
<td>Linguistic Analysis of Literary Genres</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 2010</td>
<td>Literary Analysis of Fiction, Poetry, and Drama</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 2010</td>
<td>Hispanic Literature</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
</tr>
<tr>
<td>PHIL 3040</td>
<td>Ethics in Engineering</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Sohu-Elective</td>
<td></td>
</tr>
</tbody>
</table>

2. **Mathematics (24 Credits)**

<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1330</td>
<td>Precalculus I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1340</td>
<td>Precalculus II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2310</td>
<td>Calculus I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2320</td>
<td>Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2330</td>
<td>Calculus III</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2340</td>
<td>Calculus IV</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3310</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3320</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
</tbody>
</table>
## 5. MECHANICAL ENGINEERING COMPONENT (50 CREDITS)

<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 3010</td>
<td>Applied Numerical Analysis</td>
<td>3</td>
</tr>
<tr>
<td>ME 3110</td>
<td>Thermodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>ME 4120</td>
<td>Thermodynamics II</td>
<td>3</td>
</tr>
<tr>
<td>ME 3210</td>
<td>Mechanism Design</td>
<td>3</td>
</tr>
<tr>
<td>ME 3220</td>
<td>Engineering Materials</td>
<td>3</td>
</tr>
<tr>
<td>ME 3221</td>
<td>Engineering Materials Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>ME 4210</td>
<td>Solid Mechanics I</td>
<td>3</td>
</tr>
<tr>
<td>ME 4220</td>
<td>Solid Mechanics II</td>
<td>3</td>
</tr>
<tr>
<td>ME 4230</td>
<td>Design of Machine Elements I</td>
<td>3</td>
</tr>
<tr>
<td>ME 5240</td>
<td>Design of Machine Elements II</td>
<td>3</td>
</tr>
<tr>
<td>ME 3140</td>
<td>Intermediate Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>ME 4130</td>
<td>Heat Transfer I</td>
<td>3</td>
</tr>
<tr>
<td>ME 4140</td>
<td>Heat Transfer II</td>
<td>3</td>
</tr>
<tr>
<td>ME 5150</td>
<td>Design of Thermal Systems</td>
<td>3</td>
</tr>
<tr>
<td>ME 4041</td>
<td>Engineering Measurements Lab.</td>
<td>1</td>
</tr>
<tr>
<td>ME 4240</td>
<td>Manufacturing Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ME 4241</td>
<td>Manufacturing Engineering Lab.</td>
<td>1</td>
</tr>
<tr>
<td>ME 5151</td>
<td>Thermal Engineering Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>ME 5050</td>
<td>System Dynamics and Controls</td>
<td>3</td>
</tr>
<tr>
<td>ME 5251</td>
<td>Mechatronics Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>ME 5260</td>
<td>Computer Aided Design and Computer Aided Manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>ME 5261</td>
<td>CAD/CAM Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>ME 5992</td>
<td>Mechanical Engineering Capstone Design I</td>
<td>3</td>
</tr>
<tr>
<td>ME 5994</td>
<td>Mechanical Engineering Capstone Design II</td>
<td>3</td>
</tr>
</tbody>
</table>

## 6. ELECTIVES (12 CREDITS)

<table>
<thead>
<tr>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME Elective Course I</td>
<td>3</td>
</tr>
<tr>
<td>ME Elective Course II</td>
<td>3</td>
</tr>
<tr>
<td>FREE Elective Course I</td>
<td>3</td>
</tr>
<tr>
<td>FREE Elective Course II</td>
<td>3</td>
</tr>
</tbody>
</table>

OVERALL TOTAL FOR BSME DEGREE 175 (DEVELOPMENTAL STUDIES CREDITS ARE NOT INCLUDED IN THE TOTAL)
<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 0100</td>
<td>Preparatory Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 0110</td>
<td>Algebra</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
</tr>
<tr>
<td>ATUL 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 0100</td>
<td>Preparatory English</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 0110</td>
<td>English Grammar</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
</tr>
</tbody>
</table>

**DEVELOPMENTAL STUDIES** - If required, these courses must be taken in addition to the minimum graduation requirements for the degree.

---

**1. SOCIO-HUMANISTIC STUDIES AND LANGUAGES (24 CREDITS)**

<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 1010</td>
<td>The Study of the Essay as a Literary Genre</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 1010</td>
<td>Linguistic Analysis of Literary Genres</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 2010</td>
<td>Literary Analysis of Fiction, Poetry, and Drama</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 2010</td>
<td>Hispanic Literature</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
</tr>
<tr>
<td>PHIL 3040</td>
<td>Ethics in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

**2. MATHEMATICS (21 CREDITS)**

<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1330</td>
<td>Precalculus I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1340</td>
<td>Precalculus II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2310</td>
<td>Calculus I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2320</td>
<td>Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2330</td>
<td>Calculus III</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2340</td>
<td>Calculus IV</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3310</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>COURSE NO.</td>
<td>COURSE TITLE</td>
<td>CR</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>SCIE 1210</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 1211</td>
<td>General Chemistry I Laboratory</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 1220</td>
<td>General Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 1221</td>
<td>General Chemistry II Laboratory</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 2220</td>
<td>Organic Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 2221</td>
<td>Organic Chemistry Laboratory I</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 2230</td>
<td>Organic Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 2231</td>
<td>Organic Chemistry Laboratory II</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 2430</td>
<td>Physics I, Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 2431</td>
<td>Physics I, Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>SCIE 2440</td>
<td>Physics II, Heat, Light and Sound</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 2441</td>
<td>Physics II, Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>SCIE 2450</td>
<td>Physics III, Electricity and Magnetism</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 2451</td>
<td>Physics III, Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>SCIE 3210</td>
<td>Physical Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 3211</td>
<td>Physical Chemistry Laboratory I</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 3220</td>
<td>Physical Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 3221</td>
<td>Physical Chemistry Laboratory II</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 3230</td>
<td>Analytical Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 3231</td>
<td>Analytical Chemistry Laboratory</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 3240</td>
<td>Analysis and Instrumentation</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 3241</td>
<td>Instrumentation Laboratory</td>
<td>0</td>
</tr>
<tr>
<td>COURSE NO.</td>
<td>COURSE TITLE</td>
<td>CR</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>ENGI 1110</td>
<td>Engineering Graphics</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 1130</td>
<td>Freshman Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 2110</td>
<td>Engineering Mechanics, Static</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 2210</td>
<td>Engineering, Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 2310</td>
<td>Computer Programming and Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 3210</td>
<td>Engineering Materials</td>
<td>3</td>
</tr>
<tr>
<td>EE 3000</td>
<td>Circuit Analysis I</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 4210</td>
<td>Engineering Economics</td>
<td>3</td>
</tr>
</tbody>
</table>

5. CHEMICAL ENGINEERING COMPONENT (47 CREDITS)

<table>
<thead>
<tr>
<th>COURSE NO.</th>
<th>COURSE TITLE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 3110</td>
<td>Basic Principles in Chemical Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CHE 3112</td>
<td>Chemical Engineering Thermodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>CHE 3114</td>
<td>Momentum Transfer Operations</td>
<td>3</td>
</tr>
<tr>
<td>CHE 4110</td>
<td>Chemical Engineering Thermodynamics II</td>
<td>3</td>
</tr>
<tr>
<td>CHE 4112</td>
<td>Heat Transfer Operations</td>
<td>4</td>
</tr>
<tr>
<td>CHE 4124</td>
<td>Mass Transfer Operations</td>
<td>4</td>
</tr>
<tr>
<td>CHE 4126</td>
<td>Chemical Engineering Kinetics and Catalysis</td>
<td>4</td>
</tr>
<tr>
<td>CHE 4118</td>
<td>Applied Numerical Analysis in Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHE 4113</td>
<td>Chemical Engineering Laboratory I</td>
<td>2</td>
</tr>
<tr>
<td>CHE 5110</td>
<td>Chemical Engineering Advanced Unit Operations</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5112</td>
<td>Chemical Engineering Process Design</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5114</td>
<td>Process Dynamics and Control</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5117</td>
<td>Chemical Engineering Laboratory II</td>
<td>2</td>
</tr>
<tr>
<td>CHE 5918</td>
<td>Chemical Engineering Capstone Course</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5210</td>
<td>Principles of Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>COURSE NO.</td>
<td>COURSE TITLE</td>
<td>CR</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>CHE 5120</td>
<td>Chemical Engineering Practice</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5212</td>
<td>Air Pollution Control</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5214</td>
<td>Water Pollution Control</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5216</td>
<td>Solid Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5218</td>
<td>Environmental Laws and Regulations</td>
<td>3</td>
</tr>
<tr>
<td>CHE 5310</td>
<td>Principles of Pharmaceutical Operations</td>
<td>3</td>
</tr>
</tbody>
</table>

6. CHEMICAL ENGINEERING ELECTIVES COMPONENT (6 CREDITS)

7. FREE ELECTIVES COMPONENT 6 CREDITS

OVERALL TOTAL FOR BSCH 174 (Developmental Studies credits are not included in the total)
### PREPARATORY STUDIES

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 0100</td>
<td>PREPARATORY MATHEMATICS</td>
<td>3</td>
</tr>
<tr>
<td>MATH 0110</td>
<td>ALGEBRA</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 0110</td>
<td>INTRODUCTION TO PHYSICS</td>
<td>3</td>
</tr>
<tr>
<td>ATUL 0100</td>
<td>ADJUSTMENT TO UNIVERSITY</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 0100</td>
<td>PREPARATORY ENGLISH</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 0110</td>
<td>ENGLISH GRAMMAR</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 0100</td>
<td>PREPARATORY SPANISH</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 0110</td>
<td>SPANISH GRAMMAR</td>
<td>3</td>
</tr>
</tbody>
</table>

### ENVIRONMENTAL ENGINEERING CURRICULUM

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1330</td>
<td>PRECALCULUS I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1340</td>
<td>PRECALCULUS II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2310</td>
<td>CALCULUS I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2320</td>
<td>CALCULUS II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2330</td>
<td>CALCULUS III</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2340</td>
<td>CALCULUS IV</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3310</td>
<td>DIFFERENTIAL EQUATIONS</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 1210</td>
<td>GENERAL CHEMISTRY I</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 1211</td>
<td>GENERAL CHEMISTRY I LABORATORY</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 2110</td>
<td>ENVIRONMENTAL MICROBIOLOGY</td>
<td>4</td>
</tr>
<tr>
<td>SCIE 2111</td>
<td>ENVIRONMENTAL MICROBIOLOGY LABORATORY</td>
<td>0</td>
</tr>
<tr>
<td>SCIE 2210</td>
<td>ENVIRONMENTAL CHEMISTRY</td>
<td>3</td>
</tr>
<tr>
<td>COURSE</td>
<td>COURSE TITLE</td>
<td>CR</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>ENGI 3430</td>
<td>ENGINEERING THERMODYNAMICS</td>
<td></td>
</tr>
<tr>
<td>ENGI 4210</td>
<td>ENGINEERING ECONOMICS</td>
<td></td>
</tr>
<tr>
<td>CE 3004</td>
<td>APPLIED NUMERICAL ANALYSIS</td>
<td></td>
</tr>
<tr>
<td>CE 3402</td>
<td>WATER RESOURCES AND HYDRAULIC ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>CE 4110</td>
<td>STRUCTURAL DESIGN FOR ENVIRONMENTAL ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>CE 4202</td>
<td>GEOTECHNICAL ENGINEERING I</td>
<td></td>
</tr>
<tr>
<td>CE 4203</td>
<td>GEOTECHNICAL ENGINEERING I LABORATORY</td>
<td></td>
</tr>
<tr>
<td>ENVE 4110</td>
<td>WATER SUPPLY ENGINEERING: PUMPING, STORAGE, DISTRIBUTION</td>
<td></td>
</tr>
<tr>
<td>ENVE 4120</td>
<td>WATER SUPPLY ENGINEERING : WATER QUALITY AND TREATMENT</td>
<td></td>
</tr>
<tr>
<td>ENVE 4130</td>
<td>WASTEWATER ENGINEERING: COLLECTION AND PUMPING</td>
<td></td>
</tr>
<tr>
<td>ENVE 4140</td>
<td>WASTEWATER ENGINEERING: TREATMENT, DISPOSAL, REUSE</td>
<td></td>
</tr>
<tr>
<td>ENVE 4150</td>
<td>GROUNDWATER POLLUTION AND CONTROL</td>
<td></td>
</tr>
<tr>
<td>ENVE 4160</td>
<td>UNIT OPERATIONS AND PROCESSES IN INDUSTRIAL WASTEWATER TREATMENT</td>
<td></td>
</tr>
<tr>
<td>ENVE 4210</td>
<td>AIR POLLUTION</td>
<td></td>
</tr>
<tr>
<td>ENVE 4220</td>
<td>AIR POLLUTION CONTROL DESIGN</td>
<td></td>
</tr>
<tr>
<td>ENVE 4310</td>
<td>SOLID WASTE AND RESOURCE RECOVERY ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>ENVE 4410</td>
<td>ENVIRONMENTAL TOXICOLOGY</td>
<td></td>
</tr>
<tr>
<td>ENVE 5310</td>
<td>HAZARDOUS WASTE MANAGEMENT</td>
<td></td>
</tr>
<tr>
<td>ENVE 5410</td>
<td>OCCUPATIONAL SAFETY AND HEALTH</td>
<td></td>
</tr>
<tr>
<td>ENVE 5420</td>
<td>ENVIRONMENTAL IMPACT ASSESSMENT</td>
<td></td>
</tr>
<tr>
<td>ENVE 5511</td>
<td>ENVIRONMENTAL ENGINEERING LABORATORY I</td>
<td></td>
</tr>
<tr>
<td>COURSE</td>
<td>COURSE TITLE</td>
<td>CR.</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>ATUL 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
</tr>
<tr>
<td>ENGL0100</td>
<td>Preparatory English</td>
<td>3</td>
</tr>
<tr>
<td>ENGL0110</td>
<td>English Grammar</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
</tr>
<tr>
<td>MATH0100</td>
<td>Preparatory Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH0110</td>
<td>Algebra</td>
<td>3</td>
</tr>
<tr>
<td>SCIE 0110</td>
<td>General Science</td>
<td>3</td>
</tr>
<tr>
<td>COURSE</td>
<td>COURSE TITLE</td>
<td>CR.</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>SCIE 2420</td>
<td>General Physics II</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 1140</td>
<td>Earth Sciences-Geology</td>
<td>3</td>
</tr>
<tr>
<td>SOHU2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
</tr>
<tr>
<td>SOHU 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
</tr>
<tr>
<td>ECON3010</td>
<td>Micro Economics</td>
<td>3</td>
</tr>
<tr>
<td>HIST 3030</td>
<td>History of Surveying</td>
<td>3</td>
</tr>
<tr>
<td>ENGL1010</td>
<td>English Reading &amp; Writing</td>
<td>3</td>
</tr>
<tr>
<td>ENGL2010</td>
<td>Analysis of World Literature</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 1010</td>
<td>Spanish Reading &amp; Writing</td>
<td>3</td>
</tr>
<tr>
<td>SPAN 2010</td>
<td>Hispanic Literature</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 1110</td>
<td>Engineering Graphics</td>
<td>3</td>
</tr>
<tr>
<td>ENGI 1120</td>
<td>Descriptive Geometry</td>
<td>3</td>
</tr>
<tr>
<td>REA 2902</td>
<td>General Appraisal Principles</td>
<td>3</td>
</tr>
<tr>
<td>REA 4904</td>
<td>Eminent Domain (Expropriations)</td>
<td>3</td>
</tr>
<tr>
<td>PHIL 3020</td>
<td>Ethics for Appraisers</td>
<td>3</td>
</tr>
<tr>
<td>SSPL 2300</td>
<td>Surveying Instrument</td>
<td>3</td>
</tr>
<tr>
<td>SUAP 2200</td>
<td>Surveying Applications I</td>
<td>3</td>
</tr>
<tr>
<td>SUAP 3204</td>
<td>Surveying Applications II</td>
<td>3</td>
</tr>
<tr>
<td>SUAP 3206</td>
<td>Surveying Analysis I</td>
<td>3</td>
</tr>
<tr>
<td>SUAP 3208</td>
<td>Surveying Analysis II</td>
<td>3</td>
</tr>
<tr>
<td>GEOD2500</td>
<td>Introduction to Geodesy I</td>
<td>3</td>
</tr>
<tr>
<td>SSPL 2312</td>
<td>Surveying Drafting</td>
<td>3</td>
</tr>
<tr>
<td>COURSE</td>
<td>COURSE TITLE</td>
<td>CR</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------</td>
<td>----</td>
</tr>
<tr>
<td>HWAY4440</td>
<td>Route Surveying I</td>
<td>3</td>
</tr>
<tr>
<td>HWAY4442</td>
<td>Route Surveying II</td>
<td>3</td>
</tr>
<tr>
<td>HWAY5444</td>
<td>Route Surveying III</td>
<td>3</td>
</tr>
<tr>
<td>****</td>
<td>Free Elective I</td>
<td>3</td>
</tr>
<tr>
<td>****</td>
<td>Free Elective II</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>169</strong></td>
<td></td>
</tr>
</tbody>
</table>
# POLYTECHNIC UNIVERSITY OF PUERTO RICO
## SCHOOL OF MANAGEMENT - RBA

### BBA- INDUSTRIAL MANAGEMENT

#### SEQUENTIAL CURRICULUM
**PROGRESS & ADVISORY FORM**

#### INDUSTRIAL MANAGEMENT COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 3110</td>
<td>Managerial Accounting</td>
<td>3</td>
<td></td>
<td>Fina 2010, Aco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3120</td>
<td>Operations &amp; Production Management I</td>
<td>3</td>
<td></td>
<td>Mgmt 1010, Stat 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 4110</td>
<td>Statistical Quality Control</td>
<td>3</td>
<td></td>
<td>Stat 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3130</td>
<td>Materials &amp; Purchasing Management</td>
<td>3</td>
<td></td>
<td>Mgmt 3120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3140</td>
<td>Inv. &amp; Mat. Req. Plan./Caps. Req. Plan.</td>
<td>3</td>
<td></td>
<td>Mgmt 3120, Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 4120</td>
<td>Operations &amp; Production Management II</td>
<td>3</td>
<td></td>
<td>Mgmt 3120, Stat 2020</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Directed Department Electives**: 12

**INDUSTRIAL MANAGEMENT CREDITS**: 30

#### PRACTICUM COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 4170</td>
<td>Industrial Management Practice</td>
<td>3</td>
<td></td>
<td>Area Coordinator Approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRACTICUM CREDITS**: 3

Credits towards degree 33

### **** Directed Department Electives ****

- ACCO 3330 INTERMEDIATE ACCOUNTING
- ACCO 3360 FEDERAL INCOME TAX
- ISYS 3510 MANAGEMENT INFORMATION SYSTEMS
- ISYS 3540 COMPUTER & INFORMATION TECHNOLOGY
- MGMT 3610 HUMAN RESOURCES MANAGEMENT
- MGMT 3230 CONSTRUCTION MATERIALS & METHODS
- MARK 3410 ORGANIZATIONAL BEHAVIOR
- MARK 3410 SALES & RETAIL MANAGEMENT
- MARK 3450 ADVERTISING
- MGMT 4130 INDUSTRIAL MANAGEMENT WORKSHOP

- ACCO 3310 COST ACCOUNTING
- ACCO 3350 PUERTO RICO INCOME TAX
- ISYS 3520 BUSINESS PROGRAMMING LANGUAGE - COBOL
- ISYS 3560 DATA COMMUNICATION & NETWORKS I
- MGMT 3210 CONSTRUCTION MANAGEMENT
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 4610 TOTAL QUALITY MANAGEMENT
- MARK 3440 PUBLIC RELATIONS
- STAT 4120 ADVANCED STATISTICS
- MGMT 4230 FINANCIAL PROJECT PLANNING
# COMMON BBA COMPONENT

## PREPARATORY COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atul 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 1000</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0100</td>
<td>Preparatory Math Algebra</td>
<td>3</td>
<td></td>
<td>Math 0110 CEEB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td>Math 0110 CEEB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PREPARATORY CREDITS: 16

## SOCIO-HUMANISTIC COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td>Span 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0111</td>
<td>Spanish Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0111</td>
<td>English Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Engl 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
<td></td>
<td>Sohu 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOCIO-HUMANISTIC CREDITS: 24

## MATH & SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1310</td>
<td>Applied Mathematics for Business I</td>
<td>3</td>
<td></td>
<td>Placement by Admission Office or Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 1320</td>
<td>Applied Mathematics for Business II</td>
<td>3</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 1210</td>
<td>General Chemistry &amp; Laboratory</td>
<td>4</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATH & SCIENCE CREDITS: 13

## COMPUTER SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp 1010</td>
<td>Introduction to Computer &amp; Basic Languages</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 2010</td>
<td>Business Application Program</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 3010</td>
<td>Database Management</td>
<td>3</td>
<td></td>
<td>Comp 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COMPUTER SCIENCE CREDITS: 9

Credits towards degree 46
### GENERAL BUSINESS ADMINISTRATION COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 2020</td>
<td>Business Spanish</td>
<td>3</td>
<td></td>
<td>Span 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 2020</td>
<td>Business English</td>
<td>3</td>
<td></td>
<td>Engl 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2010</td>
<td>Accounting Principles I</td>
<td>4</td>
<td></td>
<td>Math 0110, Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2020</td>
<td>Accounting Principles II</td>
<td>4</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3010</td>
<td>Micro Economics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3020</td>
<td>Macro Economics</td>
<td>3</td>
<td></td>
<td>Econ 3010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2010</td>
<td>Probabilities and Statistics</td>
<td>3</td>
<td></td>
<td>Math 131, Comp 110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2020</td>
<td>Statistics &amp; Hypothesis Testing</td>
<td>3</td>
<td></td>
<td>Stat 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fina 2010</td>
<td>Finance</td>
<td>3</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 1010</td>
<td>Marketing</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 1010</td>
<td>Introduction to Management</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2020</td>
<td>Business Law</td>
<td>3</td>
<td></td>
<td>Mgmt 1010, Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2010</td>
<td>Organization Theory Mgmt</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GENERAL BUSINESS ADMINISTRATION CREDITS: 41**

### FREE ELECTIVE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free Elective</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Free Elective</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FREE ELECTIVE CREDITS: 6**

Credits towards degree **47**

**STUDENT SHOULD TAKE SIX (6) CREDITS IN ANY OF THE UNIVERSITY OFFERINGS WITH THE APPROVAL OF STUDENT'S ACADEMIC ADVISOR. SEE ALSO THE JOINT BBA-MBA OFFERING.**

**NOTE: NOT ALL CLASSES ARE OFFERED IN ALL SCHOOL TERMS. THE STUDENT NEEDS TO PLAN HIS/HER CLASSES CAREFULLY TO FINISH IN THE OPTIMAL TIME FRAME. ALSO, LOOK AT OUR WEB PAGE TO SEE SOME NEW CLASS OFFERINGS SINCE THE PRINTING OF THIS CATALOG. THE WEB ADDRESS IS WWW.FUPR.EDU.**
# BBA - Construction Management

## Construction Management Component

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 3210</td>
<td>Construction Management</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3230</td>
<td>Construction Materials &amp; Methods</td>
<td>3</td>
<td></td>
<td>Math 1320, Mgmt 3210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3220</td>
<td>Construction Contracts &amp; Legal</td>
<td>3</td>
<td></td>
<td>Mgmt 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Documents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3240</td>
<td>Construction Estimats &amp; Costs</td>
<td>3</td>
<td></td>
<td>Mgmt 3210, Mgmt 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3250</td>
<td>Constructions Equipment</td>
<td>3</td>
<td></td>
<td>Mgmt 3210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3260</td>
<td>Construction Safety</td>
<td>3</td>
<td></td>
<td>Mgmt 3210, Mgmt 3250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 4210</td>
<td>Project Planning &amp; Control (PERT)</td>
<td>3</td>
<td></td>
<td>Mgmt 3210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 4220</td>
<td>Government Regulations (CHST)</td>
<td>3</td>
<td></td>
<td>Mgmt 3220</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Directed Department Electives</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Construction Management Credits: 30

## Practicum Component

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 4720</td>
<td>Construction Management Project</td>
<td>3</td>
<td></td>
<td>Area Coordinator Approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Practicum Credits: 3

*** Directed Department Electives ***

- ACCO 3310 INTERMEDIATE ACCOUNTING
- ACCO 3360 FEDERAL INCOME TAX
- ISYS 3510 MANAGEMENT INFORMATION SYSTEMS
- ISYS 3540 COMPUTER & INFORMATION TECHNOLOGY
- MGMT 3610 HUMAN RESOURCES MANAGEMENT
- MGMT 3110 OPERATIONS & PRODUCTION MANAGEMENT I
- MGMT 3620 ORGANIZATIONAL BEHAVIOR
- MARK 3410 SALES & RETAIL MANAGEMENT
- MARK 3450 ADVERTISING
- ACCO 3310 COST ACCOUNTING
- ACCO 3360 PUERTO RICO INCOME TAX
- ISYS 3520 BUSINESS PROGRAMMING LANG. I-COBOL
- ISYS 3550 DATA COMMUNICATION & NETWORKS I
- MGMT 3110 MANAGERIAL ACCOUNTING
- STAT 4120 ADVANCED STATISTICS
- MGMT 4810 TOTAL QUALITY MANAGEMENT
- MARK 3440 PUBLIC RELATIONS
- MGMT 4230 FINANCIAL PROJECT PLANNING
### GENERAL BUSINESS ADMINISTRATION COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 2020</td>
<td>Business Spanish</td>
<td>3</td>
<td></td>
<td>Span 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 2020</td>
<td>Business English</td>
<td>3</td>
<td></td>
<td>Engl 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2010</td>
<td>Accounting Principles I</td>
<td>4</td>
<td></td>
<td>Math 0110, Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2020</td>
<td>Accounting Principles II</td>
<td>4</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3010</td>
<td>Micro Economics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3020</td>
<td>Macro Economics</td>
<td>3</td>
<td></td>
<td>Econ 3010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2010</td>
<td>Probabilities and Statistics</td>
<td>3</td>
<td></td>
<td>Math 131, Comp 110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2020</td>
<td>Statistics &amp; Hypothesis Testing</td>
<td>3</td>
<td></td>
<td>Stat 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fina 2010</td>
<td>Finance</td>
<td>3</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 1010</td>
<td>Marketing</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 1010</td>
<td>Introduction to Management</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2020</td>
<td>Business Law</td>
<td>3</td>
<td></td>
<td>Mgmt 1010, Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2010</td>
<td>Organization Theory Mgmt</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GENERAL BUSINESS ADMINISTRATION CREDITS: 41

### FREE ELECTIVE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FREE ELECTIVE CREDITS: 6

Credits towards degree 47

**STUDENT SHOULD TAKE SIX (6) CREDITS IN ANY OF THE UNIVERSITY OFFERINGS WITH THE APPROVAL OF STUDENT'S ACADEMIC ADVISOR. SEE ALSO THE JOINT BBA-MBA OFFERING.**

**NOTE:** NOT ALL CLASSES ARE OFFERED IN ALL SCHOOL TERMS. THE STUDENT NEEDS TO PLAN HIS/HER CLASSES CAREFULLY TO FINISH IN THE OPTIMAL TIME FRAME. ALSO, LOOK AT OUR WEB PAGE TO SEE SOME NEW CLASS OFFERINGS SINCE THE PRINTING OF THIS CATALOG. THE WEB ADDRESS IS WWW.PUPRI.EDU.
# COMMON BBA COMPONENT

## PREPARATORY COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atul 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 1000</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0100</td>
<td>Preparatory Math Algebra</td>
<td>3</td>
<td></td>
<td>Math 0100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td>Math 0100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PREPARATORY CREDITS: 16**

## SOCIO-HUMANISTIC COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0111</td>
<td>Spanish Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Span 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0111</td>
<td>English Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Engl 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socu 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socu 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
<td></td>
<td>Socu 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socu 2020</td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Socu 2020</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOCIO-HUMANISTIC CREDITS: 24**

## MATH & SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1310</td>
<td>Applied Mathematics for Business I</td>
<td>3</td>
<td></td>
<td>Placement by Admission Office or Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 1320</td>
<td>Applied Mathematics for Business II</td>
<td>3</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socu 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socu 1210</td>
<td>General Chemistry &amp; Laboratory</td>
<td>4</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MATH & SCIENCE CREDITS: 13**

## COMPUTER SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp 1010</td>
<td>Introduction to Computer &amp; Basic Languages</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 2010</td>
<td>Business Application Program</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 3010</td>
<td>Database Management</td>
<td>3</td>
<td></td>
<td>Comp 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPUTER SCIENCE CREDITS: 9**

Credits towards degree 46
# BBA - ACCOUNTING

**SEQUENTIAL CURRICULUM PROGRESS & ADVISORY FORM**

## ACCOUNTING COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acco 3330</td>
<td>Intermediate Accounting I</td>
<td>4</td>
<td></td>
<td>Acco 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 3340</td>
<td>Intermediate Accounting II</td>
<td>4</td>
<td></td>
<td>Acco 3330</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 4310</td>
<td>Advanced Accounting</td>
<td>3</td>
<td></td>
<td>Acco 3340</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 3320</td>
<td>Computer Applications in Acc.</td>
<td>3</td>
<td></td>
<td>Camp 2010, Acco 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 3310</td>
<td>Cost Accounting</td>
<td>3</td>
<td></td>
<td>Acco 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 3350</td>
<td>Puerto Rico Income Tax</td>
<td>3</td>
<td></td>
<td>Acco 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 4320</td>
<td>Auditing</td>
<td>3</td>
<td></td>
<td>Acco 3330</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ACCOUNTING CREDITS: 29**

## PRACTICUM COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 4370</td>
<td>Accounting Practice</td>
<td>3</td>
<td></td>
<td>Area Coordinator Approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRACTICUM CREDITS: 3**

Credits towards degree 32

### **Directed Department Electives**

- ACCE 3360  FEDERAL INCOME TAX
- ISYS 3520  BUSINESS PROGRAMMING LANGUAGE I-COBOL
- ISYS 3550  DATA COMMUNICATION & NETWORKS I
- MGMT 3210  CONSTRUCTION MANAGEMENT
- MGMT 3220  CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 3120  OPERATIONS & PRODUCTION MANAGEMENT I
- MGMT 3620  ORGANIZATIONAL BEHAVIOR
- MARK 3410  SALES & RETAIL MANAGEMENT
- MARK 3450  ADVERTISING
- ISYS 3540  COMPUTER & INFORMATION TECHNOLOGY
- MGMT 3610  HUMAN RESOURCES MANAGEMENT
- MGMT 3230  CONSTRUCTION MATERIALS & METHODS
- MGMT 3110  MANAGERIAL ACCOUNTING
- MGMT 4120  ADVANCED STATISTICS
- MGMT 4810  TOTAL QUALITY MANAGEMENT
- MARK 3440  PUBLIC RELATIONS
- MGMT 4230  FINANCIAL PROJECT PLANNING
### GENERAL BUSINESS ADMINISTRATION COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sper 2020</td>
<td>Business Spanish</td>
<td>3</td>
<td></td>
<td>Span 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 2020</td>
<td>Business English</td>
<td>3</td>
<td></td>
<td>Engl 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2010</td>
<td>Accounting Principles I</td>
<td>4</td>
<td></td>
<td>Math 0110, Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2020</td>
<td>Accounting Principles II</td>
<td>4</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3010</td>
<td>Micro Economics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3020</td>
<td>Macro Economics</td>
<td>3</td>
<td></td>
<td>Econ 3010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2010</td>
<td>Probabilities and Statistics</td>
<td>3</td>
<td></td>
<td>Math 131, Comp 110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2020</td>
<td>Statistics &amp; Hypothesis Testing</td>
<td>3</td>
<td></td>
<td>Stat 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fin 2010</td>
<td>Finance</td>
<td>3</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 1010</td>
<td>Marketing</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 1010</td>
<td>Introduction to Management</td>
<td>3</td>
<td></td>
<td>Mgmt 1010, Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2020</td>
<td>Business Law</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2010</td>
<td>Organization Theory Mgmt</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GENERAL BUSINESS ADMINISTRATION CREDITS: 41**

### FREE ELECTIVE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FREE ELECTIVE CREDITS: 6**

Credits towards degree 47

**STUDENT SHOULD TAKE SIX (6) CREDITS IN ANY OF THE UNIVERSITY OFFERINGS WITH THE APPROVAL OF STUDENT'S ACADEMIC ADVISOR. SEE ALSO THE JOINT BBA-MBA OFFERING.**

**NOTE:** NOT ALL CLASSES ARE OFFERED IN ALL SCHOOL TERMS. THE STUDENT NEEDS TO PLAN HER/HIS CLASSES CAREFULLY TO FINISH IN THE OPTIMAL TIME FRAME. ALSO, LOOK AT OUR WEB PAGE TO SEE SOME NEW CLASS OFFERINGS SINCE THE PRINTING OF THIS CATALOG. THE WEB ADDRESS IS [WWW.PUPR.EDU](http://WWW.PUPR.EDU).
### COMMON BBA COMPONENT

#### PREPARATORY COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdl 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 1000</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0100</td>
<td>Preparatory Math Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td>Math 0100</td>
<td></td>
<td>CEEB</td>
</tr>
</tbody>
</table>

**PREPARATORY CREDITS:** 16

#### SOCIO-HUMANISTIC COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0111</td>
<td>Spanish Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Span 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0111</td>
<td>English Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Engl 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
<td></td>
<td>Sohu 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOCIO-HUMANISTIC CREDITS:** 24

#### MATH & SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1310</td>
<td>Applied Mathematics for Business I</td>
<td>3</td>
<td></td>
<td>Placement by Admission Office or Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 1320</td>
<td>Applied Mathematics for Business II</td>
<td>3</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 1210</td>
<td>General Chemistry &amp; Laboratory</td>
<td>4</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MATH & SCIENCE CREDITS:** 13

#### COMPUTER SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp 1010</td>
<td>Introduction to Computer &amp; Basic Languages</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 2010</td>
<td>Business Application Program</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 3010</td>
<td>Database Management</td>
<td>3</td>
<td></td>
<td>Comp 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPUTER SCIENCE CREDITS:** 9

Credits towards degree 46
## BBA - MARKETING

### SEQUENTIAL CURRICULUM PROGRESS & ADVISORY FORM

### MARKETING COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark 3410</td>
<td>Sales &amp; Retail Management</td>
<td></td>
<td>3</td>
<td>Mark 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 3420</td>
<td>Consumer Behavior</td>
<td></td>
<td>3</td>
<td>Mark 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 3430</td>
<td>Product Management</td>
<td></td>
<td>3</td>
<td>Mark 3410, Mark 3420</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 3440</td>
<td>Service Marketing</td>
<td></td>
<td>3</td>
<td>Mark 3410, Mark 3420</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 3450</td>
<td>Advertising</td>
<td></td>
<td>3</td>
<td>Mark 3420, Mark 3420, Mark 3440</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 3460</td>
<td>Public Relations</td>
<td></td>
<td>3</td>
<td>Mark 3410, Mark 3420, Mark 3460</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 4410</td>
<td>Marketing Research</td>
<td></td>
<td>3</td>
<td>Comp 2010, Stat 2020, Mark 3460</td>
<td></td>
<td></td>
</tr>
<tr>
<td>** Directed Department Electives**</td>
<td></td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MARKETING CREDITS: 30**

### PRACTICUM COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 4470</td>
<td>Marketing Practice</td>
<td>3</td>
<td></td>
<td>Area Coordinator Approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRACTICUM CREDITS: 3**

Credits towards degree 33

**Directed Department Electives**

- ACCO 3330 INTERMEDIATE ACCOUNTING
- ACCO 3350 FEDERAL INCOME TAX
- ISYS 3510 MANAGEMENT INFORMATION SYSTEMS
- ISYS 3540 COMPUTER & INFORMATION TECHNOLOGY
- MGMT 3610 HUMAN RESOURCES MANAGEMENT
- MGMT 3230 CONSTRUCTION MATERIALS & METHODS
- MGMT 3110 MANAGERIAL ACCOUNTING
- MGMT 3120 OPERATIONS & PRODUCTION MANAGEMENT
- STAT 4120 ADVANCED STATISTICS
- MGMT 4810 TOTAL QUALITY MANAGEMENT
- MARK 4440 LOGISTICS & PHYSICAL DISTRIBUTION

- ACCO 3310 COST ACCOUNTING
- ACCO 3350 PUERTO RICO INCOME TAX
- ISYS 3520 BUSINESS PROGRAMMING LANGUAGE I-COBOL
- ISYS 3550 DATA COMMUNICATION & NETWORKS I
- MGMT 3210 CONSTRUCTION MANAGEMENT
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 4430 ELECT. MEDIA & DESKTOP PUBLISHING
- MGMT 4230 FINANCIAL PROJECT PLANNING
# COMMON BBA COMPONENT

## PREPARATORY COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atul 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 1000</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0100</td>
<td>Preparatory Math Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td>Math 0100 CEEB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PREPARATORY CREDITS: 16**

## SOCIO-HUMANISTIC COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0111</td>
<td>Spanish Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Span 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0111</td>
<td>English Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Engl 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
<td></td>
<td>Sohu 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOCIO-HUMANISTIC CREDITS: 24**

## MATH & SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1310</td>
<td>Applied Mathematics for Business I</td>
<td>3</td>
<td></td>
<td>Placement by Admission Office or Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 1320</td>
<td>Applied Mathematics for Business II</td>
<td>3</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scle 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scle 1210</td>
<td>General Chemistry &amp; Laboratory</td>
<td>4</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MATH & SCIENCE CREDITS: 13**

## COMPUTER SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp 1010</td>
<td>Introduction to Computer &amp; Basic Languages</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 2010</td>
<td>Business Application Program</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 3010</td>
<td>Database Management</td>
<td>3</td>
<td></td>
<td>Comp 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPUTER SCIENCE CREDITS: 9**

Credits towards degree 46
**GENERAL BUSINESS ADMINISTRATION COMPONENT**

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 2020</td>
<td>Business Spanish</td>
<td>3</td>
<td></td>
<td>Span 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 2020</td>
<td>Business English</td>
<td>3</td>
<td></td>
<td>Engl 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2010</td>
<td>Accounting Principles I</td>
<td>4</td>
<td></td>
<td>Math 0110, Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2020</td>
<td>Accounting Principles II</td>
<td>4</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3010</td>
<td>Micro Economics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3020</td>
<td>Macro Economics</td>
<td>3</td>
<td></td>
<td>Econ 3010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2010</td>
<td>Probabilities and Statistics</td>
<td>3</td>
<td></td>
<td>Math 131, Comp 110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2020</td>
<td>Statistics &amp; Hypothesis Testing</td>
<td>3</td>
<td></td>
<td>Stat 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fina 2010</td>
<td>Finance</td>
<td>3</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 1010</td>
<td>Marketing</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 1010</td>
<td>Introduction to Management</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2020</td>
<td>Business Law</td>
<td>3</td>
<td></td>
<td>Mgmt 1010, Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2010</td>
<td>Organization Theory Mgmt</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GENERAL BUSINESS ADMINISTRATION CREDITS: 41**

**FREE ELECTIVE COMPONENT**

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Elective</td>
<td>Free Elective</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Elective</td>
<td>Free Elective</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FREE ELECTIVE CREDITS: 6**

Credits towards degree 47

**STUDENT SHOULD TAKE SIX (6) CREDITS IN ANY OF THE UNIVERSITY OFFERINGS WITH THE APPROVAL OF STUDENT'S ACADEMIC ADVISOR. SEE ALSO THE JOINT BBA-MBA OFFERING.**

**NOTE:** NOT ALL CLASSES ARE OFFERED IN ALL SCHOOL TERMS. THE STUDENT NEEDS TO PLAN HIS/HER CLASSES CAREFULLY TO FINISH IN THE OPTIMAL TIME FRAME. ALSO, LOOK AT OUR WEB PAGE TO SEE SOME NEW CLASS OFFERINGS SINCE THE PRINTING OF THIS CATALOG. THE WEB ADDRESS IS WWW.UPR.EDU.
# BBA - MANAGEMENT OF INFORMATION SYSTEMS

**NAME**

**S. S.**

---

**SEQUENTIAL CURRICULUM PROGRESS & ADVISORY FORM**

## MANAGEMENT OF INFORMATION SYSTEMS COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iays 3510</td>
<td>Management Information Systems</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iays 3520</td>
<td>Business Programming Language I - Cobol</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iays 3530</td>
<td>File Structure &amp; Organization-Cobol II</td>
<td>3</td>
<td></td>
<td>Iays 3520</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iays 3540</td>
<td>Computer &amp; Information Technology</td>
<td>3</td>
<td></td>
<td>Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iays 3550</td>
<td>Data Communication and Networks I</td>
<td>3</td>
<td></td>
<td>Comp 3010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iays 4510</td>
<td>System Analysis &amp; Design</td>
<td>3</td>
<td></td>
<td>Iays 3510</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iays 4550</td>
<td>Computer Security &amp; Audit</td>
<td>3</td>
<td></td>
<td>Iays 3510</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iays 4530</td>
<td>Local Area Network Systems</td>
<td>3</td>
<td></td>
<td>Iays 3550</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>**** Directed Department Electives ****</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MANAGEMENT OF INFORMATION SYSTEMS CREDITS: 30**

## PRACTICUM COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 4750</td>
<td>Information System Practice</td>
<td>3</td>
<td></td>
<td>Area Coordinator Approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRACTICUM CREDITS: 3**

---

****** Directed Department Electives ******

- ACCO 3330 INTERMEDIATE ACCOUNTING
- ACCO 3360 FEDERAL INCOME TAX
- MGMT 3610 HUMAN RESOURCES MANAGEMENT
- MGMT 3230 CONSTRUCTION MATERIALS & METHODS
- MGMT 3110 MANAGERIAL ACCOUNTING
- STAT 4120 ADVANCED STATISTICS
- MGMT 4810 TOTAL QUALITY MANAGEMENT
- MGMT 4230 FINANCIAL PROJECT PLANNING

- ACCO 3310 COST ACCOUNTING
- ACCO 3350 PUERTO RICO INCOME TAX
- MGMT 3210 CONSTRUCTION MANAGEMENT
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 3120 OPERATIONS & PRODUCTION MANAGEMENT I
- MGMT 3020 ORGANIZATIONAL BEHAVIOR
- MARK 3410 SALES & RETAIL MANAGEMENT
- MARK 3450 ADVERTISING

Credits towards degree 33
GENERAL BUSINESS ADMINISTRATION COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 2020</td>
<td>Business Spanish</td>
<td>3</td>
<td></td>
<td>Span 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 2020</td>
<td>Business English</td>
<td>3</td>
<td></td>
<td>Engl 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2010</td>
<td>Accounting Principles I</td>
<td>4</td>
<td></td>
<td>Math 0110, Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2020</td>
<td>Accounting Principles II</td>
<td>4</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3010</td>
<td>Micro Economics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3020</td>
<td>Macro Economics</td>
<td>3</td>
<td></td>
<td>Econ 3010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2010</td>
<td>Probabilities and Statistics</td>
<td>3</td>
<td></td>
<td>Math 131, Comp 110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2020</td>
<td>Statistics &amp; Hypothesis Testing</td>
<td>3</td>
<td></td>
<td>Stat 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fina 2010</td>
<td>Finance</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 1010</td>
<td>Marketing</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 1010</td>
<td>Introduction to Management</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2020</td>
<td>Business Law</td>
<td>3</td>
<td></td>
<td>Mgmt 1010, Sahu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2010</td>
<td>Organization Theory Mgmt</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GENERAL BUSINESS ADMINISTRATION CREDITS: 41

FREE ELECTIVE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FREE ELECTIVE CREDITS: 6

Credits towards degree 47

*STUDENT SHOULD TAKE SIX (6) CREDITS IN ANY OF THE UNIVERSITY OFFERINGS WITH THE APPROVAL OF STUDENT'S ACADEMIC ADVISOR. SEE ALSO THE JINT BBA-MBA OFFERING.

NOTE: NOT ALL CLASSES ARE OFFERED IN ALL SCHOOL TERMS. THE STUDENT NEEDS TO PLAN HIS/HER CLASSES CAREFULLY TO FINISH IN THE OPTIMAL TIME FRAME. ALSO, LOOK AT OUR WEB PAGE TO SEE SOME NEW CLASS OFFERINGS SINCE THE PRINTING OF THIS CATALOG. THE WEB ADDRESS IS WWW.PUPT.EDU.
# COMMON BBA COMPONENT

## PREPARATORY COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ab 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 1000</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0100</td>
<td>Preparatory Math Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td>Math 0100, CEGB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PREPARATORY CREDITS: 16**

## SOCIO-HUMANISTIC COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0111</td>
<td>Spanish Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Span 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0111</td>
<td>English Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Engl 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
<td></td>
<td>Sohu 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOCIO-HUMANISTIC CREDITS: 24**

## MATH & SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1310</td>
<td>Applied Mathematics for Business I</td>
<td>3</td>
<td></td>
<td>Placement by Admission Office or Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 1320</td>
<td>Applied Mathematics for Business II</td>
<td>3</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 1210</td>
<td>General Chemistry &amp; Laboratory</td>
<td>4</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MATH & SCIENCE CREDITS: 13**

## COMPUTER SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp 1010</td>
<td>Introduction to Computer &amp; Basic Languages</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 2010</td>
<td>Business Application Program</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 2010</td>
<td>Database Management</td>
<td>3</td>
<td></td>
<td>Comp 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPUTER SCIENCE CREDITS: 9**

Credits towards degree 46
### SEQUENTIAL CURRICULUM
### PROGRESS & ADVISORY FORM

#### MANAGEMENT COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 3610</td>
<td>Human Resources Management</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3620</td>
<td>Organizational Behavior</td>
<td>3</td>
<td></td>
<td>Mgmt 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 3630</td>
<td>Organizational Development</td>
<td>3</td>
<td></td>
<td>Mgmt 3620</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 4620</td>
<td>Strategic Management</td>
<td>3</td>
<td></td>
<td>Mgmt 3630</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 4610</td>
<td>Total Quality Management</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*** Directed Department Electives ***</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MANAGEMENT CREDITS: 20**

#### PRACTICUM COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt 4670</td>
<td>Management Practice</td>
<td>3</td>
<td></td>
<td>Area Coordinator Approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRACTICUM CREDITS: 3**

Courses towards degree 33

### *** Directed Department Electives ***

- ACCO 3330 INTERMEDIATE ACCOUNTING
- ACCO 3360 FEDERAL INCOME TAX
- ISYS 3510 MANAGEMENT INFORMATION SYSTEMS
- ISYS 3540 COMPUTER & INFORMATION TECHNOLOGY
- MGMT 3210 CONSTRUCTION MANAGEMENT
- MGMT 3220 CONSTRUCTION CONTRACTS & LEGAL DOC.
- MGMT 3120 OPERATIONS & PRODUCTION MANAGEMENT I
- MGMT 3620 ORGANIZATIONAL BEHAVIOR
- MARK 3410 SALES & RETAIL MANAGEMENT
- MARK 3450 ADVERTISING
- ACCO 3310 COST ACCOUNTING
- ACCO 3350 PUERTO RICO INCOME TAX
- ISYS 3520 BUSINESS PROGRAMMING LANG. I-COBOL
- ISYS 3560 DATA COMMUNICATION & NETWORKS I
- MGMT 3230 CONSTRUCTION MATERIALS & METHODS
- MGMT 3110 MANAGERIAL ACCOUNTING
- MGMT 4120 ADVANCED STATISTICS
- MGMT 4610 TOTAL QUALITY MANAGEMENT
- MARK 3440 PUBLIC RELATIONS
- MGMT 4230 FINANCIAL PROJECT PLANNING
## COMMON BBA COMPONENT

### PREPARATORY COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atul 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 1000</td>
<td>Preparatory English</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0100</td>
<td>Preparatory Math Algebra</td>
<td>3</td>
<td></td>
<td>Math 0100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PREPARATORY CREDITS: 16

### SOCIO-HUMANISTIC COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span 0111</td>
<td>Spanish Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Span 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0110</td>
<td>English Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 0111</td>
<td>English Reading &amp; Writing</td>
<td>3</td>
<td></td>
<td>Engl 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2010</td>
<td>Socio-humanistic Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sohu 2020</td>
<td>Socio-humanistic Studies II</td>
<td>3</td>
<td></td>
<td>Sohu 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Socio-humanistic Elective</td>
<td>3</td>
<td></td>
<td>Sohu 2020</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOCIO-HUMANISTIC CREDITS: 24

### MATH & SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1310</td>
<td>Applied Mathematics for Business I</td>
<td>3</td>
<td></td>
<td>Placement by Admission Office or Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 1320</td>
<td>Applied Mathematics for Business II</td>
<td>3</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 0110</td>
<td>Introduction to Physics</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scie 1210</td>
<td>General Chemistry &amp; Laboratory</td>
<td>4</td>
<td></td>
<td>Math 1310</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATH & SCIENCE CREDITS: 13

### COMPUTER SCIENCE COMPONENT

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp 1010</td>
<td>Introduction to Computer &amp; Basic Languages</td>
<td>3</td>
<td></td>
<td>Math 0110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 2010</td>
<td>Business Application Program</td>
<td>3</td>
<td></td>
<td>Comp 1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp 3010</td>
<td>Database Management</td>
<td>3</td>
<td></td>
<td>Comp 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COMPUTER SCIENCE CREDITS: 9

Credits towards degree 46
### General Business Administration Component

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span 2020</td>
<td>Business Spanish</td>
<td>3</td>
<td></td>
<td>Span 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engl 2020</td>
<td>Business English</td>
<td>3</td>
<td></td>
<td>Engl 0111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2010</td>
<td>Accounting Principles I</td>
<td>4</td>
<td></td>
<td>Math 0110, Comp 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acco 2020</td>
<td>Accounting Principles II</td>
<td>4</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3010</td>
<td>Micro Economics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Econ 3020</td>
<td>Macro Economics</td>
<td>3</td>
<td></td>
<td>Econ 3010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2010</td>
<td>Probabilities and Statistics</td>
<td>3</td>
<td></td>
<td>Math 131, Comp 110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stat 2020</td>
<td>Statistics &amp; Hypothesis Testing</td>
<td>3</td>
<td></td>
<td>Stat 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fina 2010</td>
<td>Finance</td>
<td>3</td>
<td></td>
<td>Acco 2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 1010</td>
<td>Marketing</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 1010</td>
<td>Introduction to Management</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2020</td>
<td>Business Law</td>
<td>3</td>
<td></td>
<td>Mgmt 1010, Sohu 2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt 2010</td>
<td>Organization Theory Mgmt</td>
<td>3</td>
<td></td>
<td>Mgmt 1010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**General Business Administration Credits:** 41

### Free Elective Component

<table>
<thead>
<tr>
<th>COURSE</th>
<th>COURSE TITLE</th>
<th>CR</th>
<th>SEC</th>
<th>PRE-REQUISITES</th>
<th>DATE PASSED</th>
<th>FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Elective</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Free Elective Credits:** 6

**Credits towards degree:** 47

---

**Note:**

- Student should take six (6) credits in any of the university offerings with the approval of student's academic advisor. See also the joint BBA-MBA offering.

---

**Note:**

- Not all classes are offered in all school terms. The student needs to plan his/her classes carefully to finish in the optimal time frame. Also, look at our web page to see some new class offerings since the printing of this catalog. The web address is www.pupr.edu.
<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Crd</th>
<th>Grades</th>
<th>Data</th>
<th>Initial</th>
<th>Equiv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATUL 0100</td>
<td>Adjustment to University Life</td>
<td>3</td>
<td>APR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 0100</td>
<td>Preparatory English</td>
<td>3</td>
<td>ACR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 0110</td>
<td>English Grammar</td>
<td>3</td>
<td>SUB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 0100</td>
<td>Preparatory Mathematics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 0110</td>
<td>Algebra</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 0110</td>
<td>Introduccion to Physics</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 0100</td>
<td>Preparatory Spanish</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 0110</td>
<td>Spanish Grammar</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 1010</td>
<td>The Essay as a Literary Genre</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGL 2010</td>
<td>Analysis of World Literature</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIST 3510</td>
<td>Historiography</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIST 3010A</td>
<td>History of Puerto Rico</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOHU 2010</td>
<td>Socio-Humanistics Studies I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOHU 2020</td>
<td>Socio-Humanistics Studies II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 1010</td>
<td>Linguistic Analysis of Literacy Forms</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAN 2010</td>
<td>Hispanic Literature</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIC SCIENCES AND MATHEMATICS (9 Credit-Hours)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 1340</td>
<td>Precalculus I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 1240</td>
<td>Precalculus II</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE 2410</td>
<td>General Physics I</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>Course Title</td>
<td>Credits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARST 4010</td>
<td>Structures III: Steel</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARST 4020</td>
<td>Structures IV: Concrete</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARTE 1010</td>
<td>Introduction to Technology</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARTE 2010</td>
<td>Materials &amp; Methods</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARTE 3010</td>
<td>Site Planning</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARTE 4010</td>
<td>Electricity, Acoustics and Telecommunications</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARTE 4020</td>
<td>Environmental and Mechanical Systems</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ELECTIVES (36 CREDITS)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCC 0400L</td>
<td>Architectural Representation</td>
<td>3</td>
</tr>
<tr>
<td>ARRH 0400L</td>
<td>History / Theory</td>
<td>3</td>
</tr>
<tr>
<td>ARTE 0400L or ARCT 0400L</td>
<td>Technology / Structures</td>
<td>3</td>
</tr>
</tbody>
</table>

**ELECTIVES**

<table>
<thead>
<tr>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>
APPENDIX J
Classroom Assessment User's Guide

A- Introduction
B- Principles of Good Practice for Assessing Student Learning
C- The Program Evaluation Standards
D- Course Goals and Performance Objectives
E- TQM Tools and Techniques
F- TQM in the Classroom
systematic diagram and nominal groups process are discussed. Control charts such as the p chart, the c chart, the x-R chart and flow charts are also explained. Force field analysis, and institutional self assessment viewed from the Malcolm Baldrige award standpoint are exposed. Other tools such as the Histogram, the part diagram, the RUN chart are helpful in analyzing data. Similarly, Scenario Builder, Quality Index Rating Profile, the Individual Moving Range (X-MR) chart the Cause and Effective diagram, the Cross-Functional Process Flow diagram, the Process Decision Program chart me Bubble chart, the activity Network diagram, Prioritization Matrices and the Competency Matrix are also described.

Additionally, a series of ideas about how to conduct assessment in the classroom are analyzed in the column TQM in the Classroom. These ideas may be very helpful to the professor in preparing himself/herself to conduct continuous assessment in the classroom. Continuous Improvement in the teaching-learning process is the most welcome achievement both by the professor and the student.
PRINCIPLES OF GOOD PRACTICE FOR ASSESSING STUDENT LEARNING

Developed under the auspices of the AAHE Assessment Forum

American colleges have a long history of grading and certifying student work. The more recent practice of assessment builds on that history by looking at student achievement not only within courses but across them, asking about cumulative learning outcomes. As a systematic process of gathering, interpreting, and using information about student learning, assessment is a powerful tool for educational improvement.

Today, hundreds of colleges and universities are doing assessment, at the classroom, program, and institutional levels. The practice has become a universal expectation for accreditation and a frequent object of state mandate; nine out of ten institutions now report that they have some type of assessment activity under way. Along the way, a "wisdom of practice" has emerged: the nine principles that follow constitute an attempt to capture some of that practical wisdom.

A Vision of Education

What, more specifically, is the intent of this document? We hope, first, that campuses will find these principles helpful for examining current practice and for developing and discussing their own principles. Further, we hope that the principles here will support campus assessment leaders in their work with the administrators, policymakers, and legislators who often set the conditions that determine whether assessment will lead to real improvement. This second purpose seems especially important given the current national debate about educational standards, testing, and accountability; the links between assessment and improved student learning must not be lost in this debate.

The core value behind this document is the importance of improving student learning. Implicit in the principles that follow is a vision of education that entails high expectations for all students, active forms of learning, coherent curricula, and effective out-of-class opportunities; to these ends, we need assessment — systematic, usable information about student learning — that helps us fulfill our responsibilities to the students who come to us for an education and to the publics whose trust supports our work.

The authors of this statement are twelve practitioner-students of assessment as it has developed on campuses and to some extent at the K-12 level. We know that no one best way exists for the doing of assessment, but effective practices have things in common. We hope you'll find this statement helpful.

December 1992

The Authors

Alexander W. Astin, University of California at Los Angeles; Trudy W. Banta, Indiana University-Purdue University at Indianapolis; K. Patricia Cross, University of California, Berkeley; Elaine El-Khawas, American Council on Education; Peter T. Ewell, National Center for Higher Education Management Systems; Pat Hutchings, American Association for Higher Education; Theodore J. Marchese, American Association for Higher Education; Kay M. McClenny, Education Commission of the States; Marcia Mentkowski, Alverno College; Margaret A. Miller, State Council of Higher Education for Virginia; E. Thomas Moran, State University of New York, Plattsburgh; Barbara D. Wright, University of Connecticut.
PRINCIPLES OF GOOD PRACTICE
FOR ASSESSING STUDENT LEARNING*

1 The assessment of student learning begins with educational values.
Assessment is not an end in itself but a vehicle for educational improvement. Its effective practice, then, begins with and enacts a vision of the kinds of learning we most value for students and strive to help them achieve. Educational values should drive not only what we choose to assess but also how we do so. Where questions about educational mission and values are skipped over, assessment threatens to be an exercise in measuring what’s easy, rather than a process of improving what we really care about.

2 Assessment is most effective when it reflects an understanding of learning as multidimensional, integrated, and revealed in performance over time.
Learning is a complex process. It entails not only what students know but what they can do with what they know; it involves not only knowledge and abilities but values, attitudes, and habits of mind that affect both academic success and performance beyond the classroom. Assessment should reflect these understandings by employing a diverse array of methods, including those that call for actual performance, using them over time so as to reveal change, growth, and increasing degrees of integration. Such an approach aims for a more complete and accurate picture of learning, and therefore firmer bases for improving our students’ educational experience.

3 Assessment works best when the programs it seeks to improve have clear, explicitly stated purposes.
Assessment is a goal-oriented process. It entails comparing educational performance with educational purposes and expectations — these derived from the institution’s mission, from faculty intentions in program and course design, and from knowledge of students’ own goals. Where program purposes lack specificity or agreement, assessment as a process pushes a campus toward clarity about where to aim and what standards to apply; assessment also prompts attention to where and how program goals will be taught and learned. Clear, shared, implementable goals are the cornerstone for assessment that is focused and useful.

4 Assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes.
Information about outcomes is of high importance; where students “end up” matters greatly. But to improve outcomes, we need to understand student experience along the way — about the curricula, teaching, and kind of student effort that lead to particular outcomes. Assessment can help us understand which students learn best under what conditions; with such knowledge comes the capacity to improve the whole of their learning.

5 Assessment works best when it is ongoing, not episodic.
Assessment is a process whose power is cumulative. Though isolated, “one-shot” assessment can be better than none, improvement is best fostered when assessment entails a linked series of activities undertaken over time. This may mean tracking the progress of individual students, or of cohorts of students; it may mean collecting the same examples of student performance or using the same instrument semester after semester. The point is to monitor progress toward intended goals in a spirit of continuous improvement. Along the way, the assessment process itself should be evaluated and refined in light of emerging insights.
6 Assessment fosters wider improvement when representatives from across the educational community are involved.
Student learning is a campus-wide responsibility, and assessment is a way of enacting that responsibility. Thus, while assessment efforts may start small, the aim over time is to involve people from across the educational community. Faculty play an especially important role, but assessment’s questions can’t be fully addressed without participation by student-affairs educators, librarians, administrators, and students. Assessment may also involve individuals from beyond the campus (alumni/ae, trustees, employers) whose experience can enrich the sense of appropriate aims and standards for learning. Thus understood, assessment is not a task for small groups of experts but a collaborative activity; its aim is wider, better-informed attention to student learning by all parties with a stake in its improvement.

7 Assessment makes a difference when it begins with issues of use and illuminates questions that people really care about.
Assessment recognizes the value of information in the process of improvement. But to be useful, information must be connected to issues or questions that people really care about. This implies assessment approaches that produce evidence that relevant parties will find credible, suggestive, and applicable to decisions that need to be made. It means thinking in advance about how the information will be used, and by whom. The point of assessment is not to gather data and return “results”; it is a process that starts with the questions of decision-makers, that involves them in the gathering and interpreting of data, and that informs and helps guide continuous improvement.

8 Assessment is most likely to lead to improvement when it is part of a larger set of conditions that promote change.
Assessment alone changes little. Its greatest contribution comes on campuses where the quality of teaching and learning is visibly valued and worked at. On such campuses, the push to improve educational performance is a visible and primary goal of leadership; improving the quality of undergraduate education is central to the institution’s planning, budgeting, and personnel decisions. On such campuses, information about learning outcomes is seen as an integral part of decision making, and avidly sought.

9 Through assessment, educators meet responsibilities to students and to the public.
There is a compelling public stake in education. As educators, we have a responsibility to the publics that support or depend on us to provide information about the ways in which our students meet goals and expectations. But that responsibility goes beyond the reporting of such information; our deeper obligations — to ourselves, our students, and society — is to improve. Those to whom educators are accountable have a corresponding obligation to support such attempts at improvement.

* Development of this document was sponsored by the American Association for Higher Education (AAHE) and supported by the Fund for the Improvement of Postsecondary Education (FIPSE); publication and dissemination was supported by the Exxon Education Foundation. Copies may be made without restriction; packets of 25 are available free while supplies last from Assessment Principles of Good Practice, AAHE, One Dupont Circle, Suite 360, Washington, DC 20036-1110; ph. 202/293-6440, fax 202/293-0073.
THE PROGRAM EVALUATION STANDARDS

Sound evaluations of educational programs, projects, and materials in a variety of settings should have four basic attributes:

- Utility
- Feasibility
- Propriety
- Accuracy

The Program Evaluation Standards, established by sixteen professional education associations, identify evaluation principles that when addressed should result in improved program evaluations containing the above four attributes.

Dr. James R. Sanders, Chair
The Joint Committee on Standards for Educational Evaluation
The Evaluation Center
Western Michigan University
Kalamazoo, Michigan 49008-5178
616-387-5895

Sage Publications, Inc.
2455 Teller Road
Thousand Oaks, CA 91320
805-499-0721

JCEE PR-1994

This tearout is not copyrighted material. Reproduction and dissemination are encouraged.

Utility

The utility standards are intended to ensure that an evaluation will serve the information needs of intended users.

U1 Stakeholder Identification Persons involved in or affected by the evaluation should be identified, so that their needs can be addressed.

U2 Evaluator Credibility The persons conducting the evaluation should be both trustworthy and competent to perform the evaluation, so that the evaluation findings achieve maximum credibility and acceptance.

U3 Information Scope and Selection Information collected should be broadly selected to address pertinent questions about the program and be responsive to the needs and interests of clients and other specified stakeholders.

U4 Values Identification The perspectives, procedures, and rationale used to interpret the findings should be carefully described, so that the bases for value judgments are clear.

U5 Report Clarity Evaluation reports should clearly describe the program being evaluated, including its context, and the purposes, procedures, and findings of the evaluation, so that essential information is provided and easily understood.

U6 Report Timeliness and Dissemination Significant interim findings and evaluation reports should be disseminated to intended users, so that they can be used in a timely fashion.

U7 Evaluation Impact Evaluations should be planned, conducted, and reported in ways that encourage follow-through by stakeholders, so that the likelihood that the evaluation will be used is increased.

Feasibility

The feasibility standards are intended to ensure that an evaluation will be realistic, prudent, diplomatic, and frugal.

F1 Practical Procedures The evaluation procedures should be practical, to keep disruption to a minimum while needed information is obtained.

F2 Political Viability The evaluation should be planned and conducted with anticipation of the different positions of various interest groups, so that their cooperation may be obtained, and so that possible attempts by any of these groups to curtail evaluation operations or to bias or misapply the results can be averted or counteracted.

F3 Cost Effectiveness The evaluation should be efficient and produce information of sufficient value, so that the resources expended can be justified.

Propriety

The propriety standards are intended to ensure that an evaluation will be conducted legally, ethically, and with due regard for the welfare of those involved in the evaluation, as well as those affected by its results.
P1 Service Orientation Evaluations should be designed to assist organizations to address and effectively serve the needs of the full range of targeted participants.

P2 Formal Agreements Obligations of the formal parties to an evaluation (what is to be done, how, by whom, when) should be agreed to in writing, so that these parties are obligated to adhere to all conditions of the agreement or formally to renegotiate it.

P3 Rights of Human Subjects Evaluations should be designed and conducted to respect and protect the rights and welfare of human subjects.

P4 Human Interactions Evaluators should respect human dignity and worth in their interactions with others associated with an evaluation, so that participants are not threatened or harmed.

P5 Complete and Fair Assessment The evaluation should be complete and fair in its examination and recording of strengths and weaknesses of the program being evaluated, so that strengths can be built upon and problems addressed.

P6 Disclosure of Findings The formal parties to an evaluation should ensure that the full set of evaluation findings along with pertinent limitations are made accessible to the persons affected by the evaluation, and any others with expressed legal rights to receive the results.

P7 Conflict of Interest Conflict of interest should be dealt with openly and honestly, so that it does not compromise the evaluation processes and results.

P8 Fiscal Responsibility The evaluator’s allocation and expenditure of resources should reflect sound accountability procedures and otherwise be prudent and ethically responsible, so that expenditures are accounted for and appropriate.

Accuracy

The accuracy standards are intended to ensure that an evaluation will reveal and convey technically adequate information about the features that determine worth of merit of the program being evaluated.

A1 Program Documentation The program being evaluated should be described and documented clearly and accurately, so that the program is clearly identified.

A2 Context Analysis The context in which the program exists should be examined in enough detail, so that its key influences on the program can be identified.

A3 Described Purposes and Procedures The purposes and procedures of the evaluation should be monitored and described in enough detail, so that they can be identified and assessed.

A4 Defensible Information Sources The sources of information used in a program evaluation should be described in enough detail, so that the adequacy of the information can be assessed.

A5 Valid Information The information gathering procedures should be chosen or developed and then implemented so that they will assure that the interpretation arrived at is valid for the intended use.

A6 Reliable Information The information gathering procedures should be chosen or developed and then implemented so that they will assure that the information obtained is sufficiently reliable for the intended use.

A7 Systematic Information The information collected, processed, and reported in an evaluation should be systematically reviewed and any errors found should be corrected.

A8 Analysis of Quantitative Information Quantitative information in an evaluation should be appropriately and systematically analyzed so that evaluation questions are effectively answered.

A9 Analysis of Qualitative Information Qualitative information in an evaluation should be appropriately and systematically analyzed so that evaluation questions are effectively answered.

A10 Justified Conclusions The conclusions reached in an evaluation should be explicitly justified, so that stakeholders can assess them.

A11 Impartial Reporting Reporting procedures should guard against distortion caused by personal feelings and biases of any party to the evaluation, so that evaluation reports fairly reflect the evaluation findings.

A12 Metaevaluation The evaluation itself should be formatively and summatively evaluated against these and other pertinent standards, so that its conduct is appropriately guided and, on completion, stakeholders can closely examine its strengths and weaknesses.

Guidelines and illustrative cases to assist evaluation participants in meeting each of these standards are provided in The Program Evaluation Standards (Sage, 1994). The illustrative cases are based in a variety of educational settings that include schools, universities, medical and health care fields, the military, business and industry, the government, and law.
Course Goals and Performance Objectives

Objectives are a means to focus on specific requirements of a course. They facilitate the selection of content, teaching techniques and strategies, and assessment procedures. There is an important first step that must come before the development of performance objectives—deciding on course goals. These are usually presented to the students in the course outline and are stated in general terms which inform the students about the purpose of the course and expectations of the instructor(s). The primary difference between course goals and performance objectives is that course goals are intended to provide general information and thus are not measurable, while performance objectives indicate concrete measurable outcomes. Performance objectives are developed from course goals. Examples of terms used in the construction of course goals are:

- gain an understanding of
- become aware of
- develop an appreciation for

Sample course goals (McBeath 1992):

**Become familiar with the social influences that affected culture**
**Introduce a chronological framework for the evolution of style in the history of art.**
**Know the characteristics of weather frontal types.**
**Grasp the significance of the changes in America during the period of the Jeffersonians.**

Performance objectives: a) indicate what concrete actions the student should be able to perform as a result of instruction, b) specify conditions under which the actions are to be performed, and c) state minimum criterion for evaluation. Once course goals have been identified, the knowledge and skills necessary for the mastery of these goals are listed. This will allow the desired behavior of the students to be described and will eliminate ambiguity concerning mastery of the objectives. Performance objectives are made up of three parts: conditions, behavior, and criterion. The conditions under which the behavior will occur are stated. This is the content—what is worth knowing, doing, or feeling. The expected behavior must be specified by name, using an observable action verb such as demonstrate, interpret, discriminate, or define. Finally, a minimum criterion (standard of performance) is stated. This specifies the degree of proficiency the student must demonstrate to master the performance objective.

When provided with (conditions) the student will be able to (behavior). Acceptable performance is (criterion).

Sample performance objectives:

Given two copies of an accident report form and the source of appropriate data, complete the accident report in compliance with the statutory regulations of the area served.

Given 25 documents to be filed alphabetically, file the documents within the files alphabetically and chronologically, where appropriate, within individual folders. No more than three documents may be misfiled.

Provided with blueprint, workpiece, work-holding device, reamers, tap wrench, lubricant, drill press, and lathe center, hand ream hole to a tolerance of +0.0001" to +0.0005".


(Foundations Coalition 4-94)
AFFECTIVE learning is demonstrated by behaviors indicating attitudes of awareness, interest, attention, concern, and responsibility, ability to listen and respond in interactions with others, and ability to demonstrate those attitudinal characteristics or values which are appropriate to the test situation and the field of study.

<table>
<thead>
<tr>
<th>Level</th>
<th>Illustrative Verbs</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiving</td>
<td>asks, chooses, describes, follows, gives, holds, identifies, locates, names, points to, selects, sits erect, replies, uses</td>
<td>willingness to receive or attend</td>
<td>listening to discussions of controversial issues with an open mind, respecting the rights of others</td>
</tr>
<tr>
<td>Responding</td>
<td>answers, assists, complies, conforms, discusses, greets, helps, labels, performs, practices, presents, reads, recites, reports, selects, tells, writes</td>
<td>active participation indicating positive response or acceptance of an idea or policy</td>
<td>completing homework assignments, participating in team problem-solving activities</td>
</tr>
<tr>
<td>Valuing</td>
<td>completes, describes, differentiates, explains, follows, forms, initiates, invites, joins, justifies, proposes, reads, reports, selects, shares, studies, works</td>
<td>expressing a belief or attitude about the value or worth of something</td>
<td>accepting the idea that integrated curricula is a good way to learn, participating in a campus blood drive</td>
</tr>
<tr>
<td>Organization</td>
<td>adheres, alters, arranges, combines, compares, completes, defends, explains, generalizes, identifies, integrates, modifies, orders, organizes, prepares, relates, synthesizes</td>
<td>organizing various values into an internalized system</td>
<td>recognizing own abilities, limitations, and values and developing realistic aspirations</td>
</tr>
<tr>
<td>Characterization by a value or value complex</td>
<td>acts, discriminates, displays, influences, listens, modifies, performs, practices, proposes, qualifies, questions, revises, serves, solves, uses, verifies</td>
<td>the value system becomes a way of life</td>
<td>a person's lifestyle influences reactions to many different kinds of situations</td>
</tr>
</tbody>
</table>

COGNITIVE learning is demonstrated by knowledge recall and the intellectual skills: comprehending information, organizing ideas, analyzing and synthesizing data, applying knowledge, choosing among alternatives in problem-solving, and evaluating ideas or actions.

<table>
<thead>
<tr>
<th>Level</th>
<th>Illustrative Verbs</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state</td>
<td>remembering previously learned information</td>
<td>memory of specific facts, terminology, rules, sequences, procedures, classifications, categories, criteria, methodology, principles, theories, and structure</td>
</tr>
<tr>
<td>Comprehension</td>
<td>classify, convert, defend, describe, discuss, distinguish, estimate, explain, express, extend, generalize, give examples, identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate</td>
<td>grasping the meaning of information</td>
<td>stating problem in own words, translating a chemical formula, understanding a flow chart, translating words and phrases from a foreign language</td>
</tr>
<tr>
<td>Application</td>
<td>apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate, schedule, show, sketch, solve, use, write</td>
<td>applying knowledge to actual situations</td>
<td>taking principles learned in math and applying them to figuring the volume of a cylinder in an internal combustion engine</td>
</tr>
<tr>
<td>Analysis</td>
<td>analyze, appraise, break down, calculate, categorize, compare, contrast, criticize, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, model, outline, point out, question, relate, select, separate, subdivide, test</td>
<td>breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized</td>
<td>discussing how fluids and liquids differ, detecting logical fallacies in a student's explanation of Newton's 1st law of motion</td>
</tr>
<tr>
<td>Synthesis</td>
<td>arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, design, explain, formulate, generate, integrate, manage, modify, organize, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write</td>
<td>rearranging component ideas into a new whole</td>
<td>writing a comprehensive report on a problem-solving exercise, planning a program or panel discussion, writing a comprehensive term paper</td>
</tr>
<tr>
<td>Evaluation</td>
<td>appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value</td>
<td>making judgments based on internal evidence or external criteria</td>
<td>evaluating alternative solutions to a problem, detecting inconsistencies in the speech of a student government representative</td>
</tr>
</tbody>
</table>

PSYCHOMOTOR learning is demonstrated by physical skills: coordination, dexterity, manipulation, grace, strength, speed; actions which demonstrate the fine motor skills such as use of precision instruments or tools, or actions which evidence gross motor skills such as the use of the body in dance or athletic performance.

<table>
<thead>
<tr>
<th>Level</th>
<th>Illustrative Verbs</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception</td>
<td>chooses, describes, detects, differentiates, distinguishes, identifies, isolates, relates, selects, separates</td>
<td>using sense organs to obtain cues needed to guide motor activity</td>
<td>listening to the sounds made by guitar strings before tuning them, recognizing sounds that indicate malfunctioning equipment</td>
</tr>
<tr>
<td>Set</td>
<td>begins, displays, explains, moves, proceeds, reacts, responds, snows, starts, volunteers</td>
<td>being ready to perform a particular action: mental, physical or emotional</td>
<td>knowing how to use a computer mouse, having instrument ready to play and watching conductor at start of a musical performance, showing eagerness to assemble electronic components to complete a task</td>
</tr>
<tr>
<td>Guided response</td>
<td>assembles, builds, calibrates, constructs, dismantles, displays, dissolves, fastens, fixes, grinds, heats, manipulates, measures, mends, mixes, organizes, sketches</td>
<td>performing under guidance of a model: imitation or trial and error</td>
<td>using a torque wrench just after observing an expert demonstrate a its use, experimenting with various ways to measure a given volume of a volatile chemical</td>
</tr>
<tr>
<td>Mechanism</td>
<td>(same list as for guided response)</td>
<td>being able to perform a task habitually with some degree of confidence and proficiency</td>
<td>demonstrating the ability to correctly execute a 60 degree banked turn in an aircraft 70 percent of the time</td>
</tr>
<tr>
<td>Complex or overt response</td>
<td>(same list as for guided response)</td>
<td>performing a task with a high degree of proficiency and skill</td>
<td>dismantling and re-assembling various components of an automobile quickly with no errors</td>
</tr>
<tr>
<td>Adaptation</td>
<td>adapts, alters, changes, rearranges, reorganizes, revises, varies</td>
<td>using previously learned skills to perform new but related tasks</td>
<td>using skills developed learning how to operate an electric typewriter to operate a word processor</td>
</tr>
<tr>
<td>Origination</td>
<td>arranges, combines, composes, constructs, creates, designs, originates</td>
<td>creating new performances after having developed skills</td>
<td>designing a more efficient way to perform an assembly line task</td>
</tr>
</tbody>
</table>

Bloom's taxonomy:

<table>
<thead>
<tr>
<th>Level</th>
<th>Illustrative Verbs</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state</td>
<td>remembering previously learned information</td>
</tr>
<tr>
<td>Comprehension</td>
<td>classify, convert, defend, describe, discuss, distinguish, estimate, explain, express, extend, generalize, give examples, identify, Indicate, Infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate</td>
<td>grasping the meaning of information</td>
</tr>
<tr>
<td>Application</td>
<td>apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate, schedule, show, sketch, solve, use, write</td>
<td>applying knowledge to actual situations</td>
</tr>
<tr>
<td>Analysis</td>
<td>analyze, appraise, break down, calculate, categorize, compare, contrast, criticize, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, model, outline, point out, question, relate, select, separate, subdivide, test</td>
<td>breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized</td>
</tr>
<tr>
<td>Synthesis</td>
<td>arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, design, explain, formulate, generate, integrate, manage, modify, organize, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write</td>
<td>rearranging component ideas into a new whole</td>
</tr>
<tr>
<td>Evaluation</td>
<td>appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value</td>
<td>making judgments based on internal evidence or external criteria</td>
</tr>
</tbody>
</table>
### Outcomes Assessment Planning Matrix

<table>
<thead>
<tr>
<th>Objective (as stated is not measurable)</th>
<th>Performance Specifications (measurable)</th>
<th>Practice</th>
<th>Assessment Method</th>
<th>When Assess'd</th>
<th>Who Assesses</th>
<th>Results Reported (When/Whom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State program achieved 1917 standards</td>
<td>Various specifications met</td>
<td>Methods</td>
<td>Methods</td>
<td>Methods</td>
<td>Methods</td>
<td>Improvements made</td>
</tr>
</tbody>
</table>

---

G.M. Rogers-Rose-Hulman Institute of Technology
SELF AND THIRD PARTY REPORTS
(Asking individuals to share their perceptions of their own attitudes and/or behaviors or those of others.)

Written Surveys and Questionnaires
(Including direct or mailed, signed or anonymous)

Advantages:
- Typically yield the perspective that students, alumni, the public, etc., have of the institution which may lead to changes especially beneficial to relationships with these groups.
- Convey a sense of importance regarding the opinions of constituent groups.
- Can cover a broad range of content areas within a brief period of time.
- Results ten to be more easily understood by lay persons.
- Can cover areas of learning and development which might be difficult or costly to assess more directly.
- Can provide accessibility to individuals who otherwise would be difficult to include in assessment efforts (e.g., alumni, parents, employers).

Disadvantages
- Results tend to be highly dependent on wording of items, salience of survey or questionnaire, and organization of instrument. Thus, good surveys and questionnaires are more difficult to construct than they appear.
- Frequently rely on volunteer samples which tend to be biased.
- Mail surveys tend to yield low response rates.
- Require careful organization in order to facilitate data analysis via computer for large samples.
- Commercially prepared surveys tend not to be entirely relevant to an individual institution and its students.
- Forced response choices may not allow respondents to express their true opinions.
- Results reflect perceptions which individuals are willing to report and thus tend to consist of indirect data.
- Locally developed instrument may not provide external references for results.

Ways to Reduce Disadvantages:
- Use only carefully constructed instruments that have been reviewed by survey experts.
- Include open-ended, respondent worded items along with forced-choice.
- If random sampling or surveying of the entire target population is not possible, obtain the maximum sample size possible and follow-up with nonrespondents (preferably in person or by phone).
- If commercially prepared surveys are used, add locally developed items of relevance to the institution.
- If locally developed surveys are used, attempt to include at least some externally-reference items (e.g., from surveys for which national data are available).
- Word reports cautiously to reflect the fact that results represent perceptions and opinions respondents are willing to share publicly.
- Use pilot or "try out" samples in local development of instruments and request formative feedback from respondents on content clarity, sensitivity, and format.
- Cross-validate results through other sources of data.

BOTTOM LINES
A relatively inexpensive way to collect data on important evaluative topics from a large number of respondents. Must always be treated cautiously, however, since results only reflect what subjects are willing to report about their perception of their attitudes and/or behaviors.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88. Winter 94. Material used with permission of author.
SELF AND THIRD PARTY REPORTS
(Asking individuals to share their perceptions of their own attitudes and/or behaviors or those of others.)

EXIT INTERVIEW AND OTHER INTERVIEWS
(Evaluating student reports of their attitudes and/or behaviors in a face-to-face interrogative dialogue.)

Advantages
- Student interviews tend to have most of the attributes of surveys and questionnaires with the exception of requiring direct contact, which may limit accessibility to certain populations. Exit interviews also provide the following additional advantages:
  - Allow for more individualized questions and follow-up probes based on the responses of interviewees.
  - Provide immediate feedback
  - Include same observational and formative advantages as oral examinations.
  - Frequently yield benefits beyond data collection that come from opportunities to interact with students and other groups.
  - Can include a greater variety of items than is possible on surveys and questionnaires, including those that provide more direct measures of learning and development.

Disadvantages
- Require direct contact, which may be difficult to arrange.
- May be intimidating to interviewees, thus biasing results in the positive direction.
- Results tend to be highly dependent on wording of items and the manner in which interviews are conducted.
- Time consuming, especially if large numbers of persons are to be interviewed.

Ways to Reduce Disadvantages
- Plan the interviews carefully with assistance from experts
- Provide training sessions for interviewers that include guidance in putting interviewees at ease and related interview skills.
- Interview random samples of students when it is not feasible to interview all.
- Conduct telephone interviews when face-to-face contact is not feasible.
- Develop an interview format and questions with a set time limit in mind.
- Conduct pilot-testing of interview and request interviewee formative feedback.
- Interview small groups of individuals when individual interviewing is not possible or is too costly.

BOTTOM LINES
Interviews provide opportunities to cover a broad range of content and to interact with respondents. Opportunities to follow-up responses can be very valuable. Direct contact may be difficult to arrange, costly, and potentially threatening to respondents unless carefully planned.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges. No. #88, Winter 94. Material used with permission of author.*
SELF AND THIRD PARTY REPORTS
(Asking individuals to share their perceptions of their own attitudes and/or behaviors or those of others.)

Third Party Reports
(Influences regarding student/alumni attitudes or observations on student/alumni behaviors, made by someone other than the student or assessor, e.g., parents, faculty, employers, etc.)

Advantages

Third-party reports tend to have attributes similar to student self-reports, plus the following additional advantages:

- Can provide unique consumer input, valuable in its own right (especially employers and parents). How is our college serving their purposes?
- Offer different perspectives, presumably less biased than either student or assessor.
- Enable recognition and contact with important, often under-valued constituents. Relations may improve by just asking for their input.
- Can increase both internal validity (through "convergent validity"/"triangulation" with other data) and external validity (by adding more "natural" perspective).

Disadvantages

Similar to disadvantages to self-reports, plus...

- As with any indirect data, inference and reports risk high degree of error.
- Third-parties can be biased too, in directions more difficult to anticipate than self-reports.
- Less investment by third-parties in assessment processes often means lower response rates, even lower than student/alumni rates.
- Usually more logistical, time-and-motion problems (e.g., identifying sample, making contact, getting useful responses, etc.), therefore more costly than it looks.
- If information about individuals is requested, confidentiality becomes an important and sometimes problematic issue that must be addressed carefully.

Ways to Reduce Disadvantages

- Conduct face-to-face or phone interviews wherever possible, increasing validity through probing and formative evaluation during dialogue.
- Very careful, explicit directions for types and perspectives of responses requested can reduce variability.
- Attain informed consent in cases where information about individuals is being requested.
- Coordinate contacts with other campus organs contacting the same groups, to reduce "harassment" syndrome and increase response rates.
- Other self-report and interview "ways to reduce..." apply here as well.

BOTTOM LINES

Third-party reports are valuable in that they access important data sources usually missed by other methods, but they can be problematic in cost of implementation and in gaining access to respondents. If personally identifiable information about individual students or alumni is requested, informed consent is needed.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author.
Portfolios
(Collections of multiple student work samples usually compiled over time.)

Advantages:
- Can be used to view learning and development longitudinally (e.g., samples of student writing over time can be collected), which is most valid and useful perspective.
- Multiple components of a curriculum can be measured (e.g., writing, critical thinking, research skills) at the same time.
- Samples in a portfolio are more likely than test results to reflect student ability when pre-planning, input from others, and similar opportunities common to most work settings are available (which increases generalizability/external validity of results).
- The process of reviewing and grading portfolios provides an excellent opportunity for faculty exchange and development, discussion of curriculum goals and objectives, review of grading criteria, and program feedback.
- Economical in terms of student time and effort, since no separate "assessment administration" time is required.
- Greater faculty control over interpretation and use of results.
- Results are more likely to be meaningful at all levels (i.e., the individual student, program, or institution) and can be used for diagnostic/prescriptive purposes as well.
- Avoids or minimizes "test anxiety" and other "one shot" measurement problems.
- Increases "power" of maximum performance measures over more artificial or restrictive "speed" measures on test or in-class sample.
- Increases student participation (e.g., selection, revision, evaluation) in the assessment process.

Disadvantages
- Costly in terms of evaluator time and effort.
- Management of the collection and grading process, including the establishment of reliable and valid grading criteria, is likely to be challenging.
- May not provide for externality.
- If samples to be included have been previously submitted for course grades, faculty may be concerned that a hidden agenda of the process is to validate their grading.
- Security concerns may arise as to whether submitted samples are the students' own work, or adhere to other measurement criteria.

Ways to Reduce Disadvantages
- Consider having portfolios submitted as part of a course requirement, especially a "capstone course" at the end of a program.
- Utilize portfolios from representative samples of students rather than having all students participate (this approach may save considerable time, effort, and expense but be problematic in other ways).
- Have more than one rater for each portfolio; establish inter-rater reliability through piloting designed to fine-tune rating criteria.
- Provide training for raters.
- Recognize that portfolios in which samples are selected by the students are likely represent their best work.
- Cross-validate portfolio products with more controlled student work samples (e.g., in-class tests and reports) for increased validity and security.

BOTTOM LINE
Portfolios are a potentially valuable option adding important longitudinal and "qualitative" data, in a more natural way. Particular care must be taken to maintain validity. Especially good for multiple-objective assessment.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author.
"Stone" Courses
(Courses, usually required for degree/program completion, which in addition to a full complement of instructional objectives, also serve as primary vehicles of student assessment for program evaluation purposes; e.g., Capstone, Cornerstone, and Keystone courses.)

Advantages:
- Provides for a synergistic combination of instructional and assessment objectives.
- A perfect mechanism for course-embedded assessment of student learning and development (i.e., outcomes, pre-program competencies and/or characteristics, "critical indicators," etc.)
- Can add impetus for design of courses to improve program orientation/integration/updating information for students.

BOTTOM LINE

"Stone" courses are perfect blends of assessment and instruction to serve program quality improvement and accountability goals (capstones for outcomes measures; cornerstones for pre-program measures); and should be considered by all academic programs.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author.
Archival Data
(Biographical, academic, or other file data available from college or other agencies and institutions.)

Advantages:
- Tend to be readily available, thus requiring little additional effort.
- Further utilize efforts that have already occurred.
- Cost efficient
- Constitute unobtrusive measurement, not requiring additional time or effort from students or other groups.
- Very useful for longitudinal studies

Disadvantages:
- Especially in large institutions, may require considerable effort and coordination to determine exactly what data are available campus-wide.
- If individual records are included, may raise concerns regarding protection of rights and confidentiality.
- Easy availability may discourage the development of other measures of learning and development.
- May encourage attempts to "find ways to use data" rather than measurement related to specific goals and objectives.

Ways to Reduce Disadvantages:
- Early-on in the development of an assessment program, conduct a comprehensive review of existing assessment and evaluation efforts and data typically being collected throughout the institution and its units (i.e., "campus data map").
- Be familiar with the Family Educational Rights and Privacy Act (Buckley Amendment) and avoid personally identifiable data collection without permission. Assure security/protection of records.
- Only use archival records that are relevant to specific goals and objectives of learning and development.

BOTTOM LINES
Relatively quick, easy, and cost-effective method. Usually limited data quality but integral to valuable longitudinal comparisons. Should be a standard component of all assessment programs.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author.
Behavioral Observations
(Measuring the frequency, duration, topology, etc. of student actions, usually in a natural setting with noninteracting methods.)

Advantages
- Best way to evaluate degree to which attitudes, values, etc. are really put into action (= most internal validity).
- Catching students being themselves is the most "natural" form of assessment (= best external validity).
- Least intrusive assessment option, since purpose is to avoid any interference with typical student activities.

Disadvantages
- Always some risk of confounded results due to "observer effect; " i.e., subjects may behave atypically if they know they're being observed.
- Depending on the target behavior, there may be socially or professionally sensitive issues to be dealt with (e.g., invasion of privacy on student political activities or living arrangements) or even legal considerations (e.g., substance abuse or campus crime).
- May encourage "Big Brother" perception of assessment and/or institution.
- Inexperienced or inefficient observers can produce unreliable, invalid results.

Ways to Reduce Disadvantages
- Avoid socially or ethically sensitive target behaviors, especially initially.
- Include representative student input in process of determining "sensitivity" of potential target behaviors.
- Utilize electronic "observers" (i.e., audio and videorecorders) wherever possible, for highly accurate, reliable, permanent observation record (although this may increase assessment cost in the short run if equipment is not already available.)
- Strictly adhere to ethical guidelines for the protection of human research subjects.

BOTTOM LINES
This is the best way to know what students actually do, how they manifest their motives, attitudes and values. Special care and planning are required for sensitive target behaviors, but it's usually worth it for highly valid, useful results.

"Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author."
Oral Examination

An evaluation of student knowledge levels through a face-to-face interrogative dialogue with program faculty.

(Oral exams generally have the same basic strengths and weaknesses of local tests, plus the following advantages and disadvantages:)

Advantages

- Allows measurement of student achievement in considerably greater depth and breadth through follow-up questions, probes, encouragement of detailed clarifications, etc. (= increased internal validity and formative evaluation of student abilities)
- Non-verbal (paralinguistic and visual) cues aid interpretation of student responses.
- Dialogue format decreases miscommunications and misunderstandings, in both questions and answers.
- Rapport-gaining techniques can reduce "test anxiety," helps focus and maintain maximum student attention and effort.
- Dramatically increases "formative evaluation" of student learning; i.e., clues as to how and why they reached their answers.
- Identifies and decreases error variance due to guessing.
- Provides process evaluation of student thinking and speaking skills, along with knowledge content.

Disadvantages

- Requires considerably more faculty time, since oral exams must be conducted one-to-one, or with very small groups of students at most.
- Can be inhibiting on student responsiveness due to intimidation, face-to-face pressures, oral (versus written) mode, etc. (May have similar effects on some faculty!)
- Inconsistencies of administration and probing across students reduces standardization and generalizability of results (= potentially lower external validity).

Ways to Reduce Disadvantages

- Prearrange "standard" questions, most common follow-up probes, and how to deal with typical students' problem responses; "pilot" training simulations.
- Take time to establish open, non-threatening atmosphere for testing.
- Electronically record oral exams for more detailed evaluation later.

BOTTOM LINES

Oral exams can provide excellent results, but usually only with significant — perhaps prohibitive — additional cost. Definitely worth utilizing in "Low N" programs, and for the highest priority objectives in any program.

*Prus. J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges. No. #88, Winter 94. Material used with permission of author.
Locally Developed Exams
(Objective and/or subjective tests designed by faculty of the program being evaluated.)

Advantages:
- Content and style can be geared to specific goals, objectives, and student characteristics of the institution, program, curriculum, etc.
- Specific criteria for performance can be established in relationship to curriculum.
- Process of development can lead to clarification/crystallization of what is important in the process/content of student learning.
- Local grading by faculty can provide immediate feedback related to material considered meaningful.
- Greater faculty/institutional control over interpretation and use of results.
- More direct implication of results for program improvements.

Disadvantages:
- Require considerable leadership/coordination, especially during the various phases of development.
- Costly in terms of time and effort (more “frontload” effort for objective; more “backload” effort for subjective).
- Demands expertise in measurement to assure validity/reliability/utility.
- May not provide for externality (degree of objectivity associated with review, comparisons, etc. external to the program or institution).

Ways to Reduce Disadvantages:
- Enter into consortium with other programs, departments, or institutions with similar goals and objectives as a means of reducing costs associated with developing instruments. An element of externality is also added through this approach, especially if used for test grading as well as development.
- Utilize on-campus measurement experts whenever possible for test construction and validation.
- Contract with faculty “consultants” to provide development and grading.
- Incorporate outside experts, community leaders, etc. into development and grading process.
- Embed in program requirements for maximum relevance with minimum disruption (e.g., a “capstone” course).
- Validate results through consensus with other data.

BOTTOM LINES
Most useful for individual student or program evaluation, with careful adherence to measurement principles. Must be supplemented for external validity.

*Prus, J. and Johnson, R. “Assessment & Testing Myths and Realities.” New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author.
Commercial Norm-Referenced, Standardized Exams

(Group administered, mostly or entirely multiple-choice, "objective" tests in one or more curricular areas. Scores are based on comparison with a reference or norm group.)

Advantages:

- Can be adopted and implemented quickly
- Reduce/eliminate faculty time demands in instrument development and grading (i.e., relatively low "frontloading" and "backloading" effort)
- Objective scoring
- Provide for externality of measurement (i.e., external validity)
- Provide reference group(s) comparison often required by mandates.
- May be beneficial or required in instances where state or national standards exist for the discipline or profession.

Disadvantages:

- Limit what can be measured to relatively superficial knowledge/learning.
- Eliminate the important process of learning and clarification of goals and objectives typically associated with local development of measurement instruments.
- Unlikely to measure the specific goals and objectives of a program, department, or institution.
- "Relative standing" results tend to be less meaningful than criterion-referenced results for program/student evaluation purposes.
- Norm-referenced data is dependent on the institutions in comparison group(s) and methods of selecting students to be tested in those institutions. (Caution: unlike many norm-referenced tests such as those measuring intelligence, present norm-referenced tests in higher education do not utilize, for the most part, randomly selected or well stratified national samples.)
- Group administered multiple-choice tests always include a potentially high degree of error, largely uncorrectable by "guessing correction" formulae (which lowers validity).
- Summative data only (no formative evaluation)
- Results unlikely to have direct implications for program improvement or individual student progress
- Results highly susceptible to misinterpretation/misuse both within and outside the institution

Ways to Reduce Disadvantages

- Choose test carefully, and only after faculty have reviewed available instruments and determined a satisfactory degree of match between the test and the curriculum.
- Request and review technical data, especially reliability and validity data and information on normative sample from test publishers.
- Utilize on-campus measurement experts to review reports of test results and create more customized summary reports for the institution, faculty, etc.
- Whenever possible, choose tests that also provide criterion-referenced results
- Assure that such tests are only one aspect of a multi-method approach in which no firm conclusions based on norm-referenced data are reached without cross-validation from other sources.

BOTTOM LINES

Relatively quick, easy, and inexpensive, but useful mostly where group-level performance and external comparisons of results are required. Not as useful for individual student or program evaluation.

*Prus, J. and Johnson,R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges. No. #88, Winter 94. Material used with permission of author.
COMPETENCY-BASED METHODS
(Measuring pre-operationalized abilities in most direct, real-world approach.)

Simulation
(Primarily utilized to approximate the results of performance appraisal, but when – due to the target competency involved, logistical problems, or cost – direct demonstration of the student skill is impractical.)

Advantages
- Better means of evaluating depth and breadth of student skill development than tests or other performance-based measures (= internal validity).
- More flexible; some degree of simulation can be arranged for virtually any student target skill.
- For many skills, can be group administered, thus providing and excellent combination of quality and economy.

Disadvantages
- For difficult skills, the higher the quality of simulation the greater the likelihood of the problems of performance appraisal; e.g., cost, subjectivity, etc. (see "Performance Appraisals").
- Usually requires considerable "frontloading" effort; i.e., planning and preparation.
- More expensive than traditional testing options in the short run.

Ways of Reducing Disadvantages
- Reducing problems is relatively easy, since degree of simulation can be matched for maximum validity practicable for each situation.
- Can often be "standardized" through use of computer programs (=enhanced external validity).

BOTTOM LINES
An excellent means of increasing the external and internal validity of skills assessment at a minimal long-term costs.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author.
COMPETENCY-BASED METHODS
(Measuring pre-operationalized abilities in most direct, real-world approach.)

Performance Appraisals
(Systematic measurement of overt demonstration of acquired skills.)

Advantages:
- Provide a more direct measure of what has been learned (presumably in the program)
- Go beyond paper-and-pencil tests and most other assessment methods in measuring skills
- Preferable to most other methods in measuring the application and generalization of learning to specific settings, situations, etc.
- Particularly relevant to the goals and objectives of professional training programs and disciplines with well defined skill development.

Disadvantages:
- Ratings/grading typically more subjective than standardized tests
- Requires considerable time and effort (especially front-loading), thus being costly
- Sample of behavior observed or performance appraised may not be typical, especially because of the presence of observers

Ways to Reduce Disadvantages:
- Develop specific, operational (measurable) criteria for observing and appraising performance
- Provide training for observers/appraisers
- Conduct pilot-testing in which rate of agreement (inter-rater reliability) between observers/appraisers is determined. Continue training and/or alter criteria until acceptable consistency of measurement is obtained
- Conduct observations/appraisals in the least obtrusive manner possible (e.g., use of one-way observational mirrors, videotaping, etc.)
- Observe/appraise behavior in multiple situations and settings
- Consider training and utilizing graduate students, upper level students, community volunteers, etc. as a means of reducing the cost and time demands on faculty.
- Cross-validate results with other measures

BOTTOM LINES

Generally the most highly valued but costly form of student outcomes assessment – usually the most valid way to measure skill development.

*Prus, J. and Johnson, R. "Assessment & Testing Myths and Realities." New Directions for Community Colleges, No. #88, Winter 94. Material used with permission of author.
TQM Tools and Techniques

The Affinity Diagram

In this portion of TQM/HE, we will illustrate the various quality tools and techniques and explain their uses.

A useful planning tool for defining large and/or difficult problems or processes is the affinity diagram. Invented by Kawakita Jiro, the affinity diagram tries to organize — without quantification — the issues surrounding a particular problem.

One benefit of using the affinity diagram at the start of the TQM implementation process is that it helps build consensus among the team members studying a particular problem.

An affinity diagram is rarely used alone. When used with a relations diagram and/or the nominal group process, it can help a team to identify the major root causes of a problem or issue. When these causes are identified, the group can more efficiently direct its efforts.

Procedure

1. **State the Problem**
   Under the direction of a team leader, TQM team members should arrive at a statement of the problem or issue being addressed. This is best done in the form of a question. For example: “What are the obstacles to establishing TQM throughout the institution?”

2. **Record the Perceptions**
   Each person writes his/her comments on sticky note paper or on an index card after announcing his/her idea to the group. The purpose of announcing the perception is to permit other team members to piggyback any related ideas. Each piece of note paper or index card should contain only a single idea.

   This proceeds until all team members have exhausted their perceptions. Remember, as in any brainstorming session, there’s no verbal exchange between team members. All of the notes are placed on the wall or in the center of a large conference table. Let’s assume the following perceptions were generated and posted.

3. **Group Similar and/or Related Perceptions**
   Team members place similar cards (or sticky notes) into related groups. These are said to have an “affinity” for each other. It’s important that team members do this in silence. The note pads or cards can be moved any number of times. It’s not uncommon to have as many as ten related groups or as few as three.

4. **Assign a Name to Each Group With a Header Designation**
   The team leader reads all of the cards in each group and the member agrees to a name that can be assigned to each of the groups. For each group, the team leader writes a header card. If there’s a miscellaneous group, team members should examine each perception and, if possible, place each note or card into one of the previously named groups.

   If not, it’s acceptable to have a group simply named “miscellaneous.”

   The four groups with headers are shown below:

   **Group 1**
   **The Administration**
   - The president wouldn’t permit it
   - The vice presidents wouldn’t support it
   - The deans wouldn’t support it
   - The president would feel “out of control.”

   **The governing board wouldn’t support the thrust towards quality because they’re too cheap.**

   **Group 2**
   **The Faculty and Staff**
   - The faculty would think it’s another way to increase productivity without increasing the budget.
   - The staff would agree with the faculty and they would be suspicious as to the intent of TQM.
   - The faculty wouldn’t want to form another committee to examine what TQM is all about.

   **Group 3**
   **The Union Executive Committee**
   - The union leadership would consider TQM as a management tool to make the union powerless.
   - The union wouldn’t permit full empowerment of the faculty and staff because under TQM, people would be working outside of their job descriptions and wouldn’t be compensated for their efforts.

   **Group 4**
   **Marketing Procedures**
   - There’s a total misunderstanding about what TQM is all about.
   - It’s too expensive to a quality university.
   - We have too many people set in their ways to begin thinking about new concepts.

5. **Draw the Affinity Diagram**
   Team members should tape the cards/sticky notes in each group either onto a board or a large flip chart. With the header cards at the top, the leader should draw borders around each group. In our example, the four header groups with the related issues/problems are shown below in the completed affinity diagram.
6. Discuss Each Group

Team members should discuss how each of the groups relate to the problem. This will result in a better understanding of the issues and/or processes making up the problem.

In order to arrive at deeper understandings of each of the root causes, the action team may want to use a relations diagram for each of the groups. Depending upon the problem or issue, the systematic diagram and cause and effect diagram may be of value.

Next month: The relations diagram

"If you refuse to accept anything but the best, you very often get it."
— W. Somerset Maugham

**AFFINITY DIAGRAM**

**OBSTACLES TO ESTABLISHING TQM**

<table>
<thead>
<tr>
<th>The Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>The president would not permit it.</td>
</tr>
<tr>
<td>The vice presidents would not support it.</td>
</tr>
<tr>
<td>The dean would not support it.</td>
</tr>
<tr>
<td>The president would feel out of control.</td>
</tr>
<tr>
<td>The university would not support the threat towards quality; they are too cheap.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The Faculty &amp; Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>The faculty would think it is another way to increase not meet another productivity without committee.</td>
</tr>
<tr>
<td>Increasing the budget.</td>
</tr>
<tr>
<td>The staff would agree with the faculty and they would be suspicious as to the intent of TQM.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The Union Executive Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>The union leadership would consider TQM as a management tool to make the union powerless.</td>
</tr>
<tr>
<td>The union would not permit full empowerment of the faculty and staff as people would be working outside of their job descriptions and would not be compensated for their efforts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marketing Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a total misunderstanding of what TQM and TCI are all about.</td>
</tr>
<tr>
<td>It is too expensive to have a quality university.</td>
</tr>
<tr>
<td>We have too many people set in their ways to begin to think about new concepts.</td>
</tr>
</tbody>
</table>
TQM Tools and Techniques

The Relations Diagram

designed as a planning tool, the relations diagram is rarely used alone. Instead, when used with other tools such as the affinity diagram (see TQM/HE, October 1992), the relations diagram functions as a powerful instrument for identifying the root causes and effects of a process or a problem.

When a TQI team uses the relations diagram to examine a complex problem over an extended period of time, the diagram directs its efforts towards the major root causes of the problem(s). It will also continuously update and modify the actions resulting from observed changes in the "system" under study.

Procedure

1. Statement of the Problem

Although it's possible to identify a problem/issue and then state it briefly using the relations diagram, it's more efficient to use other tools to examine a complex problem/issue before using the relations diagram.

For example, we recommend using the nominal group process and/or the affinity diagram to arrive at a consensus on the process/issue under investigation, then analyze the findings further with the relations diagram.

(Ed. note: The nominal group process consists of six stages, summarized as follows:

- A facilitator explains the nominal group process to the participants.
- The facilitator presents the question to be considered and asks each participant to take five minutes to jot down specific three- to five-word answers, working quietly and independently.
- The facilitator asks each participant in turn to read aloud one of the answers on his/her list. The facilitator lists each answer on a master list. This continues until all participants have given all their answers. There's no discussion at this point.
- The facilitator asks each participant to rank what he/she believes to be the five most important answers, assigning a value to each, from 5 for the top priority to 1 for the lowest.
- The facilitator tallies the score for each answer, putting the results on the master list for all to consider. The participants then elaborate, defend, or dispute the items, no matter what their rank. They may not, however, add any items to the list. The purpose of this stage is to express opinions and persuade other participants. The facilitator keeps the discussion orderly and prevents any participants from dominating.
- The facilitator asks each participant to rank the top five answers once again. The facilitator then records those tallies on the master list. This provides a final ranking of issues.)

The example below followed a session with the chairs and the dean in a school of technology. The dean and her faculty were attempting to start a new degree program in total quality management.

Since the college was under considerable financial constraints, it was difficult for them to obtain optimistic support from other areas within the institution.
After using the affinity diagram to analyze the issue, the TQI team posted the following header cards to the question, "What are the issues associated with our establishing a new B.S. degree in TQM?"
- Develop and distribute a needs survey.
- Demonstrate need to the vice president of academic affairs.
- Gain the curriculum committee's support.
- Gain regional business support and input.
- Gain the faculty's support.
- Develop a curriculum.
- Develop and implement informational activities.

In order to arrive at the root cause and effects of the issue, the team next did a relations diagram, which is shown below.

2. Record the Perceptions
Place the header cards from the affinity diagram in a circular pattern around the problem/issue being examined, as shown below. This can be done on an overhead projector, but a large sheet of flip chart paper is usually better.

3. Demonstrate Interrelationships
One should ask if there's a "cause-and-effect" between the header groups. If a relationship exists, draw a line to connect the headers. An arrow is placed from the header that causes something to affect another header.

In the diagram below, for example, the team decided it was necessary to develop and distribute a survey to gain support and input from regional industries. As a result, team members drew arrows away from the cause to the header it would affect or influence. The interrelations are continually examined until all headers are compared with each other.

After comparing headers, the team assembled diagram A:

4. Analyze the Interrelationships
Count the number of arrows directed toward individual headers and the number that leave. Express this as a ratio (A towards: A from). Write the numbers next to their respective headers, as shown in diagram A.

The root causes are those headers that have the greatest number of arrows going from; the root effects are those headers having the greatest number of arrows going toward.

In the above example, the two root causes suggest that the TQI team should conduct a needs survey and get regional business support in order to positively affect the curriculum committee and the VPAA.

To demonstrate the power in this simple tool, we refer the reader to the affinity diagram in the October 1992 issue of TQM/HE. When the TQI team from that institution did a relations diagram on the slightly modified headers from the affinity diagram, they obtained diagram B:

The results were clear. Before this institution could implement TQM, the TQI team would need to implement marketing procedures for the administration, faculty and staff, and the union executive committee. (Actually, the initial "marketing procedures" was simply to conduct educational workshops.)

Next month: The systematic diagram.

"Wealth does not bring excellence, but wealth comes from excellence." — Plato
TQM Tools and Techniques

The Systematic Diagram

As a planning tool, the systematic diagram is used to determine the specific action steps necessary to achieve a broader goal, especially if a number of people/departments/units are involved. It's usually not used alone but with an affinity diagram or a relations diagram.

Procedure

1. State the Problem

We will build upon the example presented in the November 1992 issue of TQM/HE when we discussed the relations diagram. A task force consisting of the dean and a group of faculty in the School of Technology were attempting to establish a B.S. degree program in TQM.

After using an affinity diagram and a relations diagram to examine the issues surrounding the goal, the task force continued examining the problem with the systematic diagram. The goal is drawn on the left-hand side of the paper. This can be done using an overhead projector or a large sheet of flip-chart paper.

2. Generate Levels of Events and Actions Necessary to Achieve the Ends

The first level of events and actions is usually broad, but as one moves from left to right the tasks become very specific. One level builds upon the other.

In the example that follows, the task force knows that it ultimately will require approval from the chancellor's office and support from the president, vice president of academic affairs, and the council of trustees if they are to accomplish their goal.

In order for the upper-level approval to occur, however, the task force recognizes that it will require support from the academic deans, curriculum committee, and the faculty senate, and will need to develop a curriculum, do a needs survey, and obtain support from regional businesses. The various steps are spelled out in the completed systematic diagram.
3. Analyze the Diagram and Assign Tasks

After completing the systematic diagram, task force members should analyze their findings and discuss them with members of their department/unit. Then specific tasks or action steps with specific time lines should be assigned.

In fact, it's a good idea to post the systematic diagram with the names of the person(s) responsible for accomplishing a specific task.

Ed. note: The cynical reader may object that this systematic diagram assumes that agents within a system can both means and ends in the TQI process. In the above case, the cynical reader asks, is it fair to assume that, once the faculty senate has gained the VPAA's approval, he or she will necessarily become a committed advocate for the recommended change? What if the VPAA gives nominal approval, but deep down remains uncommitted or even negative about the recommended change? Such a VPAA could sabotage the process by presenting it to the president in such a way that, while apparently its advocate, he or she is actually its assassin.

The editor has no easy answer to this question. Total quality management and improvement processes must be continually talked up at all institutional levels, relying on Deming's principles that organizations need to first "improve constantly" and "involve everyone in the transformation." Obviously, much more work needs to be done at an institution such as the one where the cynical reader resides.

Next month: An expanded nominal group process.

"We are judged by what we finish, not what we start." — Unknown
TQM Tools and Techniques

The Nominal Group Process

The nominal group process helps a group identify and rank major problems or issues. This technique is also good for identifying major strengths because it gives each participant an equal voice, a key element of the group process.

The example below is taken from a meeting of a college of arts and sciences at a rural, comprehensive public university. The dean called the meeting during a planning process. Each of the chairs and one faculty member from each department were to arrive at a consensus about the perceived problems that inhibited quality.

For the nominal group process it’s recommended that each group have a facilitator — with a stopwatch — who’s not part of the task force/unit, since s/he may need to encourage some members who are reluctant to contribute or restrain those who normally try to control such processes. All members need to feel comfortable with the process and comfortable participating.

Each group consists of five to 10 persons. Since large units will have several groups, it’s possible that groups may perceive different problems. If this happens, the facilitator will need to review the results and plan another meeting for the entire unit before arriving at the final ranking.

Procedure

1. Introduce the Process (5 Minutes)

The facilitator issues instructions and refrains from influencing the group’s decision. S/he also keeps the group on time.

The facilitator explains that the nominal group process allows the group to explore areas systematically and arrive at a consensus through developing a list and ranking perceived problems. The group discusses the results and identifies the most important perceived problems.

2. Present the Question (15 Minutes)

The facilitator presents the specific question to the group. In this case, the facilitator was instructed to ask the group, “What do you consider to be the major problem in your unit that’s affecting quality?”

The facilitator then asks participants to write short and specific three-to-five word answers for each perceived problem on Form A. Members take five minutes to complete Form A — silently and independently. While group members develop their list of perceived problems, the facilitator uses an overhead to project Chart 1.

At the end of the allotted time, if it appears that several members haven’t finished, the facilitator allows two extra minutes. If most members have already finished, the facilitator moves to step 3.

FORM A
Listing of Perceived Problems
What do you think are the major problems inhibiting quality?
Please use the form and write short, specific answers.

<table>
<thead>
<tr>
<th>Item #</th>
<th>Perceived Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

3. Develop a Master List (20 Minutes)

At the end of the allotted time, the facilitator asks each member to read aloud one of the perceived problems on his/her list. Those problems identified early on need not be repeated. If an item appears to be the same as one already presented, although phrased differently, the facilitator asks group members to indicate with a show of hands if they think the items are the same. If a majority feel they are, the perceived problem isn’t listed again. There’s no discussion at this point; otherwise, less assertive members won’t raise problems that they alone might perceive.

As each problem is given, the facilitator records and numbers the item on Chart I without editing or suggesting categories or combinations. (Shortening the phrasing of the problem without changing the meaning is allowed.) If, at the end of 20 minutes, some members have items that haven’t been presented, the facilitator asks everyone to give the one most important problem remaining on his/her list.

CHART 1, Perceived Problems that Inhibit Quality in the College of
Arts & Sciences

<table>
<thead>
<tr>
<th>Item #</th>
<th>Perceived Problem</th>
<th>Init. Value</th>
<th>Final Value</th>
<th>Final Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lack of Facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Insuff. Courses/Gen. Ed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Dirty Classrooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Not Enough Majors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Leq. Class Sizes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Untimely Prannel Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Poor Students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Insuff. Lab Supplies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Boss Type Micromgrs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Poor Budget Process</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Poor Lateral Commun.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Uncommitted Faculty</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Union-Mgmt. Relations</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n
Initial results of the perceived problems resulting from the nominal group process are shown below.

4. Clarify the Master List Items (15 Minutes)

The facilitator reads each item on the master list aloud and asks if it's understood. If an item is unclear, the facilitator asks the individual who initiated the item to clarify it. The facilitator doesn't condense the list or permit the group to discuss the relative importance of the problems at this point.

5. Initially Rank the Items (15 Minutes)

The facilitator distributes Form B and requests that each member select and rank the five most important perceived problems of the unit. The most important one is assigned a #5; the least important receives a #1. Participants then record their rankings on Form B. The facilitator collects the forms and tallies the results on the master list, giving each item an Initial score.

**FORM B**

Initial Ranking of Perceived Problems. Please refer to Chart I which describes the grouped perceived problems and indicates in the table below what you think are the five major problems.

<table>
<thead>
<tr>
<th>Item # from Master List</th>
<th>Initial Subjective Ranking Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#5 (Most Important)</td>
</tr>
<tr>
<td></td>
<td>#4</td>
</tr>
<tr>
<td></td>
<td>#3</td>
</tr>
<tr>
<td></td>
<td>#2</td>
</tr>
<tr>
<td></td>
<td>#1 (Least Important)</td>
</tr>
</tbody>
</table>

Using the listings from the example in Chart I, group members assigned the following values to the listed perceived problems.

**CHART I**

Perceived Problems That Inhibit Quality in the College of Arts and Sciences

<table>
<thead>
<tr>
<th>Item #</th>
<th>Perceived Problem</th>
<th>Init. Value</th>
<th>Final Value</th>
<th>Final Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lack of Facilities</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Insuff. Sctions/Gen. Ed.</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Dirty Classrooms</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Not Enough Majors</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Lg. Class Sizes</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Untimely Prinmel Plan</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Poor Students</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Insuff. Lab Supplies</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Boss Type Micromugs</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Poor Budget Process</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Poor Lateral Commun.</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Uncommitted Faculty</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Union-Mgmt. Relats.</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>Others</td>
<td>70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Discuss Initial Ranking (30 Minutes)

The facilitator asks participants to discuss the results of the ranking. Participants can elaborate, defend, and dispute the rankings but not add items. Items may be discussed even if they didn't receive a high score. The facilitator reminds participants that this is their oppor-

tunity to express opinions and persuade others. The facilitator attempts to keep the discussion orderly.

At this point, the facilitator can combine several items into a single category. In the above example, 27 separate items were eventually reduced to nine.

7. Break (20 Minutes)

Participants take this time to break. Some may find this a welcome relief from the previous discussion. Others may continue the discussion in the hallway.

8. Develop Final List and Rank Items (15 Minutes)

After discussing the items, the facilitator distributes a copy of Form C and requests that each member rank the top five choices. Then the facilitator records the final values for each item on the master list.

Please refer to the revised Chart I that describes the grouped perceived problems and indicate in the table what you think are the five major problems.

**FORM C**

Final Ranking of Perceived Problems

<table>
<thead>
<tr>
<th>Item # from Master List</th>
<th>Final Subjective Ranking Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#5 (Most Important)</td>
</tr>
<tr>
<td></td>
<td>#4</td>
</tr>
<tr>
<td></td>
<td>#3</td>
</tr>
<tr>
<td></td>
<td>#2</td>
</tr>
<tr>
<td></td>
<td>#1 (Least Important)</td>
</tr>
</tbody>
</table>

The results of the master list are recorded and typed on Form D.

**FORM D**

Summary and Rank of the Perceived Problems Inhibiting Quality in the College of Arts and Sciences

<table>
<thead>
<tr>
<th>Item #</th>
<th>Perceived Problem</th>
<th>Init. Value</th>
<th>Final Value</th>
<th>Final Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lack of Facilities</td>
<td>13</td>
<td>114</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Insuff. Sctions/Gen. Ed.</td>
<td>33</td>
<td>114</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Dirty Classrooms</td>
<td>2</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Not Enough Majors</td>
<td>21</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Lg. Class Sizes</td>
<td>23</td>
<td>66</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Untimely Prinmel Plan</td>
<td>53</td>
<td>42</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Poor Students</td>
<td>10</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>Insuff. Lab Supplies</td>
<td>5</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>Boss Type Micromugs</td>
<td>18</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Poor Budget Process</td>
<td>6</td>
<td>36</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>Poor Lateral Commun.</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Uncommitted Faculty</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Union-Mgmt. Relats.</td>
<td>35</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>Others</td>
<td>70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Next month: control chart: np
Control Charts: The np Chart

With this issue, we begin a five-part series on control charts. Walter Shewhart of Bell Labs first developed control charts as a way of determining if a given process was stable and, thus, in "statistical control."

Shewhart demonstrated that the output variation of all processes was made up of two components: variation due to chance causes (causes continuously present in the process and that routinely affect the output) and variation that occurs irregularly (usually caused by factors operating irregularly).

He called the former cause "common or inherent" — variation that can't be eliminated unless the processes' underlying attributes are changed.

The latter cause he named "special or assignable" — a variation with a specific and identifiable source. The source of special variation can be detected and removed. A stable process, one that is in statistical control, is influenced only by "common cause" variation.

For manufacturing environments, differentiating between these two was very important. Shewhart demonstrated that process operators were responding to common cause variation — attempting to control it with myriad adjustments of machine settings that only increase the variation of the process output and thus create more waste and require more rework. By differentiating between "common" and "special" variations, workers could focus only on that variation that they could control.

Control Charts: Determining when, and if, to intervene

The purpose of a control chart is to decide when to intervene in a process and when to leave it alone. For example: before you fire the director of admissions, determine if the process of new student admissions is stable. It may be that the recent downturn is simply a chance fluctuation, not at all under the director's control.

Control charts can be used in a wide variety of educational environments. They're invaluable in determining if, and when, to fundamentally alter the process that's delivering or producing the product or service.

Each of the seven types of control charts are used in a specific set of circumstances. These seven types are first subdivided into two general categories: charts used for continuous or "variable" data — data generated by counting or weighing; and charts used for discrete or "attributes" data — data which are dichotomous, such as pass/fail; defective/not defective; class cancelled/not cancelled.

In other words, the quality characteristic of interest has just two dimensions: it either does or doesn't possess the characteristic of interest. Many educationally related processes have this form. This first article will deal with a type of control chart that permits analysis, the np chart.

The np chart is used to analyze process stability for a dichotomous attributes characteristic. The value of interest is the "number" of events possessing or not possessing the characteristic. The p chart, to be discussed in a later issue, is similar but is used when you're interested in the "proportion" (p) of the events that possess the characteristic. Whether you use np or p depends upon which characteristic (number or proportion) is more valuable to you and/or what type data are available to you.

Factors common to control charts

All seven control charts are constructed using essentially the same principles:

1. Establish a process mean.
2. Calculate upper and lower control limits, based on process variation.
3. Plot the values of the process over time and inscribe the mean and control limits on the plot.
4. Interpret sample values outside the control limits as evidence the process is "out of control" — special causes of variation are present.
5. Analyze the process to determine the causes and then take action to remove these special causes of variation.

The key to fully understanding the power of control charts is to understand that the calculations permit us to estimate the common cause or inherent variation. We view variation in excess of that as special or assignable variation.

The estimate of inherent process variation is accomplished by examining the variation within each subgroup of the same data set. Within a given subgroup, the only reason the data vary is because of inherent variation. From a probability perspective, it's unlikely that data variation within a subgroup is caused by anything other than normal (inherent) process variation.

When we see variation with a relatively small provability of occurrence, we conclude that it's not inherent but special variation.

We make this probability judgment on the basis of the overall estimate of variation in the entire data set, expressed as the "standard deviation." For any type of control chart, the common or inherent process variation is captured within +/−3 standard deviations from the process mean. These control charts are referred to as "3−3 control charts."

When a subgroup data point falls outside this 3−3 limit, we take that as evidence that something other than inherent variation is present — some "special" cause is operating in that subgroup because that level variation would only occur with an extremely small probability.

Said another way, "it" (the variation that exceeds the 3−3 limit) occurs infrequently, irregularly and isn't part of the inherent process variation. Given this, we presume the cause of this special variation is knowable and therefore detectable.
When using control charts to analyze processes, start with a "stable process" — one that's in statistical control — meaning there's only inherent variation operating. Remember, without understanding the concept of special causes of variation, you might react to a data point, radically change or adjust the process — for example, fire the admissions director — and then expect the process to improve. When, in fact, the data point represents nothing other than inherent variation. By altering the process then, all you've done is made the process more variable and caused even more variation in the process output.

One final note regarding the theory of control charts: even though the control chart analysis shows a process to be stable, that state doesn't mean the process is producing products or services acceptable to the customer. The process could very well be reliably producing unacceptable products or services.

To illustrate these fundamental concepts, we constructed and interpreted an np chart based on a data set dealing with the admissions process.

High school graduates who are accepted by the institution either do or don’t accept admission. Knowledge of this process can be invaluable because it reflects on the criteria for admission, student recruiting efforts, PR efforts, the institution's competitive position, and can give some insight into the decision process, especially when the student has multiple admission invitations.

In gathering data and constructing the np chart, follow these three rules scrupulously:
1. The sample size for each subgroup must be the same.
2. You should have a minimum of 15 subgroups (samples), preferably 25 to 30.
3. The sample size should be large enough so that in each subgroup, the characteristic of interest — received a letter of admission but didn’t select your institution — occurs at least four or more times.

Applying the np Chart
For this illustration, we've provided a data set, the steps used in constructing the np chart, and the completed np chart, followed by an Interpretation.

The vice president of academic affairs is interested in better understanding the process by which accepted students ultimately decide to attend another institution. Further, whatever the level of rejection, her goal was to further reduce the rate.

She wisely chooses to collect data on the number of students who make this rejection decision because it's entirely possible that this process is producing a stable input of students. Without these data, she might react to only chance fluctuations in these numbers and radically change the process which would disturb an otherwise stable operation.

For 30 consecutive quarters, the VPAA randomly selects 100 prospective students who’ve received acceptance letters. These students are divided into 30 subgroups, each with sample size of 100. For each sample, the admissions staff checks the records to determine how many of the 100 rejected the invitation to register — the characteristic.

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Sample Size</th>
<th>Rejects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>100</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>13</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>17</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>18</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>21</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>22</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>23</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>24</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>26</td>
<td>100</td>
<td>12</td>
</tr>
<tr>
<td>27</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>28</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>29</td>
<td>100</td>
<td>6</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>Totals</td>
<td>3,000</td>
<td>183</td>
</tr>
</tbody>
</table>

The np chart is then constructed as follows:
1. Compute the average or mean number of rejection decisions.
   \[ \text{Average} = \frac{\sum np}{30} \]
   \[ = \frac{(14+2+11+…+9)}{30} \]
   \[ = 183/30 \]
   \[ = 6.1 \]

   Record this number (6.1) in the space labeled "Avg" in the control chart.

2. Calculate the upper control limit. The UCL lies 3 standard deviations above the mean or average.
   \[ \text{UCL} = \text{Avg} + 3 \sqrt{\text{Avg} \times (1-\text{Avg}/n)} \]
   \[ = 6.1 + 3 \sqrt{6.1 \times (1-0.061)} \]
   \[ = 6.1 + 3 \times 6.1 \times 0.939 \]
   \[ = 6.1 + 3 \times 5.728 \]
   \[ = 6.1 + 9.2 \]
   \[ = 6.1 + 7.18 \] (Note: 7.18 is the value of 3 standard deviations)
   \[ \text{UCL} = 13.3 \]

   Enter this value, 13.3, in the np chart in the space labelled "UCL".

---

The np chart is then constructed as follows:

1. Compute the average or mean number of rejection decisions.
   \[ \text{Average} = \frac{\sum np}{30} \]
   \[ = \frac{(14+2+11+…+9)}{30} \]
   \[ = 183/30 \]
   \[ = 6.1 \]

   Record this number (6.1) in the space labeled "Avg" in the control chart.

2. Calculate the upper control limit. The UCL lies 3 standard deviations above the mean or average.
   \[ \text{UCL} = \text{Avg} + 3 \sqrt{\text{Avg} \times (1-\text{Avg}/n)} \]
   \[ = 6.1 + 3 \sqrt{6.1 \times (1-0.061)} \]
   \[ = 6.1 + 3 \times 6.1 \times 0.939 \]
   \[ = 6.1 + 3 \times 5.728 \]
   \[ = 6.1 + 9.2 \]
   \[ = 6.1 + 7.18 \] (Note: 7.18 is the value of 3 standard deviations)
   \[ \text{UCL} = 13.3 \]

   Enter this value, 13.3, in the np chart in the space labelled "UCL".
3. Calculate the lower control limit. The LCL lies 3 standard deviations below the mean. Therefore:

\[ \text{LCL} = 6.1 - 7.18 = -1.08 \]

Since there can be no negative values for the LCL, we set the LCL at 0.

Record the value "0" for the LCL in the space labelled "LCL".

4. Draw the chart.
   a. Draw horizontal lines representing the values of the Avg., UCL, and LCL.
   b. Plot the values for each of the 30 samples and connect the points.

5. Interpret the chart. Most control charts use the following analysis rules:
   a. Points above or below the control limits indicate an out of control or unstable process — special causes of variation present.
   b. A run of seven or more points all either above or all below the average indicates instability — independent of where these points fall with respect to the control limits.
   c. Seven or more points consecutively ascending or descending indicates instability.
   d. Any pattern showing regularity or cycles indicates instability.

In our example, the 1st and 14th quarters exceeded the control limits. These must be carefully examined to determine the cause(s) for excessive rejection rates. The VPAA shouldn’t attempt to reduce the rejection rate until these two points are analyzed and the special causes removed. Once identified and corrected, she can then analyze the overall process, now stable, to determine what factors will lead to overall reduction.

Contributed by: Lawrence Sharp, President and Principal Consultant, Six Sigma Enterprises, 7318 Murdoch Drive, Colorado Springs, CO 80920; Ph./Fax: 719/598-8393.

Next month: control chart: p
TQM Tools and Techniques

Control Charts: the p Chart
Part Two of a Five-Part Series

The core of process management theory rests on three often not well understood and frequently misapplied observations regarding variation:

- The outcome of any process will show variation.
- Simply because variation occurs isn't sufficient justification to conclude the process is unstable and in need of intervention.
- If the process manager takes action to control the variation without knowing its real causes, variation in the process outcome may actually increase.

Control charts provide a decision-making buffer that cautions the administrator to be wary of either “over-” or “under-controlling” a process. Reacting to either “high” or “low” process values without knowing their root causes is labeled “tampering” — and, unfortunately, it’s widely practiced.

When to Use a p Chart

The p Chart is used when the characteristic of interest is the number of items that possess a certain quality. It’s also used when the sample size isn’t constant; therefore, the proportion of events possessing a certain characteristic becomes meaningful.

For this application, we chose as a data set the proportion of entering freshmen whose SAT scores were below 1100. The dean of arts and sciences, suspecting the applicant pool is increasingly ill-prepared for college work, is considering implementing an extensive and costly basic skills program.

The key question is: Are the SAT score variations showing nothing more than inherent variation or are there factors that would warrant the remedial program?

The dean asks the admissions office to randomly select entering freshmen SAT scores from the last 30 semesters. While the data from each semester are randomly selected, the number available for each semester varies because of inaccuracies in the database. The data are shown in Table 1, and the completed p Chart is shown in Figure 1.

As is the case for all control charts, a process average and upper and lower control limits are established. The chart is then interpreted for inherent and special cause variation and process instability.

Procedure

1. Calculate the proportion for each subgroup (semester of entry).

   Divide the total number, np, by the subgroup size, n. For the first semester listed, 15 (the number of entering freshmen in the sample of 100 whose SAT scores were below 1100) is divided by 100 (sample size). Calculate the proportion for each semester’s sample.

Table - p chart data set

<table>
<thead>
<tr>
<th>Semester</th>
<th>Subgroup Size</th>
<th># &lt; 1100 SAT</th>
<th>Proportion np + n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>15</td>
<td>0.150</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>6</td>
<td>0.060</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>11</td>
<td>0.110</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>4</td>
<td>0.040</td>
</tr>
<tr>
<td>5</td>
<td>94</td>
<td>9</td>
<td>0.096</td>
</tr>
<tr>
<td>6</td>
<td>94</td>
<td>7</td>
<td>0.074</td>
</tr>
<tr>
<td>7</td>
<td>94</td>
<td>4</td>
<td>0.043</td>
</tr>
<tr>
<td>8</td>
<td>94</td>
<td>8</td>
<td>0.085</td>
</tr>
<tr>
<td>9</td>
<td>91</td>
<td>3</td>
<td>0.033</td>
</tr>
<tr>
<td>10</td>
<td>91</td>
<td>2</td>
<td>0.022</td>
</tr>
<tr>
<td>11</td>
<td>91</td>
<td>1</td>
<td>0.011</td>
</tr>
<tr>
<td>12</td>
<td>91</td>
<td>10</td>
<td>0.109</td>
</tr>
<tr>
<td>13</td>
<td>91</td>
<td>7</td>
<td>0.077</td>
</tr>
<tr>
<td>14</td>
<td>91</td>
<td>25</td>
<td>0.275</td>
</tr>
<tr>
<td>15</td>
<td>91</td>
<td>5</td>
<td>0.055</td>
</tr>
<tr>
<td>16</td>
<td>79</td>
<td>3</td>
<td>0.038</td>
</tr>
<tr>
<td>17</td>
<td>79</td>
<td>8</td>
<td>0.101</td>
</tr>
<tr>
<td>18</td>
<td>79</td>
<td>4</td>
<td>0.051</td>
</tr>
<tr>
<td>19</td>
<td>79</td>
<td>2</td>
<td>0.025</td>
</tr>
<tr>
<td>20</td>
<td>79</td>
<td>5</td>
<td>0.063</td>
</tr>
<tr>
<td>21</td>
<td>79</td>
<td>5</td>
<td>0.063</td>
</tr>
<tr>
<td>22</td>
<td>72</td>
<td>7</td>
<td>0.097</td>
</tr>
<tr>
<td>23</td>
<td>72</td>
<td>9</td>
<td>0.125</td>
</tr>
<tr>
<td>24</td>
<td>72</td>
<td>1</td>
<td>0.014</td>
</tr>
<tr>
<td>25</td>
<td>72</td>
<td>3</td>
<td>0.042</td>
</tr>
<tr>
<td>26</td>
<td>72</td>
<td>12</td>
<td>0.167</td>
</tr>
<tr>
<td>27</td>
<td>72</td>
<td>10</td>
<td>0.176</td>
</tr>
<tr>
<td>28</td>
<td>72</td>
<td>3</td>
<td>0.042</td>
</tr>
<tr>
<td>29</td>
<td>72</td>
<td>6</td>
<td>0.083</td>
</tr>
<tr>
<td>30</td>
<td>72</td>
<td>9</td>
<td>0.125</td>
</tr>
<tr>
<td>Totals</td>
<td>2535</td>
<td>203</td>
<td></td>
</tr>
</tbody>
</table>

2. Calculate the average proportion.

Divide the total number in the subgroup column (203) by the total number in the sample size column (2535).

Average proportion (\( \bar{p} \))

\[
\bar{p} = \frac{\sum np}{\sum n} = \frac{203}{2535} = 0.0801
\]

3. Calculate the average subgroup size.

The average subgroup size \( \bar{n} \) is calculated by dividing the total subgroup size (2535) by the number of subgroups \( k \) (30).

Average subgroup size (\( \bar{n} \))

\[
\bar{n} = \frac{\sum n}{k} = \frac{2535}{30} = 84.5
\]

It's important that subgroup size not vary from the average subgroup size by more than 25%. To determine these limits, multiply 84.5 (average subgroup size) by 1.25 (to obtain the +25% boundary) and by .75 (to obtain the -25% boundary). These values are 105.6 and 63.4, respectively. If any subgroup exceeds these values, then separate upper
control limits (UCL) and lower control limits (LCL) must be calculated for those subgroups.

Since none of the subgroups are larger than 105.6 or smaller than 63.4, calculation of individual control limits isn't required.

4. Calculate the control limits.

Similar to the np chart, the control limits are a reasonable +/-3 standard deviations from the process average. In this case +/-3 standard deviations from the average proportion is \( \overline{p} = 0.0801 \).

\[
\text{UCL} = \overline{p} + 3 \sqrt{\frac{\overline{p}(1-\overline{p})}{n}} = 0.0801 + 3 \sqrt{0.0801(1-0.0801)} = 0.0801 + 3 (0.02953) = 0.0801 + 0.0886 = 0.1687
\]

\( \text{UCL} \) is the equivalent to 3 standard deviations.

b. Scale the y axis from 0.0 to 0.3 (the range of values that captures the LCL, average proportion, and the UCL).

c. Draw in LCL, \( \overline{p} \), and UCL.

d. Plot the proportion value for each semester (30 points).

e. Connect the points.

6. Interpret the chart.

The following conditions indicate special cause variation and/or an unstable process:

a. Points above the UCL or below the LCL, representing special cause variation;

b. A run of seven or more points above or below the process average (p);

c. An increasing or decreasing run of seven or more points;

d. Repeating or cyclical patterns.

The proportion of students with SAT scores lower than 1100 is above the UCL for semester 14. With the exception of that point, the process appears to be stable. The dean examines the process during semester 14 and discovers that a new group of admissions counselors began to operate the semester who weren't fully trained regarding the college's admission criteria. Beyond that, the process for recruiting students based on SAT scores appears to be stable.

The dean may not be pleased with the overall process average (8 of 100 entering freshmen with SATs below 1100), but the control chart tells her that this value will not change significantly without fundamental changes in the recruiting process. More important, after explaining the semester 14 data, if she's satisfied with the proportion of entering students with SAT scores lower than 1100, the dean shouldn't "tamper" with the process by reacting to short-term increases or decreases in the proportion.

Next month: control chart: c
TQM Tools and Techniques

Control Charts: The c-Chart

The control chart examples presented in prior issues of TQM/HE allow you to analyze the stability of process outputs when the characteristic of interest is discrete; that is, the characteristic exists in either of two states: acceptable/unacceptable, paid dorm deposit fee/didn’t pay, registered/didn’t register.

The np-Chart (February 1993) permits you to analyze these characteristics that occur in repeated samples. The p-Chart (March 1993) gives you the analysis tool for testing the stability of the proportion of the characteristic that occurs in the repeated sample. Remember; you usually select the p-Chart when the sample size varies from sample to sample and the proportion is the only quantity you can work with.

These two charts are referred to as attributes charts because you’re measuring attributes of the characteristics — the event occurred or it didn’t. You’re not measuring variables — the weight, height, mass, or velocity of the occurrence. A control chart discussed in a later issue will address variables.

In this issue, we present the c-Chart. It’s an attributes control chart used to measure the stability of a process. Instead of counting the number of occurrences of a characteristic (np-Chart) or analyzing the proportion of times the characteristic occurs (p-Chart), the c-Chart allows you to analyze the occurrence of a characteristic, when that characteristic is imbedded in a larger element. It permits the analysis of good/bad, right/wrong, or occurs/doesn’t occur, when those attributes could be present in some larger unit — for example, the number of errors in an admission application, the number of incorrect entries in a financial aid package, the number of errors in a work order.

Generally, you use a c-Chart when there are opportunities for one or more defects (occurrences of the characteristic) in a unit or group of units. Obviously, you could simply label the entire unit unacceptable if one element within it was defective and then use either the p- or np-Chart for analysis. However, this would give you no information about the stability of the process as it relates to the internal elements of the unit. Using the c-Chart allows a much more precise analysis of stability.

We applied the c-Chart to a recurring student complaint: inability to log on to the university computer system. Because they couldn’t get into the system, students were blaming the computer center hardware, the software, and center advisors.

Before replacing hardware or software or hiring additional advisors, the computer center director chose to analyze the log-on problems reported by the students and also those tracked by the software. The log-on process is a unit; within that unit, a number of elements can be accomplished properly or not or be operating correctly or not.

The director listed the elements that could fail in this process — hardware, software, or student action. In this case he chose the following elements:

- modem lines busy,
- incorrect student password,
- software update,
- computer down for maintenance, and
- advisor not available for student assistance.

The director tracked these data over a 20-day period and recorded them in Table 1.

### Day Log-On Problems to the University Computer Over Twenty Days

<table>
<thead>
<tr>
<th>Day</th>
<th>Modem</th>
<th>Password</th>
<th>Software Up</th>
<th>Date</th>
<th>System Maint.</th>
<th>Advisor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**TOTAL**: 72

After the director recorded the data, he established a process mean, an upper control limit (UCL), and a lower control limit (LCL).

**Procedure**

1. Calculate the mean defects for the process.
   \[ \bar{c} = \frac{\text{sum of the problems reported divided by days}}{20} = 72 \]
   \[ = \frac{2 + 2 + 3 + 3 + 2 + 2 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1}{20} = 72 \]
   \[ = 3.6 \]

2. Calculate UCL and LCL. Remember that the UCL and LCL are conventionally defined as the process mean +/−3 standard deviations from the mean. In this case:
   \[ \text{UCL} = \bar{c} + 3 \sqrt{\bar{c}} \]
   \[ = 3.6 + 3 \sqrt{3.6} = 3.6 + 5.69 \]
   \[ = 9.29 \]
   Enter this value in the c-Chart space labeled “UCL.”
   \[ \text{LCL} = \bar{c} - 3 \sqrt{\bar{c}} \]
   \[ = 3.6 - 3 \sqrt{3.6} \]
   \[ = -2.09 \] (Since the LCL can’t be less than 0, we set it at 0.)
   Enter “0” on the c-Chart space labeled “LCL.”
3. Draw the chart.
   a. Draw horizontal lines representing the values of the UCL and LCL.
   b. Plot the values for each of the 20 points.
4. Interpret the chart.
   All the data points fell within the control limits. Therefore, the process of logging on to the computer was stable, and special cause variations weren't present (see Figure 1). While logging on problems existed, they weren't producing an unstable system.
   The computer center director could now analyze the causes of the problems, especially the high-frequency problems, and take action to reduce the overall process mean. The system would be stable and appropriate for process analysis so he could continuously improve the service to students by reducing the log-on problems.

Next month: control chart X - R.

---

"The one thing which has become clearer and clearer to me in the course of my life is that keeping an open mind is of the utmost importance. The right kind of openness is the most precious human possession.... We need to take a firm stand, but we also need to feel that we have not thus put our feet in shackles. Wherever we stand, we should stand free and unbiased and grow aware of the world.

—Martin Buber
The control chart examples presented in earlier issues (p, np, c) are used to analyze the stability of processes for attributes data. That is, the characteristic under study is either good or bad, or it conforms or doesn't conform. The characteristic of interest was a binary variable. When we counted the number of non-conforming characteristics or calculated the proportion that were unacceptable, we were analyzing the process for the stability of the binary attribute.

The X-R or means-range chart presented here allows us to analyze variables rather than attributes data — data that are the result of counting or measuring on a ratio scale, which the process output takes on over time.

For example, the counseling center director has received student complaints charging that they're being put on long telephone holds and their information needs aren't being met.

The quick and expensive fix would be to hire more staff to handle the perceived increase in demand for telephone access to the center's staff. However, the director wisely decides to gather data related to the process of telephone wait time to determine if the process is stable and in control before attempting to take action to reduce the hold time.

While trying to reduce telephone hold time is an admirable end in itself, before the director implements procedures to reduce the average hold time, the process must first be free of special cause variation.

With the technical assistance of the communications staff, the director collects telephone hold time data for a five-week period. There are four telephone extensions, each serving one counselor, and calls are automatically switched to the open line. Therefore, there are a total of 100 data points (25 days times four counselors). The data for each of the points represents the total telephone hold time in minutes for each day by counselor and is recorded in Table 1.

Control charts for these variables data can explain process output in terms of both the output's spread (in this case the variability over the four counselors) and the location (the overall hold time or process average). Because of this, control charts for variables data are used in pairs — one chart for location and one for spread.

The most frequently used pair is the one presented here: the X bar and R charts. The X bar is used to analyze the average of the subgroups — counselors — and the R is used to analyze the range within each subgroup.

**Procedure**

1. Add the values for each column.
2. Find the average or mean value for each column. (Add the values in each column and divide by 4.)
3. Calculate the overall average. Add the 25 columns’ means and divide by 25 (0.5 + 4.0 + 4.3 + 4.8 ... + 2.5 + 25 = 4.12). This is X double bar.
4. Note the largest and smallest values in each column.
5. Determine the range for each column by subtracting the smallest value from the largest.
6. Find the average range R by adding the 25 ranges and divide by 25 (1 + 6 + 7 + 9 ... + 7 + 25 = 6.20).

**Calculate the Upper and Lower Control Limits for the Range Chart**

This is typically done before the control limits for the means chart are calculated since the range chart analyzes variability within subgroups. If the variation in ranges (within groups) isn't stable due to special cause variation, it's impossible to calculate limits for the means chart.

1. UCLR = D4 × R
   
   (D4 varies as a function of sample size; for a subgroup size of 4 it's 2.282. This value comes from external sources and is related to the standard deviation. Consult any statistical process control text for other values of D4.)

2. UCLR = 2.282 × 6.20

3. UCLR = 14.15

4. Draw a horizontal line across the range chart at the 14.15 value and label it UCLR.

5. Since the sample size is less than 6, draw a horizontal line across the range chart at the zero value of the Y-axis and label it LCLR.

6. Add the overall average for the ranges (R bar) to the range chart by drawing a horizontal line across the range chart at the value of 6.20 on the Y-axis.

7. Plot each of the sample ranges on the range chart.

**Table 1: The telephone hold times in minutes by day and by counselor**

| Counselor | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|-----------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| SUM       | 2 | 3 | 3 | 4 | 5 | 4 | 6 | 5 | 5 | 5   | 5   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   |
| AVG       | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 5 | 5 | 5   | 5   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   | 4   |

| Overall Average | X = 4.12 minutes |
| Mean Range      | R = 6.20 minutes  |
Interpret the Range Chart

Points outside the control limits would indicate the ranges aren't in statistical control and that the variation within subgroups is unstable. Since this isn't the case, we can proceed to calculate the means chart control limits.

Additional patterns that would indicate unstable ranges are a run of seven or more points either above or below the process average, a run of seven or more points either increasing or decreasing, and either cyclical or repetitive patterns. These are also not present in our example.

Calculate the Upper and Lower Control Limits for the Means Chart

1. \( \text{UCL}_X = \bar{X} = (A_2 \times \bar{R}) \)

\( A_2 \) varies as a function of sample size; for a subgroup of 4 (the counselors), it's 0.729. This value comes from external sources and is related to the standard deviation. Consult any statistical process controls text for other values of \( A_2 \).

2. \( \text{UCL}_X = 4.12 + (0.729 \times 6.20) \)

3. \( \text{UCL}_X = 4.12 + 4.52 \)

4. \( \text{UCL}_X = 8.64 \)

5. Draw a horizontal line across the means chart at the value of 8.64 on the Y-axis and label it UCLx.

6. \( \text{LCL}_X = 4.12 - (A_2 \times \bar{R}) \)

7. \( \text{LCL}_X = 4.12 - (0.729 \times 6.20) \)

8. \( \text{LCL}_X = 4.12 - 4.52 \)

9. \( \text{LCL}_X = 0 \) since \( \text{LCL}_X \) can't be less than 0.

10. Draw a line across the means chart at a value of 0 on the Y-axis and label it LCLx.

11. Draw a line across the means chart at a value of 4.12 on the Y-axis, as this \( \bar{X} \) (X double bar) is the grand process mean.

12. Plot each of the column means on the means chart.

Interpret the Means Chart

All subgroup (column) means are within the control limits. Therefore, there are no special causes of variation affecting the hold time means — in other words, there are no unique differences between counselors with respect to hold times. The charts can now be used to monitor and control the process.

While the counseling center director may not be pleased with an average total hold time of 4.12 minutes, since the process is statistically stable, she can now proceed to establish an action team to analyze the process with the goal of reducing the mean hold time. If the system is flowing as well as can be expected, she may need additional staff to reduce the hold time.

Contributed by: Lawrence Sharp, President and Principal Consultant, Six Sigma Enterprises, 7318 Murdoch Drive, Colorado Springs, CO 80920; Ph./Fax: 719/598-8393.

Next month: flow chart.
TQM Tools and Techniques

Flow Charts: the Deployment Flow Chart

Although flow charting is one of TQM's most useful tools, it's probably the most underutilized in education. Flow charting lets you get a “snapshot” of each process within a system. A flow chart can also demonstrate where non-value-added work is performed. Non-value-added work adds to the cost of doing business without adding to the value of the product. In the case of higher education, this cost can be substantial.

When you draw a flow chart and identify redundant processes, a task force can easily generate a different flow chart showing how the system’s processes should be done. So it’s essential that everyone working within the system be involved in drawing the system’s flow chart.

There are many different types of flow charts, but here we'll describe one that we’ve found to be specifically useful to higher education — the deployment flow chart. A deployment flow chart is useful when you want to show the relationships between the individuals and the tasks they perform.

Procedure

1. Define the System

Each system consists of a series of processes. However, since many systems involve more than one process, it's not always clear where one system ends and another begins. For example, student registration not only involves each academic department, but also the services of admissions, financial aid, and housing. So task force members should agree on the starting and ending points they're studying.

As with any universal visual tool, flow charting has a set of standardized symbols. They are:

- Task
- Shadow indicates additional flow chart processes within this task
- Report or form
- Decision
- Indicates meeting leader
- End
- Yes
- No
- Provide support for
- Conduct a meeting

2. Draw the Deployment Flow Chart

Before drawing a flow chart, task force members should actually walk through each step in the system. As they do, they should ask the individuals performing each task what is actually involved. Members should take copious notes along with sketches. Only after this is done should they begin to draw a flow chart.

Problems within a system aren’t the only reason to create flow charts. To identify and eliminate non-value work, charts should be created for every task and process within all systems. If there are any changes within a system, the flow chart for the system should be updated immediately.

To prepare the deployment flow chart, enter the “people” coordinate horizontally. The boxes can contain either the individual or his/her position or the particular department/unit performing a task.

In the example below, we'll follow the development of an actual deployment flow chart of an assignment for students in a sociology class.

First, list the actual tasks and/or major steps and who’s responsible:

1. Prepare assignment (professor)
2. Determine options (professor and group)
3. Analyze options and make choice (group)
4. Approve group option (professor)
5. Research assignment (individual students)
6. Compile research (group)
7. Outline research paper and submit for approval (group)
8. Approve outline (professor)
9. Write subsections or implement project (individual students)
10. Approve subsections (group)
11. Combine paper or project results (group)
12. Approve combined effort (group)
13. Submit final results (group)
14. Approve or reject (professor)
15. Evaluate (professor and group)

Draw the chart using the symbols described above.

3. Record and Discuss the Results

Because the horizontal lines represent a customer-supplier relationship, the flow chart reveals the nature of the interactions. The flow chart must reflect all steps, even the illogical duplication brought about by system errors. Examine the lines to determine if there's any non-value-added work that you can reduce or eliminate.

If there appears to be a breakdown in the system, where someone isn't supplying his/her customer with quality work, explore the reason(s) why. Are there barriers or decision-making delays that slow the flow?

After examining the system of assignments in the sociology class, a task force recommended the revision shown on page 5, bottom right. The revision reduced inspection time and empowered groups of students to make decisions about each member's work quality. As a result, the students worked harder, completed assignments faster, and encountered excellent results.

Next month: process flow chart
1. Prepare assignment (professor)
2. Determine options (professor and group)
3. Analyze options and select preferred (group)
4. Approve group option (professor)
5. Research assignment (individual students)
6. Compile research (group)
7. Outline research paper and submit for approval (group)
8. Approve outline (professor)
9. Write subsections or implement project (individual students)
10. Approve subsections (group)
11. Combine paper or project results (group)
12. Approve combined effort (group)
13. Submit final results (group)
14. Approved? (professor)
15. Evaluate (professor and group)
TQM Tools and Techniques

**Flow Charts: The Process Flow Chart**

Although flowcharting is one of TQM’s most useful tools, it’s probably the most underutilized in education. Flowcharting provides a way to get a “snapshot” of each process within a system.

Useful for documenting a program, flow charts can examine how various steps in a process are related to each other. Flow charts can also uncover potential sources of trouble and demonstrate where non-value-added work is performed, adding to the cost of doing business.

When you draw a flow chart and identify redundant processes, a task force can easily generate a different flow chart showing how the processes within the system work. Therefore, it’s essential when drawing a flow chart that everyone working within the system be involved in creating it.

There are many different types of flow charts. Last month we described the deployment flow chart. This month we will describe another one that we’ve found useful in an academic setting — the process flow chart.

**Procedure**

1. **State the problem**
   - The process flow chart simply shows the major steps within a system and doesn’t attempt to demonstrate the interrelationships between the individuals doing the tasks.
   - As with any type of flow chart, the task force should agree to the starting and ending points of the system under study.

2. **Draw the Process Flow Chart**
   - Task force members should walk through each step in the system. As they do, they should ask the individuals performing each task what is actually involved. Members should take copious notes and make sketches. Only after this is done should the task force begin to draw a process flow chart.
   - To prepare the process flow chart, list the system’s major steps. Then using the standardized symbols shown below, draw the flow chart.

<table>
<thead>
<tr>
<th>Start / End</th>
<th>Task</th>
<th>Decision?</th>
</tr>
</thead>
</table>

**We’ve used as an example a group project that a professor assigned to his students in a history class. The major steps are as follows:**

1. **Prepare assignment**
2. **Determine options**
3. **Choose best option**
4. **Research assignment**
5. **Outline paper**
6. **Write subsections**
7. **Prepare final paper**
8. **Submit results**
9. **Get approval**
10. **Evaluate**

"The first problem for all of us, men and women, is not to learn, but to unlearn."

— Gloria Steinem
The process flow chart would indicate the following:

3. Record and Discuss the Results
   By studying the flow chart, task force members may be able to recommend ways to better reduce redundant steps and improve the system's processes.
   Next month: force field analysis
continued from p. 3

From crayons to computers, there's a marked difference in quality. When students use inferior quality items, they're at a disadvantage in producing quality work.

Although price doesn't ensure quality, in the long run lesser-priced supplies and equipment can cost more. For example, calculators are produced by many companies and sold at varying prices. Cheap — but look-alike — calculators have limited applications and less memory capability, and can hamper quality work.

Deming's Fifth Point:
Improve constantly and forever the system of production and service.

Management
Improvement isn't a one-time effort. Management is obligated to continually look for ways to reduce waste in time and materials and improve quality. Management's also responsible for leading, educating, and encouraging employees to continually seek ways to reduce waste and improve quality.

This principle focuses on the system of production and service rather than on the individual. Deming points out that 94% of the variations in quality are system-produced rather than individually caused.

Instructional Applications
Improve teaching methods, content, assessment, and materials constantly and forever.

There's no single "best" way to teach, and improvement isn't a one-time effort. Teachers are obligated to continually look for ways to reduce inefficient or less effective methods and materials, and to continually improve the quality of student learning.

Measuring student gains in learning and comparing and experimenting with various methods, materials, and assessment techniques are an integral part of constantly improving production and service.

This requires that each teacher actively analyze and experiment with content and methods to improve the quality of student learning.

When teachers collaborate and share findings, learning organizations will develop and constantly create knowledge to improve quality.

Student Applications
Students are obligated to constantly and forever improve their products of learning.

The level of achievement — production — increases from kindergarten through graduate school. With each new assignment, students have a major responsibility for bettering their achievements and quality.

This represents a paradigm shift from the teacher being primarily responsible for improving student performance, to the student being equally or co-responsible for increases in quality achievement.

While some "better" students currently exhibit responsibility for bettering their achievements, this focus or governing principle is available to all students.

For more information, contact: Peter Loehr, Department of Educational Administration and Supervision, College of Education, Western Illinois U., 99 Horrabin Hall, Macomb, IL 61455-1396; Ph: 309/298-1070.

TQM in K-12

Superintendents' Views on Quality
A ccording to a survey conducted by the American Association of School Administrators:

• Seven out of 10 superintendents were familiar with the concepts of TQM.

• Of those who were familiar with TQM, nearly 50% said their school districts are engaged in a quality improvement program.

• The "vast majority" said their districts have made a significant commitment to use TQM principles to improve education.

• 75% of the superintendents familiar with TQM have attended courses or workshops on quality management within and outside their district.

• 66% have read publications on quality.

• 45% have joined an organization that provides quality management information as part of its mission.

• Most superintendents familiar with TQM said they're willing to learn about its application in industry.

• Between 60% to 75% believed that teachers, classified staff, librarians, and counselors would benefit from information about TQM experiences in industry.

• The major obstacle to implementing TQM in their schools is training time and costs.

• 87% felt that TQM would be effective in improving education.

Source: Quality Network News,
January/February 1993.

Case Study Documents

TQM Application
A partnership with Wisconsin Power and Light and the Wisconsin Association of School Boards provides interested staff in the Stoughton (WI) area school district with TQM training.

Twenty staff members volunteered to participate and apply the TQM principles to specific school district problems and to document the application as a case study. The case study evolved into a book, Quality in Education Guide, which is available for purchase.


Voice of the Customer

Practicing What One Preaches

Ed. note: Walk the TQM talk, or an article like the following written by Phillip Kummer might end up in the student paper.

"Service quality is an issue that's receiving much attention, in both the academic and business communities. As our economy becomes more competitive, it will become a force that will drive businesses, non-profit organizations, and government institutions to perform in ways that maximize customer satisfaction.
TQM Tools and Techniques

**Force Field Analysis**

Force field analysis, the product of federally funded research into changing the meat-buying habits of American housewives during World War II, was invented by Kurt Lewin of the U. of Iowa.

Force field analysis helps a quality improvement team identify the perceived driving and restraining forces affecting a recommended change. Either by increasing the forces driving the change, or by decreasing the forces preventing the change, or both, the team can recommend actions to successfully bring about the change. When there's no change, the opposing forces are equal or the restraining forces are too strong to allow it.

If the recommended change runs counter to the institution's "tradition," force field analysis is more effective when combined with other tools, such as the nominal group process, the affinity diagram, and/or the five "whys."

Force field analysis involves the use of proper brainstorming procedures:
- a facilitator is selected,
- team members have an equal opportunity to express their ideas without criticism, and
- members are encouraged to build upon the ideas of others.

**Procedure**

1. **State the Problem**
   Under the leader's, or facilitator's direction, team members should state the precise desired change that they will recommend to management. To arrive at this statement, team members may need to use other tools, such as the nominal group process and the affinity diagram.

   For example, a medium-size, comprehensive, public university wanted to increase the number of minority students it enrolled. Officials recognized the goal as a system problem and clearly stated it as such.

2. **Record the Suggestions**
   After determining the driving and restraining forces, the team — consisting of the president, executive director of the local faculty union, faculty and student representatives — recorded the perceived forces as shown in the figure below.

3. **Discuss and Prioritize the Driving and Restraining Forces**
   We recommend that the individual who generated the idea give his/her rationale as to why it's important. Then the team should conduct an open discussion on each point and, if possible, combine certain points under a single heading if team members agree.

   After discussing and grouping all of the driving and

<table>
<thead>
<tr>
<th>Driving Forces (+)</th>
<th>Restraining Forces (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of interested minority students is limited. (5)</td>
<td>Not enough student aid and minority scholarships. (6)</td>
</tr>
<tr>
<td>Administrators, faculty, and union want to increase minority enrollment. (1)</td>
<td>No articulation agreements with community colleges to encourage minority transfers. (4)</td>
</tr>
<tr>
<td>Good working rel. with community colleges that have high minority student pop. (3)</td>
<td>No minority programs to encourage students to stay. (8)</td>
</tr>
<tr>
<td>Administrators, faculty, and union want more minority faculty. (2)</td>
<td>No incentives for faculty to recruit minority students. (2)</td>
</tr>
<tr>
<td>Few minority faculty on board to be role models. (1)</td>
<td>No minority organizations on campus. (7)</td>
</tr>
<tr>
<td>No minority administrators on campus. (3)</td>
<td></td>
</tr>
</tbody>
</table>

**Recommended Actions**

1. The president should reward departments that hire minority faculty members with additional development funds and/or faculty. (Addresses the No. 1 restraining force and the No. 2 driving force)

2. Departments that increase minority enrollment by more than 15% should get more professional development funds. (Addresses the No. 2 restraining force)

3. Chairs and deans should establish articulation agreements with community colleges and off-campus mentoring programs for these students. (Addresses the No. 4 and No. 5 restraining forces and the No. 1 and No. 3 driving forces)

4. Selection committees should encourage more minority faculty and administrators to apply for positions at our university. (Addresses the No. 3 restraining force)

5. On-campus minority organizations should be established to tutor and mentor minority students.
restraining forces, the team should assign a value of relative importance to each point, possibly by using the nominal group process to determine either a rank value or total points, using a (n-1) numbering system.

In this case, the team decided to use the nominal group process and the final ranking value — #1 was considered the most significant driving/restraining force, #2, the second most important. These values are placed alongside the comments and are shown in the figure below.

4. Recommend Actions

After the team records, discusses, and prioritizes the driving and restraining forces, it should recommend steps to effect the desired change. This should be done on the bottom of the figure, as shown.

The recommendations are now solidly based on documented observations and evaluation of the forces. From beliefs and values we get a set of proposed behaviors — policies — that with some certainty the team feels will be successful.

The Five "Whys"

Originating in Japan, the technique of the five "whys" provides an effective way of getting to the root cause of a problem.

In the example given here, to find the root cause of why there aren't more minority students on a particular campus, the facilitator would begin by asking, "Why are there so few minority students on campus?"

One of the team members may answer, "Because the number of minority students who would find our campus of interest is limited."

The facilitator would then ask, "Why would so few minority students be interested in our campus?"

Another team member may respond, "Because there aren't any student service organizations specifically for them."

The facilitator would ask, "Why aren't there any student service organizations targeted specifically for them?"

A third team member may point out that there wasn't any funding available to start a new organization.

The facilitator would then ask, "Why isn't funding available?"

A fourth team member may explain that the students requested the funds after the student organization monies were disbursed.

The facilitator then asks, "Why did the students request funds after the monies were disbursed?"

A fifth team member might explain that the students were never instructed how to apply for funds — thereby identifying the root cause of the problem.

Sometimes a question will elicit multiple answers, especially if the team members represent different units or constituencies. When the facilitator asks, for example, "Why would so few minority students be interested in our campus?" team members could offer several responses:

- "Because there aren't any student service organizations specifically for them."
- "Because our campus has a conservative image."
- "Because we've never done much recruiting."
- "Because our tuition is higher than at other schools in the region."

The facilitator should ask "Why?" to follow up on each response, to determine root causes. When a "why" question branches in several directions, it may be helpful to sketch a tree, so team members can easily track the results of the questioning (see example below).

Occasionally the result is the opposite: a "why" may lead into a circle. For example, the question, "Why would so few students be interested in our campus?" might trigger the response, "Because there are so few minority students here." The facilitator should help team members work beyond such apparent dead ends.

There's nothing magical about the number five. The five "whys" work because they push team members to go beyond the immediately apparent. This probe tool will often reveal surprising causes and stimulate valuable thought and interaction.

Next month: An institutional self-assessment tool based on the Malcolm Baldrige Quality Award.
Institutional Self-Assessment, Part 1 of 2

Ed. note: On April 17, 1993, institutions involved in the AAHE Academic Quality Consortium met with Curt Reimann, of the Malcolm Baldrige Award, to offer their help in applying the national award criteria to higher education. It appears imminent that the Baldrige Award criteria will be applied to colleges and universities.

This tool represents an efficient method to estimate the strengths and weaknesses of your institutional quality based on the Baldrige Award categories. After obtaining this baseline, you can begin to focus your TQI program.

You should note that the suggested method — which we will publish in two parts — can be used to rate either a small or large institution. (Future issues will present a suggested modification of this procedure to evaluate teaching performance.) I recommend that a team or several teams consisting of management, faculty, students, and staff be established when this tool is used.

The team should be fully informed and allowed adequate time for the exercise — four hours is adequate. Participants need a clear explanation about why the activity is taking place and how their candid and sincere opinions are essential if your institution is to begin a process toward TQI.

Note: this “quick” method is not a replacement for actually completing a Baldrige Award application. However, it will provide you with an estimate of how your institution would most likely do if you applied for the award.

I’ve modified the criteria in the Baldrige Award categories in the following quality index (QI) tool. The entire Baldrige Award application package can be obtained from the National Institute of Standards and Technology at 301/975-2036.

Scoring the Organization’s Quality Index Part I

The categories are:
1. Leadership (13%)
2. Information and analysis (8%)
3. Strategic quality planning (7%)
4. Human resource excellence (17%)
5. Quality assurance of products and services (13%)
6. Quality and operational results (17%)
7. Customer focus and satisfaction (25%)

To begin the exercise, team members should assign points (1-5) for each category subsection based on the described criteria. (The scores will be totaled on the quality index rating sheet that we’ll print next month.) It’s permissible to assign decimal equivalents — 2.5, 3.2.

Team members may wish to review the index’s purpose and read through the categories before actually beginning the exercise, as scoring is not linear — it’s possible to score a 4.0 without meeting the guidelines for 1, 2, and 3.

Team members should also agree to, or recognize, a common objective: to create a comfortable environment for reaching consensus throughout the exercise.

Category 1: Leadership (13%)

This category consists of three subcategories and examines how senior management creates and sustains a clear, visible, quality value and management system to guide the organization’s activities.

1.1 Can you describe what quality means to your institution? Does your institution have a formal statement on quality?
1. No formal statement.
2. Formal statement is focused on traditional characteristics, such as finest quality, zero mistakes, best value.
3. Formal quality statement is in the mission statement as well as in departmental handbooks, brochures.
4. All employees know what the formal statement on quality means to their department and the organization.
5. Formal statement relates to world-class quality results and continuous improvement in processes, systems, and education.

1.2 How has the quality policy and/or mission been deployed or spread throughout the organization?
1. Mainly “talk” about quality.
2. Have a quality manual.
3. Quality manual and/or policy statements about quality are distributed throughout the entire institution.
4. Workshops and/or seminars are routinely conducted on quality procedure and policy.
5. Quality policy is deployed as to cause clear direction, commitment of people, and integration of separate activities.

1.3 Describe management’s leadership, personal involvement, and visibility through communication (speeches, publications, interviews) of quality inside and outside the organization to the community, region, state, and national organizations.
1. Traditional management role of directing, controlling, and telling us what quality is and should be.
2. Management is visible in quality issues internally.
3. Management is visible in external activities on quality as a means to demonstrate their commitment.
4. Supports participative management within the entire organization and implements the suggestions of quality circle groups. Is a cheerleader inside the institution as s/he monitors the progress and improvement of groups.
5. Recognized as a leader outside the institution for instituting quality.
Category 2: Information and Analysis (8%)
This category examines the scope, validity, use, and management of data and information that underlie the organization’s quality system. Adequacy of data and information supports a prevention-based quality approach using management by fact.
2.1 In what areas (such as accounting, enrollments, number of errors, time for delivering a service) do you have data to illustrate quality trends by function and/or process?
1. No data or just the standard accounting data.
2. Standard rework/redo data.
3. Use of statistical methods to monitor critical processes and systems.
4. Cost of quality analysis data available for all to examine.
5. All functions and departments/units collect and analyze statistical data and use a TQI process cycle to increase the quality of product/service produced.

Category 3: Strategic Quality Planning (7%)
This category examines the organization’s planning process in order to meet its short- and long-term goals and to achieve or sustain a leadership position.
3.1 Summarize the organization’s specific principal quality goals, objectives, and plans for the short term (1-2 years) and longer term (3-5 years).
1. Standard MBO that keys on either financial results or top management’s goals.
3. Management by policy deployment.
4. Management by policy deployment where all employees have quality work plan assignments related to the institution’s mission.
5. All objectives of the organization key on achieving “world-class” capabilities in quality related performance.
3.2 How do you plan for innovation?
1. Hope it occurs.
2. Numerical objectives given to the department heads.
3. Innovation is recognized and encouraged by all employees.
4. Innovation is by policy deployment where all employees are challenged to constantly come forth with new ideas.
5. Innovation is part of the organizational culture.

Category 4: Human Resource Excellence (17%)
This category examines the organization’s effort to develop and utilize the full potential of the workforce for quality and to maintain an environment conducive to full participation, continuous improvement, and personal growth.
4.1 What are the organization’s key strategies for increasing the effectiveness, productivity, and participation of all employees?
1. No institutional strategy.
2. Strategy is dependent on management’s direction and efforts.
3. Participative management which involves working on processes and systems.
4. Participative management which empowers employees to make decisions on-the-spot.
5. Management supportive of the efforts of empowered employees. TGIF means “Thank God It’s Fun” to work here — employee morale is high.

4.2 Describe how the organization educates the employees in TQI processes.
1. No education of employees.
2. Education of employees on skills related to their job.
3. Education of employees on the principles of quality.
4. Education of employees on the principles of quality, including aspects of total quality improvement using statistical process control.
5. All training is based on the continuous improvement of all personnel.

4.3 What percentage of the current employees have ever received education in TQI concepts?
1. 0%
2. Less than 25%
3. 25% to 60%
4. 61% to 90%
5. 91% to 100%

4.4 Describe how the organization positively reinforces employees for contributions to quality improvement (such as recognition of teams, awards).
1. The rewards are either strictly monetary and are arbitrarily disbursed by management, such as merit pay, or there isn’t a formal program.
2. Typical performance review system, which focuses on individual efforts.
3. Commendations and other non-monetary rewards that are dispensed by management’s judgment.
4. Commendations and other non-monetary rewards that are dispensed by management’s judgment but with the input of at least two or more people in the evaluation process.
5. Team recognition and incentives for efforts based on the improvement of the processes and systems where the manager’s role involves supporting team efforts.

4.5 What has the organization done to ensure the quality of work life, to maintain a supportive work environment, and to empower all employees to actively participate?
1. Organization has a “do your job and leave your brains at home” environment.
2. Suggestion boxes available; suggestions are reviewed and discussed.
3. Participative management between employees and administration.
4. Participative management involving all employees.
5. Upside-down pyramid, where the manager’s role is to be a leader and to support the value-added work and the personnel performing that work.
TQM Tools and Techniques

Institutional Self-Assessment, Part 2 of 2

Ed. note: This tool offers an efficient way of estimating the strengths and weaknesses of your institution's quality based on the Baldrige award categories.

Team members should use the Quality Index Rating Sheet on page 5 to record points (1-5) for each question. You may assign decimal equivalents — 2.5, 3.2.

Category 5: Quality Assurance of Products and Services (13%)

This category examines the organization's processes and systems, including control of procured materials, equipment, and services.

5.1 How does your organization define waste, and what preventive measures is it taking to prevent waste?

1. No formal effort.
2. Determines waste solely by inspection — an unsatisfied customer or a job that needs redoing.
3. Includes measurable external failure costs as waste, such as the cost of recruiting, advertising, and processing in order to maintain the status quo.
4. Considers process orientation for waste, such as time, complexity, and scheduling, and considers both internal and external costs.
5. Recognizes waste as a result of poor processes and systems and routinely employs ongoing efforts using work groups and cross-functional teams.

5.2 How does your organization improve the quality of goods and services from vendors?

1. Purchasing is by contract specifications and goes to the lowest bidder.
2. Processes and systems track purchased items and data related to on-time delivery.
3. Suppliers are required to show quality control capabilities; otherwise, various departments write and adhere to stringent specifications.
4. Identified suppliers having process-oriented, quality improvement capabilities.
5. An active partnership with its suppliers that includes combined training.

5.3 How does your organization evaluate external suppliers' product and service quality?

1. No formal tracking program.
2. Tracks rejects only.
3. Annually evaluates suppliers' quality.
4. Active advisory committees that include major suppliers.
5. Partnership and total performance teams in areas of quality, total cost, and on-time delivery. Suppliers are expected to improve continuously.

5.4 How does your organization evaluate internal suppliers' product and service quality?

1. No available program.
2. A committee works to establish a program.
3. Each area tracks its own quality indicators.
4. Organization's culture recognizes internal customer-supplier relationships.
5. President audits the performance of processes and systems supporting the organization's mission.

Category 6: Quality and Operational Results (17%)

This category examines quality based upon objective measures derived from analyzing customer requirements/expectations and operations. Current quality levels are compared with those of competing organizations.

6.1 Can your organization construct a graph showing key improvement data for your products and/or services — graduation rates, retention rates, number and percent of completed work orders — over the past five years?

1. No reliable data or just standard accounting data. Organization generates graphs only for special applications, such as a self-study or governing board report.
2. Traditional quality indicator information, such as routine inspection by internal or external customers.
3. Department uses graphs to regularly evaluate traditional information.
4. Department gathers field intelligence data and evaluates it using graphs; for example, the percentage of purchase orders processed within three working days.
5. Organization regularly posts information related to its mission and strategic quality objectives.

6.2 What are one or two continuous improvement projects that have led to the results in 6.1?

1. No project teams or measurable results.
2. Project teams or committees are put together quickly to examine the special cause effects.
3. Management appoints committees to address such issues as enrollments, remodeling, and production costs.
4. Management routinely appoints mandatory project teams to study areas for improvement and almost always implements their recommendations.
5. Management appoints mandatory project teams to study issues related to quality and value-added work. Front-line personnel do the main work, using quality tools and methods.

6.3 How do you compare your organization with others within or outside of your service area?

1. No comparable data available.
2. Standard accounting information, such as profits, enrollments, or student-to-faculty ratio.
3. Passively collects and analyzes data from outside sources, such as the alumni association.
4. Benchmarks against competitors, using for example, percentage of repeat customers compared with other institutions in service region.
5. Actively obtains benchmarking data on all functions and services from the best in those areas, whether or not they're direct competitors.

6.4 What have been the results of innovation, such as improvements seen in products and/or services?

1. No comparable data.
2. Standard accounting information to measure results, such as profits or returns on assets.
3. Passively collects and analyzes data on innovations from outside sources, such as customer surveys.
4. Rewards innovation regardless of immediate results.
5. Encourages innovation as part of its culture and for its long-term survival.
Category 7: Customer Focus and Satisfaction (25%)

This category examines the organization’s knowledge of the customer, the overall customer service system, and the ability to meet customer requirements/expectations.

7.1 How does your institution determine the satisfaction level of your external customers?
1. No formal collection systems to measure external customer satisfaction. All information is hearsay.
2. A follow-up process for complaints is in place.
3. A formal complaint handling system is in place, providing feedback to appropriate areas. Complaints are treated as “special cases.”
4. Organization uses information gathered from customer satisfaction surveys as well as using processes to monitor key indicators of customer satisfaction.
5. Organization has a comprehensive data collection system leading to quality function deployment.

7.2 How do you determine the satisfaction level of your internal customers?
1. No formal program.
2. Communication of satisfaction is channeled through hierarchy.
3. Routinely uses cross-functional teams to survey for satisfaction.
4. Routinely uses cross-functional teams to survey for satisfaction and then uses a TQI process to improve the internal customer-supplier relationship.
5. All organizational functions use TQI processes. Team communications are horizontal.

7.3 In what functional areas, processes, or systems do you have defined, measurable quality criteria?
1. None.
2. Management measures certain products or services.
3. Management measures at least 50% of the products or services.
4. Management and employees measure at least 50% of the products or services.
5. The organization has a total quality system oriented toward data gathering.

7.4 How do you determine customer satisfaction?
1. No analysis.
2. Some tracking of passively gathered data.
3. Regularly tracks passively gathered data.
4. Actively accumulates and analyzes customer satisfaction data.
5. The entire organization is actively involved in measuring internal and external customer satisfaction.

7.5 How does your organization measure trends in customer satisfaction in specific areas?
1. No information.
2. Information is just hearsay.
3. External sources show increased customer satisfaction through specific measurable data.
4. Organization constantly produces and mails statistically valid questionnaires.
5. Specifically generates and monitors data evaluating key quality criteria to determine year-to-year improvements.

7.6 What does your organization do to continuously improve customer satisfaction?
1. Nothing.
2. Recognizes quality successes through awards, certification, accreditation.
3. In addition to recognition awards, the president personally sends kudos to the individual/unit.
4. Shows improvement through TQI and TQM training.

5. Becomes active locally and nationally in the quality movement, and communicates widely about its processes and systems quality.

Quality Index Rating Sheet
Enter your results on the following rating sheet and perform the calculations.

- Organization: __________________________ Date: __________
- Reviewer(s): __________________________
- Document notes, questions on separate sheet.

1.0 Leadership
1.1 ______
1.2 ______
1.3 ______ (TOTAL + 3) x 0.13 ______

2.0 Information and Analysis
2.1 ______ TOTAL x 0.08 ______

3.0 Strategic Quality Planning
3.1 ______
3.2 ______ (TOTAL + 2) x 0.07 ______

4.0 Human Resource Excellence
4.1 ______
4.2 ______
4.3 ______
4.4 ______
4.5 ______ (TOTAL + 5) x 0.17 ______

5.0 Quality Assurance of Products and Services
5.1 ______
5.2 ______
5.3 ______
5.4 ______ (TOTAL + 4) x 0.13 ______

6.0 Quality and Operational Results
6.1 ______
6.2 ______
6.3 ______
6.4 ______ (TOTAL + 4) x 0.17 ______

7.0 Customer Satisfaction
7.1 ______
7.2 ______
7.3 ______
7.4 ______
7.5 ______
7.6 ______ (TOTAL + 6) x 0.25 ______

Quality Index = sum of category ratings = ______

Quality Index Category Description
0.0-2.9 I Poor
3.0-3.4 II Commitment
3.5-3.9 III Significant Progress
4.0-5.0 IV World Class

For more information, contact: Robert Cornesky, Editor, TQM/HE, Magna Publications, 2718 Dryden Drive, Madison, WI 53704.

Next month: histogram.
The Histogram

The histogram is a graphic tool that displays in bar graph form the frequency at which certain events occur. It lets you see patterns that are difficult to see in a table of numbers.

You can use a histogram to analyze variation within a system. To do this, you must have a set of either related attributes (counts) data or variables (measurements) data.

If a system is unstable, a histogram can be used to predict system improvements or show the results of system modifications. If the system is unstable, the histogram might take on different shapes at different times. Because of this, the histogram is often used with a control chart.

In the following example, we’ll describe how a histogram is prepared and how a histogram’s shape may vary. We won’t, however, calculate the statistics. Instead, we’ll refer you to any elementary statistics book for the calculations.

The chair of a chemistry department used a histogram to demonstrate to his dean the benefits of additional funding for professional development. He made his case using data he collected after sending a specific faculty member — Professor Smith — to a workshop on teaching/learning styles.

At one time, only 25% of the students who took Smith’s general chemistry class received a grade of “C” or better. The remaining 75% received either a “D” or an “F.” (At this university “F” was 59% or less, “D” was 60-69%, “C” was 70-79%, “B” was 80-89% and “A” was 90% or above.) Smith assigned final grades based on his students’ performance on the chemistry department’s standardized final exam. He attributed his students’ poor performance to laziness and lack of motivation.

Since it was apparent that his teaching style was reaching only 25% of his class, the chair suggested forcefully that Smith examine his style and enroll in an intensive workshop on teaching/learning styles.

Several semesters after Smith took the workshop, the chair used a histogram to demonstrate the grade distributions on standardized tests of the students in Smith’s general chemistry classes. These histograms are shown in figures 1 and 2.

Procedure

1. Select the Data to Be Analyzed

We’ve assumed that the task force or the individual studying the system has already collected either the attribute data or variable data. In this case, the chemistry chair gave a standardized general chemistry proficiency exam after the students completed the course. His data compared student performance among classes and various professors.

2. Record the Data

Construct a frequency table similar to those on page five and record the attribute data. In this case, the numbers of test scores are recorded by grade and frequency. Absolute frequency is actual numbers of grades received. Relative frequency is the percentage of grades received at that level. Relative cumulative frequency is the ongoing total of the percentage of grades received up to and including any given level.

3. Draw the Histogram

Start with an x-axis (horizontal) and a y-axis (vertical), of approximately equal length and of sufficient size to best display the data. The chair created a histogram by drawing a bar for each “grade” with the corresponding “frequency” with which it occurred.

The resulting histograms show the distribution of grades of Smith’s students on the department’s proficiency exam from 1986-89 (before the teaching/learning styles workshop) and from 1990-91 (after the workshop).

4. Analyze the Histogram’s Shape

Histograms have six common shapes:

- symmetrical,
- skewed right,
- skewed left,
- uniform,
- random, and
- bimodal.

The symmetrical figure, also called a bell-shaped curve, usually represents a “normal” distribution, indicating that the system under investigation is probably under control. Ideally, the mean (average), mode, and median of the class data are equal and 99.73% of the total area under the curve is plus or minus three standard deviations.

Histograms can also trail off either to the right or the left. Trailing to the right is known as a positive skew. Trailing to the left is known as a negative skew. These skews occur when the data has values greater than zero — as in our example on page five.

The uniform and random distributions can indicate that the system is out of control. A uniform distribution may result from having an insufficient number of classes in your data, while random distribution may occur if you have multiple sources of variation in the system. In either case, these distributions usually provide little information.

A bimodal-shaped histogram — having two different peaks — may indicate that the system is the result of several sources of data.

The first histogram in our example is either bimodal or skewed left. The bimodal shape might indicate that two different systems are operating and need to be separated and analyzed individually.

In this case, you could argue that Smith did have two separate “systems” operating — students who were learn-
ing and students who weren’t and that his teaching style was compatible with approximately 25% of his students. If Smith was able to learn the same way he taught, he might think that all students should be able to learn under similar conditions. Those who couldn’t would be considered unmotivated and “dumb.”

The skewed left histogram is “negatively skewed”—it has a larger number of instances occurring in the upper classes (C-F) and fewer in the lower classes (A-B). This skewed distribution occurs when the data within a system has a possible zero point and all the collected data have a value larger than zero.

The second histogram is probably symmetrical since it has a bell-shaped curve. Because of its shape, and with plus or minus three standard deviations, the percentage of data that fits under the curve is very close to 100%. The histogram suggests that the system is probably under control.

With the second example, you could make the case that Smith was able to effectively teach the majority of his students, since over 95% of them received a grade of a “C” or better on the proficiency exam. You could argue that Smith’s modification of his teaching style accommodated 95% rather than 25% of his students.

By using histograms to show the difference in the cost of retaining students rather than recruiting new ones to replace those suspended for poor grades, the chemistry chair was able to make the case for additional professional development money to retain faculty in the different teaching and learning styles.

Next issue: *Pareto diagram.*

### Distribution of grades, 1988-91

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ab. Freq.</th>
<th>Rel. Freq. %</th>
<th>Rel. Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>55</td>
<td>13.75</td>
<td>13.75</td>
</tr>
<tr>
<td>B</td>
<td>35</td>
<td>8.75</td>
<td>22.50</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>3.00</td>
<td>25.50</td>
</tr>
<tr>
<td>D</td>
<td>195</td>
<td>48.75</td>
<td>74.25</td>
</tr>
<tr>
<td>F</td>
<td>103</td>
<td>25.75</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

### Distribution of grades, 1992-93

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ab. Freq.</th>
<th>Rel. Freq. %</th>
<th>Rel. Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>52</td>
<td>26.13</td>
<td>26.13</td>
</tr>
<tr>
<td>B</td>
<td>89</td>
<td>44.72</td>
<td>70.85</td>
</tr>
<tr>
<td>C</td>
<td>49</td>
<td>24.62</td>
<td>95.47</td>
</tr>
<tr>
<td>D</td>
<td>7</td>
<td>3.52</td>
<td>98.99</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>25.75</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>199</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

**Distribution of grades of Dr. Smith’s students on the Chemistry Department Proficiency Exam, 1988-91**

**Distribution of grades of Dr. Smith’s students on the Chemistry Department Proficiency Exam, 1992-93**
TQM Tools and Techniques

Pareto diagram

The Pareto diagram is a vertical bar graph which helps determine which problems to solve in which order. It’s used to identify the few significant factors that contribute to a problem and separate them from the insignificant ones.

Based on the work of Vilfredo Pareto, a 19th century Italian economist, the diagram was made popular by Joseph Juran in the 1940s. However, it was Alan Lakein who came up with 80/20 rule common to the Pareto diagram. The rule states that about 80% of the problem comes from 20% of the causes.

Although many consider it a problem-solving tool, Pareto diagrams are really best used for guiding a team to the problem areas that should be addressed first. Since the diagram draws everyone’s attention to the key factors where the payback is likely to be greatest, it can also be used to build group consensus.

Pareto Diagram Application

The bars in the Pareto diagram are arranged in descending order of height from left to right. This means the categories represented by the tall bars on the left are relatively more important than those on the right.

We’ve selected a case study from a university where requests for renovation and repairs — work orders — to the building and grounds department weren’t being completed in a timely fashion. Many of the repairs weren’t accomplished simply because the “work order” form wasn’t completed correctly.

The maintenance staff identified six categories, which attributed to the majority of errors:
- unclear requests,
- missing supervisor’s signature,
- missing unit cost code,
- missing date when the work was to be performed,
- location of renovation/repair not specified, and
- work order request misfiled.

The director of buildings and grounds appointed a task force and asked them to collect and analyze the data. They used the Pareto diagram as part of their study.

Procedure

1. Select the Categories to be Analyzed

Task force members should identify data they will need to collect to address a particular problem — time, location, number of defects, number of errors. Once identified, the data is placed into categories — keeping the number of categories to 10 or fewer.

2. Specify the Time Period in Which the Data Will Be Collected

The time period selected will vary according to the system under study. For example, it may be hours as with the time it takes the accounting department to cut a check, or years, as in the case of testing an improvement theory. However, the time selection should be constant for all diagrams that are being compared.

In the following example, the director chose to compare the six categories over the past academic year.

3. Record the Data

Task force members constructed a table with a category column and a frequency column as shown below.

<table>
<thead>
<tr>
<th>Category</th>
<th># of Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclear request</td>
<td>130</td>
</tr>
<tr>
<td>Supervisor’s signature</td>
<td>74</td>
</tr>
<tr>
<td>Absent</td>
<td></td>
</tr>
<tr>
<td>Cost code absent</td>
<td>46</td>
</tr>
<tr>
<td>Date to perform absent</td>
<td>40</td>
</tr>
<tr>
<td>Location not identified</td>
<td>38</td>
</tr>
<tr>
<td>Work order misfiled</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Occurrences</th>
<th>Relative Percentage</th>
<th>Cumulative Occurrences</th>
<th>Cumulative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclear request</td>
<td>130</td>
<td></td>
<td>130</td>
<td>36.1</td>
</tr>
<tr>
<td>No supervisor’s signature</td>
<td>74</td>
<td>19.7</td>
<td>204</td>
<td>55.8</td>
</tr>
<tr>
<td>No cost code</td>
<td>46</td>
<td>12.8</td>
<td>250</td>
<td>68.6</td>
</tr>
<tr>
<td>Date to perform</td>
<td>40</td>
<td>11.1</td>
<td>290</td>
<td>79.7</td>
</tr>
<tr>
<td>Location not identified</td>
<td>38</td>
<td>10.6</td>
<td>328</td>
<td>90.3</td>
</tr>
<tr>
<td>Work order misfiled</td>
<td>32</td>
<td>8.9</td>
<td>360</td>
<td>99.2</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
<td>99.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Draw the Graph

Task force members drew the x-axis — horizontal — long enough to best display the graph. While this may vary from several inches to six or seven inches, the width of each bar should be equal.

In the case study, the director selected the x-axis of 3.6 inches and the scaling factor of 0.60 inch to represent each of the categories.

Task force members drew two y-axes — vertical lines — of equal length as shown below. The y-axes should be as long as the x-axis, if not longer; but should be long enough to best display the graph.

They then labeled and scaled these axes. Here, the x-
axis represents the categories being compared, the y-axis on the left represents the number of occurrences, and the right y-axis represents cumulative percent.

After they drew the graph, task force members plotted the cumulative frequencies and drew a line connecting the marks (x) as shown below.

5. Analyze the Diagram

As Alan Lakein noted, it's not unusual for 80% of the problem to be caused by a few categories. In the above example, over 55% of the occurrences were due to the first two categories.

You must be careful when using this tool. It's true the Pareto diagram can point out chunks of data for a task force to use to analyze causes and then direct their efforts towards a few categories.

However, there are data that can't be easily categorized. Some data, without further analysis, may be misleading if they're too general. For example, here the data could be misinterpreted if the director simply concentrated on the first two categories. Instead, the director further analyzed the data by constructing another Pareto diagram plotting the number of unclear requests with the departments submitting the requests.

From the data the director constructed the following frequency table.

<table>
<thead>
<tr>
<th>Administrative Unit</th>
<th>Number of Occurrences</th>
<th>Percentage</th>
<th>Cumulative Occurrences</th>
<th>Cumulative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>50</td>
<td>38.5%</td>
<td>50</td>
<td>38.5%</td>
</tr>
<tr>
<td>#3</td>
<td>30</td>
<td>23.1%</td>
<td>80</td>
<td>61.6%</td>
</tr>
<tr>
<td>#14</td>
<td>25</td>
<td>19.2%</td>
<td>105</td>
<td>88.8%</td>
</tr>
<tr>
<td>#5</td>
<td>10</td>
<td>7.7%</td>
<td>115</td>
<td>96.5%</td>
</tr>
<tr>
<td>#1</td>
<td>5</td>
<td>3.9%</td>
<td>125</td>
<td>96.3%</td>
</tr>
<tr>
<td>#4</td>
<td>5</td>
<td>3.9%</td>
<td>130</td>
<td>100.2%</td>
</tr>
<tr>
<td>#3</td>
<td>0</td>
<td>0%</td>
<td>130</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this case study, the Pareto diagram and the corresponding data indicate that department seven generated the greatest number of unclear requests. Furthermore, analysis shows that Lakein's rule applies: roughly 80% of the problems from just departments seven, eight, and fourteen. The concentration represents an definite sign to focus first on those three departments.

Next month: Run chart and Scatter diagram

"Every organization is perfectly designed to get the results it gets."
—Anonymous Eastman Kodak executive
TQM Tools and Techniques

Run Chart

A run chart, also called a tier chart, is a line graph of data where the observed values can be either measurements (variables) or counts (attributes). The data are plotted on the vertical axis while the time is plotted on the horizontal axis.

Run charts are often used to examine the function of a system over time. They're the simplest tool to construct and use and are useful for capturing a single snapshot or for following trends. Similar data plotted together in a histogram may not reveal an important trend requiring corrective action.

A run chart is constructed from data collected while the system is in operation. Usually more than 25 points are required for a valid run chart.

In a run chart, the time factor can be seconds, minutes, hours, days, weeks, or years. Depending upon the data, it may be possible to add the statistical upper and lower control limits and make the run chart a “control chart.” (For an example of a control chart see TQM/HE, February 1993.)

Procedure

1. Select the Data to Be Analyzed

We've assumed that the task force studying a particular system has collected either the attribute (counts) data or the variables (measurements) data.

In the following case study, we will examine the average final grade of students in an introductory computer science course as a function of the MWF class periods over five semesters. The courses were taught by six different instructors, all using the same syllabus and textbook.

2. Record the Data

Record the data in the order in which it was collected.

<table>
<thead>
<tr>
<th>Class Period &amp; Time</th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWF Class Period</td>
<td>1st</td>
<td>2nd</td>
<td>1st</td>
</tr>
<tr>
<td>12-5-90 AM</td>
<td>86%</td>
<td>81%</td>
<td>84%</td>
</tr>
<tr>
<td>1-12-90 AM</td>
<td>86%</td>
<td>83%</td>
<td>89%</td>
</tr>
<tr>
<td>2-12-90 AM</td>
<td>86%</td>
<td>83%</td>
<td>87%</td>
</tr>
<tr>
<td>3-12-90 AM</td>
<td>86%</td>
<td>83%</td>
<td>89%</td>
</tr>
<tr>
<td>4-12-90 AM</td>
<td>86%</td>
<td>83%</td>
<td>89%</td>
</tr>
<tr>
<td>5-12-90 AM</td>
<td>86%</td>
<td>83%</td>
<td>89%</td>
</tr>
</tbody>
</table>

3. Draw the Chart

Scale the chart using the collected data. This will vary depending upon the type of data you've collected — variables or attributes.

To scale variables data, find the largest and smallest values and determine the difference between them. In our case study, the largest was 98% and the smallest was 65% — (98 - 65 = 33). A rule of thumb for producing readable graphs with sufficient space above the highest value is to count the number of lines on your graph paper and multiply it by 0.66.

Our chart has 30 lines, therefore 30 x 0.66 = 19.8, or approximately 20. The graph will use the bottom 20 lines. (Ed. note: Almost any chart paper can be used to plot run chart data. The process of scaling would be the same.)

Label the chart so that the results can be clearly understood. An example is shown below.

4. Analyze the Chart

In analyzing the results, look for “runs” of seven or more points as well as for other patterns.

In our case, the task force discovered that the highest grades were in class periods #11 and #12, regardless of
TQM in higher education

January 1994

which instructor was teaching. The explanation: in these late-evening classes, the students were mainly older, working, and goal-oriented, taking one class at a time for either a degree or personal advancement.

The lowest grades were in periods #7 and #8, the mid-afternoon classes. Again it didn’t appear to make any difference which instructor taught the classes. Later the task forced discovered that these periods had the highest rate of student absences.

To counteract this problem, the college established a peer and faculty mentoring program and students received a call every time they missed a class. Over the next several semesters, it appeared that the students in the afternoon classes were performing as well as those in the morning classes.

wanted to examine whether the mid-term grade of students in a freshman mathematics course was related to class size. She wanted to test the proportion receiving a “D” or lower grade — including “D,” “F,” “I,” or “W” — to the class size during the fall quarter. (Ed. note: While a minimum number of 25 pairs of data is desirable for an appropriate analysis, the following case study only has 22 samples.)

2. Record the Data (see figure 1)
3. Draw the Diagram (see figure 2)

Scale the diagram so that both axes are approximately the same length. The length of the axes should be long enough to accommodate your entire range of values using the entire length of each axis.

In our example, class size ranged from 25 to 55 so we made each marker on the x-axis 0.5 inch. The x-axis usually contains the data believed to be the influencing or independent factor, while the y-axis contains the dependent or responding factor.

The chair believed that larger class sizes resulted in faculty having little or no interaction with the students and thus caused poor grades. The independent factor is class size and the dependent factor — the item which responds to the independent factor — is the proportion of grades at mid-term lower than a “D.”

Label and date the diagram and then plot the points. The completed diagram is shown below.

4. Analyze the Diagram

Although it looks as if there might be a positive correlation between class size and the proportion of students receiving a grade of “D” or less at mid-term, there were other factors that influenced the grades.

Further analysis using other TQM tools uncovered that the time of day the classes were offered and the number of absences in the classes were the major causes of poor grades. Class size had little to do with students’ grades in this particular math class. This example warns the user of the potential for misinterpreting data that appear to be correlated but which have other underlying factors.

Scatter Diagram

Scatter diagrams are used to test the possible interrelationships of two factors. If a relationship appears to exist, the factors are correlated. However, a cause-and-effect relationship can be verified only using control charts. A scatter diagram is useful for analyzing causes of poor processes or systems.

Figure 1

<table>
<thead>
<tr>
<th>Course MA103</th>
<th>Section</th>
<th>Class Size</th>
<th>Proportion with a grade of D or F</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>14</td>
<td>.036</td>
<td></td>
<td></td>
</tr>
<tr>
<td>002</td>
<td>27</td>
<td>.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>003</td>
<td>30</td>
<td>.135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>004</td>
<td>29</td>
<td>.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>005</td>
<td>20</td>
<td>.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>006</td>
<td>20</td>
<td>.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>007</td>
<td>50</td>
<td>.167</td>
<td></td>
<td></td>
</tr>
<tr>
<td>009</td>
<td>10</td>
<td>.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>011</td>
<td>11</td>
<td>.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>012</td>
<td>15</td>
<td>.125</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Procedure

1. Select the Data to Be Analyzed
   In the following case study, a department chair
TQM Tools and Techniques

Scenario Builder

The scenario builder is a planning tool that roughly quantifies potential outcomes resulting from implementing one or more proposed changes to a system.

A scenario builder asks, "What if?" and concentrates on proposing the most likely positive and negative outcomes. It combines many features of the affinity diagram, nominal group process, force field analysis, and systematic diagram.

Like the affinity diagram, it attempts to organize complex issues. Like the nominal group process, it identifies and ranks the most likely effects of the proposed change. Like the force field analysis, it concentrates on both positive and negative, driving and restraining forces, and the steps needed to overcome resistance to change. Finally, like the systematic diagram, it helps identify possible steps needed to implement a broader goal.

The scenario builder should be used only when task force members are familiar with the other tools and when the situation has required using two or more for clarification.

Although the scenario builder requires a minimum of three hours to complete, it may save many hours if three tools would be required to arrive at similar conclusions.

Procedure

1. Spell Out the Recommended Changes

   Before using the scenario builder, define the system requiring modification. Team members should solidify the change(s) to be implemented in order to improve the system.

   Place the recommended change (C) in the middle of the hexagon (see Figure 3). Stipulate the acceptance of appropriate recommendations for implementing the change.

2. Record the Perceptions

   List at least three beneficial and three undesirable outcomes of the proposed change. The beneficial outcomes should be listed in the squares labeled 1-3; the undesirable ones should be listed in squares 4-6.

   (Ed. note: Sometimes it’s almost impossible to identify three truly unacceptable outcomes resulting from the implementation of improvements in processes or systems. However, you should attempt to identify at least two.)

   Following the above pattern, label four scenarios that are likely to result from each of the outcomes identified in the squares labeled 1-6. If possible, two should be positive and two negative. These scenarios correspond to the four triangles that branch off from each square in Figure 1.

   Repeat the pattern with the ellipsoids, which are labeled “results of scenarios.” At least one of these results should be either positive or negative at any of the levels.

3. Score the Scenarios

   Scoring the scenarios can be done either as they’re listed, or afterward. All six first-level outcomes (depicted as squares) should have at least a 70% perceived probability of occurring.

   To score the scenario builder, rate from +1 to +10 any positive outcome that might occur if the change is implemented, and from -1 to -10 any potential negative outcome.

   For example, the group may decide that positive outcome A (in square 1) would happen if the change is executed. It’s assigned a value of +10, which means the scenario would occur 100% of the time if the change were implemented and if nothing were done to stop it. Likewise, a +3 would receive a value of 30%, a +4 a value of 40%, and so on. Positive outcomes B and C may be assigned values of +7 and +5 respectively.

   If negative outcome D would almost definitely occur 100% of the time if the change were implemented; it would receive a value of -10. Negative outcomes E and F would receive a -3 (30%) and -4 (40%) since they were less likely to occur if the change was implemented.

   If a very positive scenario would occur if the change is executed, and if its effect couldn’t be altered, it should receive a value of +50. Likewise, a potential disaster should receive a value of -50.

   Record the values of the first-level outcomes (1-6) on a scenario builder tally sheet, as shown in Figure 2. Likewise, enter the values for the second-level scenarios — 1.1 through 6.4. Finally, record the values for the third level results — 1.1.1 through 6.4.3. The scoring guidelines for the scenario builder are shown in the following table.

   Figure 1

<table>
<thead>
<tr>
<th>Positive</th>
<th>Negative</th>
<th>Percentage of Time Scenario Would Occur</th>
<th>Effect Can Be Altered?</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5</td>
<td>-3</td>
<td>30%</td>
<td>Yes</td>
</tr>
<tr>
<td>+4</td>
<td>-3</td>
<td>20%</td>
<td>Yes</td>
</tr>
<tr>
<td>+4</td>
<td>-4</td>
<td>20%</td>
<td>Yes</td>
</tr>
<tr>
<td>-3</td>
<td>+3</td>
<td>30%</td>
<td>Yes, Can Be Altered</td>
</tr>
<tr>
<td>-3</td>
<td>+3</td>
<td>30%</td>
<td>Yes, Can Be Altered</td>
</tr>
<tr>
<td>-3</td>
<td>-4</td>
<td>40%</td>
<td>Yes</td>
</tr>
<tr>
<td>-4</td>
<td>-3</td>
<td>40%</td>
<td>Yes, Can Be Altered</td>
</tr>
<tr>
<td>-4</td>
<td>-4</td>
<td>50%</td>
<td>Yes</td>
</tr>
<tr>
<td>-5</td>
<td>-4</td>
<td>50%</td>
<td>Yes</td>
</tr>
</tbody>
</table>

4. Interpret the Scores

   Examine the first-level outcomes labeled 1-6, which should all have values +/-7. They should have a greater than 70% chance of occurring if the changes were implemented. If not, ignore them.

   Continue to build on the major positive and negative projections through levels two and three. Concentrate only on those with values of +/-7 or greater.

5. Describe What Will Likely Happen for Each Outcome and What Action Step Needs to Be Taken to Accentuate Positive and Minimize Negative Outcomes

   After identifying and ranking both positive and negative outcomes, the task force can now identify action steps
recommending the change and minimizing possible negative outcomes, or abandoning the change if the projected negative outcomes suggest that it would prove disastrous.

6. List and Analyze Any Scenario With an Absolute Value Greater Than 100

When hypothetical projections have high scores, it usually means that if the recommended changes were implemented and if the task force’s perceptions were accurate, then the projections would actually take place.

7. Suggest One or Two Systems for Improvement to Maximize the Positive and Minimize the Negative

The task force determines which suggestions to offer in its report to the decision-makers.

---

"At the heart of the improvement process is information. We need to generate data on what goes into a process, what steps have been taken to alter those inputs, and what the outcomes are. We need to measure these variables. ... But even though measurement is a way of generating ‘friendly facts’ ..., there still remains a fear that some faceless, humorless bureaucrat will use a measuring device to label us as ‘too slow’ or ‘not good enough.’ This fear is heightened when it comes to measuring quality.”

— Daniel T. Seymour, On Q: Causing Quality in Higher Education

---

"If you can’t measure something, you can’t understand it; if you can’t understand it, you can’t control it; if you can’t control it, you can’t improve it."

— H.J. Harrington, The Improvement Process
TQM Tools and Techniques

Quality Index Rating Profile — Part 1 of 2

The quality index rating profile provides a way to assess the strengths and weaknesses of your classroom processes and systems. It’s based on modified Baldrige criteria and was recently published in *The Quality Professor: Implementing TQM in the Classroom*.

The categories are: leadership (9%), information and analysis (8%), strategic quality planning (6%), and human resource development and management (15%). Next month, we’ll cover management of process quality (14%), quality and operational results (18%), and customer focus and satisfaction (30%).

Procedure

To determine the “quality index” (QI) of your classroom processes and systems, assign points (1-5) for each category subsection, based on the described criteria. It’s permissible to assign decimal equivalents – 2.5, 3.2. Then, next month, enter your scores in the QI rating sheet.

Category 1.0: Leadership (9%)

This category examines your commitment to leading your students to achieving quality work.

1.1 Describe what “quality” means to you. Do you have a formal statement?

1. I have no formal statement about quality.
2. I mention quality work only at the beginning of the class, with no formal statement or examples.
3. I give a formal statement to students and share it with employers, business and community leaders, and administrators.
4. I present a formal statement to my students at the beginning of the class. I display quality work for all to use as a model. I make sure students know what quality work means to their own success and the success of the class and institution.
5. My formal statement relates to students and to the expectations of other customers who are committed to continuous improvement of the classroom processes, systems, and outcomes.

1.2 How have you deployed your quality policy and/or mission statement among your students?

1. I discuss quality.
2. I display a quality manual in the classroom, with examples of quality work enclosed.
3. I distribute quality manuals and/or policy statements about quality to all students.
4. I train all students on quality procedures and goals.
5. My students and I work together to improve classroom activities by discussing the quality policy and establishing a clear direction.

1.3 Describe your leadership in promoting quality.

1. I use a traditional leadership role of directing and controlling.
2. My leadership is visible in my concern for quality issues within my institution.
3. My leadership is visible in expressing the quality mission beyond the institution to governing boards, industry representatives, and city and state officials.
4. I’m active in supporting advocacy and collaborative learning in the classroom and implement suggestions that result from student input. I’m a supportive leader for all students, monitoring progress and constantly seeking ways to improve the learning process.
5. I’m recognized outside the institution as a leader in instituting quality.

1.4 Describe your teaching style(s).

1. I mostly lecture, with some question-and-answer periods.
2. I make use of lecture, demonstration, and question-and-answer periods.
3. I use more traditional methods, interspersed with group work and research assignments.
4. I use a variety of methods, adapting to the learning styles of my students, including some collaborative learning.
5. I use mostly student-led, collaborative learning techniques with goal-setting as a major focus. We achieve mastery learning of basic facts in various ways. I help students with different learning styles in order to provide all students with opportunities to contribute in a variety of ways.

1.5 Describe the nature of any ongoing education/training you’ve had to stay current with the latest trends in your content area.

1. I meet the institutional requirements for annual increments each year.
2. I subscribe to at least one professional journal and attend at least one workshop or conference each year.
3. I maintain communication with local and state curriculum specialists, read and implement the latest information, and attend as many conferences as possible.
4. I make recommendations to the librarian for purchases, send for information on the latest trends in my discipline, encourage specialists to visit my classroom to provide demonstrations and/or offer suggestions for improvement, read journals and newspapers to keep current on trends, and make meaningful assignments in concert with world events.
5. I actively engage in national, state, and local organizations and cultivate a network with other professionals. I maintain an ongoing, well-planned continuing education program for myself, professionally and personally, that revolves around a long-term, global perspective.

1.6 How do you define quality in your own work? How do you exemplify that to your colleagues?

1. I give no thought to quality.
2. I define quality as traditional evaluation by management.
3. I define quality as student achievement and I present this information in written form to my colleagues.
4. I define quality of work as it’s reflected in the students’ enthusiasm for learning and achieving quality work. As a super-leader, I’m available to assist my colleagues.
5. I define quality of work as it’s reflected in the “world-class” quality of students’ work and their enthusiasm for helping their
classmates achieve success. The numbers of students choosing to pursue a career in my discipline, or enrolling in advanced courses in my discipline are also a measure of the quality of my work. Finally, my students and I are having fun learning.

Category 2.0: Information and Analysis (8%)

This category examines the scope, validity, use, and management of data and information that underlie the total quality system in the classroom.

2.1 Consider the areas in which you have data to illustrate quality trends in your classroom (materials, student satisfaction, student involvement, employer satisfaction, students entering graduate institutions, students adequately prepared for the next level of instruction in any given curricular area, student retention, time for achieving mastery in any curricular area).

1 I have no data or just the standard evaluation data.
2 I have standard retention data, with some information on curricular trends.
3 I use statistical methods to monitor processes and systems.
4 I collect quality analysis data and make it available for all (including students) to examine.
5 I use statistical data to analyze all classroom processes and systems. I use the Plan-Do-Check-Act cycle to improve classroom processes and systems.

Category 3.0: Strategic Quality Planning (6%)

This category examines your planning process for encouraging students to do quality work and your short-term and long-term priorities.

3.1 Summarize your principal quality goals, objectives, and plans for the short term (3-6 months) and longer term (1-2 years).

1 I set standard goals based on the bell-shaped curve.
2 I set numerical objectives related to quality, cost effectiveness, and customer satisfaction.
3 I practice management by policy deployment, in which all students have work plan assignments related to the quality goals of the classroom mission.
4 My quality goals exceed those of similar classes and everyone is committed to achieving those goals.
5 All objectives of the classroom are anchored on achieving "world-class" capabilities in quality-related performance, which includes process and system orientations.

Category 4.0: Human Resource Development and Management (15%)

This category examines the outcomes of your efforts to develop and use the full potential of all students and to maintain an environment conducive to full participation, continuous improvement, and classroom growth.

4.1 What are your key strategies for increasing the effectiveness, productivity, and participation of all students?

1 I have no formal strategy.
2 My strategy is dependent on the course content.
3 I have a formal and flexible strategy that encourages my students to participate in assessing the classroom climate and offering suggestions for improving it. Students are empowered to work for the success of all.
4 My classroom environment is completely without fear, and cooperative learning opportunities are essential parts of each class period. Therefore, all students share in the success of the group.

I assume the role of a quality instructor, challenging my students to tap their fullest potentials. Students evaluate their own work as well as others' for quality, offering suggestions and encouragement.

4.2 Describe how you educate students in total quality improvement.

1 My students receive no education in the principles of TQI.
2 My students are educated only in the TQM techniques that apply to immediate subject matter skills.
3 All of my students are educated in the principles of TQM and TQI.
4 My students are educated in the principles and processes of quality, including the Plan-Do-Check-Act cycle, and use them in their daily work.
5 Learning is based on the continuous improvement of all students as the keystone to success.

4.3 What percentage of your current students have ever received education in quality improvement concepts and processes?

1 0%
2 Less than 25%
3 25% to 60%
4 61% to 90%
5 More than 90%

4.4 Describe how you positively reinforce student contributions to quality improvement — recognition of teams, awards.

1 I use traditional grades to reward achievement.
2 I use typical performance reviews that focus on individual efforts.
3 I give commendations and other rewards as I deem appropriate.
4 I give commendations and other rewards as my students and I deem appropriate.
5 Team recognition and incentives for efforts are based on improvement of the processes and systems. My role is to support and facilitate the efforts of the team. I post information about team rewards. I have a system for distributing information to parents, community members, and colleagues.

4.5 What have you done to ensure the quality of the environment in the classroom, to make it more supportive, and to empower all students to actively participate in the learning process?

1 My classroom environment reflects an attitude of: be quiet, do your work, and don't question or make suggestions.
2 My students and I discuss and consider suggestions from the administration.
3 My students and I discuss only certain selected students' suggestions.
4 I use a participation management approach, where I encourage all my students to make suggestions, discuss options, and collaborate with others to implement group decisions.
5 I use an inverted pyramid, where my role is to be a leader and to support quality work. All my students are performing that work — advocacy at its best.

To order The Quality Professor: Implementing TQM in the Classroom, contact: Magna Publications, 2718 Dryden Drive, Madison, WI 53704; Ph: 800/433-0499. Cost: $22.95.

Next month: Quality Index Rating Profile — Part 2.
TQM Tools and Techniques

Quality Index Rating Profile — Part 2 of 2

The quality index rating profile, based on modified Baldridge criteria, offers a way to assess the strengths and weaknesses of your classroom processes and systems.

This month we'll cover: management of process quality (14%), quality and operational results (18%), and customer focus and satisfaction (30%).

Procedure

To determine the "quality index" (QI), assign points (1-5) for each category subsection, based on the described criteria. It's permissible to assign decimal equivalents — 2.5, 3.2. Then, enter your scores in the QI rating sheet.

Category 5.0: Management of Process Quality (14%)

This category examines the classroom systems based upon quality improvement processes, including the control of course curriculum materials, equipment, and services.

5.1 What methods do you use to evaluate your students' academic performance?

1. I use traditional paper/pencil evaluation, which I grade.
2. I have students grade each others' quizzes.
3. I grade all tests. Students are able to continue improving their grade until they achieve mastery.
4. Students turn in a portfolio of work at the end of each unit, along with self-evaluation. I then evaluate the level of achievement for mastery learning at the 80% level.
5. Students work together to evaluate each others' work, including a portfolio of work reflecting cross-curricular, critical thinking, and writing or computational assignments, and provide appropriate feedback for revision/discussion. My assessment of their work reflects mastery learning at "world-class" levels.

5.2 How do you define "waste" in your classroom and what preventive measures do you take to reduce it?

1. I have no formal definition of "waste."
2. I define "waste" as students who don't pass. Passing is determined solely by inspection, such as tests.
3. My definition of "waste" includes measureable external failure costs, such as the cost of dropouts to society.
4. I consider process orientation for "waste," such as time, steps, complexity, or special projects as students reach minimum standards.
5. I recognize "waste" as a result of poor processes and systems: it includes all aspects of the educational system. As a result, I make an ongoing effort to use curriculum teams composed of representatives from kindergarten through college, cooperative learning, cross-curricular teams, and mastery learning.

5.3 How do you help those who supply you with students to improve their quality?

1. I make no effort to help them improve.
2. I have an informal agreement to discuss student deficiencies with their former instructors and high school teachers.
3. I provide the students' former instructors and teachers with TQM instruction and encourage them to incorporate the principles.
4. Through my efforts, the students' former instructors and K-12 teachers have developed process-oriented quality improvement capabilities.
5. I maintain an active partnership with all suppliers in order to set and improve quality. There's cross-training throughout the college.

5.4 How do you evaluate and integrate the quality of your students' skills that they've acquired in other classes in your institution?

1. There's no formal tracking system.
2. I make no effort to meet with other instructors, but I express concern about the skills of the students.
3. I participate in the annual evaluation of skills from cross-curricular classes.
4. There's productive interaction among all instructors across the undergraduate curriculum. We share skills evaluations.
5. Partnerships are formed and assignments are constructed so skills from across the curriculum will build toward higher-quality performance. As supplies, we're expected to continuously improve.

Category 6.0: Quality and Operational Results (18%)

This category examines quality improvement based upon objective measures derived from an analysis of customer requirements and expectations, and from an analysis of operations. Also examined are current quality levels in relation to those of competing organizations.

6.1 How do you use graphs to display key improvement data on your students?

1. I don't generate graphs.
2. I graph traditional quality indicator information — the grade.
3. I regularly evaluate traditional information in class, using graphs that students understand.
4. I gather data and examine it in graphical form — the number or percent of students passing professional certification tests or being hired by a Fortune 500 company.
5. I regularly use information related to strategic quality objectives and post it in graphical form throughout the classroom for all to see. I provide reports to the governing board, administration, and employers.

6.2 Consider one or two of your continuous improvement projects that have had positive quality and operational results.

1. I have no project groups or measurable results available.
2. I form project groups quickly, putting effort into the nature of the project and how it might lead to quality improvement.
3. I use mastery learning and chart the results, but only occasionally use cooperative learning.
4. I establish project groups with assignments that are cross-curricular, global, and meaningful.
5. All my students work in project groups that study issues and result in: cross-curricular, global, and meaningful work. I serve as a supportive leader; my students do the main work, using quality methods and tools.

6.3 Describe how you compare your courses with other courses in or outside your discipline (benchmarking).

1. I have no comparable data available.
2. I use standard accounting information, such as standardized test scores and students' grades.
3. I collect and analyze data from outside sources, such as employers and former students.
4. I benchmark competitors, comparing percentages of students going on to graduate school.
5. I obtain comparative benchmarking data on all functions and services from the best in those areas, whether they are competitors or
Category 7.0: Customer Focus and Satisfaction (30%)

This category examines your knowledge of your customers, your overall customer service system, your responsiveness, and your ability to meet customer demands and expectations.

7.1 How do you determine who your customers are outside the classroom and how do you measure their satisfaction levels?
1. I have no formal system to measure customer satisfaction.
2. A complaint follow-up process is in place, but I use the information only infrequently.
3. A formal complaint handling system is in place that provides me with feedback. Complaints are treated as "special cases."
4. I use a Plan-Do-Check-Act process with the information from customer satisfaction surveys of alumni, parents, employers, graduate schools.
5. Processes monitor key indicators of customer satisfaction.
6. I maintain a comprehensive data collection system that leads to quality function deployment for course processes and assignments.

7.2 How do you measure the satisfaction levels of your students and your colleagues?
1. I have no formal system.
2. They communicate their satisfaction to me mainly through hearsay.
3. I routinely use surveys to determine satisfaction.
4. I routinely use surveys to determine satisfaction. We also use a Plan-Do-Check-Act process to improve the relationship between students and other instructors within the college.
5. All functions are engaged in quality satisfaction of students and other instructors. Communications are horizontal.

7.3 In what functional areas, processes, or systems have you defined measurable criteria for product and/or service quality?
1. None.
2. I measure certain products or services.
3. I measure at least 50% of the products or services.
4. My students and I measure at least 50% of the products or services.
5. I use a total quality system oriented toward data-gathering.

7.4 What methods do you use to determine customer satisfaction?
1. I don't do any analysis.
2. I track some passively gathered data by keeping a mental count of reports of satisfaction.
3. I regularly track passively gathered data by maintaining records with information and sources on a yearly basis.
4. I actively accumulate and analyze data on customer satisfaction.
5. I'm actively involved with all measures of internal and external customer satisfaction and I gather information from employers, parents, graduates, and graduate schools.

7.5 Summarize trends in customer satisfaction and list measurements you have in specific areas.
1. I have no information.
2. The information I have is just hearsay, such as "enrollment in this class is up, therefore I must be doing something right."
3. I have specific measurable data available from external sources, such as employers or graduate schools, showing increasing customer satisfaction with the results of the students' work in class.
4. I regularly send questionnaires to other instructors, parents, graduate schools, and employers to identify trends.
5. I collect and monitor data, which highlights key quality criteria showing constant year-to-year improvements.

7.6 What happens in your classroom that significantly promotes continuous improvement?
1. Nothing.
2. I recognize quality successes through awards, certificates, and other tangible items.
3. In addition to recognition awards, I personally send kudos to students and parents.
4. I've applied for a classroom quality award and have demonstrated measurable improvement.
5. I've become actively involved in the quality movement not only locally, but also nationally. I've published papers and/or made speeches about the quality processes and systems.

Quality Index Rating Sheet
Enter your ratings.

1.0 Leadership (9%)
1.1
1.2
1.3
1.4
1.5
1.6

Total +6 = x .09 = (rating)

2.0 Information and Analysis (8%)
2.1

2.2

3.0 Strategic Quality Planning (6%)
3.1

3.2

4.0 Human Resource Development and Management (15%)
4.1

4.2

4.3

4.4

4.5

Total +5 = x .15 = (rating)

5.0 Management of Process Quality (14%)
5.1

5.2

5.3

5.4

Total +4 = x .14 = (rating)

6.0 Quality and Operational Results (18%)
6.1

6.2

6.3

Total +3 = x .18 = (rating)

7.0 Customer Focus and Satisfaction (30%)
7.1

7.2

7.3

7.4

7.5

7.6

Total +6 = x .30 = (rating)

Total Quality Index Score = sum of 7 ratings

We suggest the following interpretation of the scores:
1.0-2.9: Traditional Instructor
3.0-3.9: Progressive Instructor
4.0-5.0: Total Quality Instructor

Next month: control chart
The Individual-Moving Range (X-MR) Chart
Lawrence Sharp

The X-MR Chart (also known as an individual-moving range chart) is a special type of control chart used to test the stability of a process generating continuous data, where the data come from an individual measurement rather than from a small sample of measurements.

The X-MR Chart is an ideal tool for classroom use because it permits the instructor to monitor a wide variety of student characteristics. It also allows students to monitor their own progress as they keep a portfolio.

Rather than wait until mid-term or final exams to signal trouble, both the student and the professor can use daily performance, aided by the interpretive power of the X-MR chart to signal problems. With the availability of statistical process control software, the instructor can easily set up a control chart for each student or have them form their own.

In our example, a statistics professor administers daily quizzes in her “Introduction to Statistics” class. The inherent nature of the material requires that students have a firm grasp of each day’s material, so sequential material won’t produce debilitating anxiety which often characterizes students’ reactions to statistics.

With just an hour or so of instruction at the beginning of the term, each student can learn to format the X-MR chart and the simple calculations, and plot daily performance against the control limits.

Within the first five class periods, both the students and the professor now have a tool to clearly signal deficits in mastering the material. As with all continuous improvement strategies, the object is to detect unsatisfactory performance early in the process cycle, then remove the causes.

While the X-MR chart is offered as a tool for individual measurements (n=1), the chart’s power comes from comparing each value against each subsequent value (in fact, creating a sub-group of 2, n=2).

What’s important is the change in performance over time. The magnitude of the change indicates what’s happening to the learning process. Figure 1 shows a typical student’s performance over the first 10 lessons on the daily 20-point quizzes.

**Procedure**

As with all control charts, average values are determined, control limits are established based on +/-3 standard deviations from the process average, points are plotted and examined for signals of an out-of-control process.

The X-MR chart has two sections: a moving range control chart and an individual values control chart.

To create the moving range chart:

1. Calculate the average moving range.

\[
MR = \bar{R} + (n-1)
\]

\[
= 18 + 9
\]

\[
= 2
\]

2. At a value of 2 on the Y axis of the moving range chart, draw a horizontal line. This represents the average moving range or the center line (CL).

3. Calculate the upper control limit (UCL) for the moving range chart.

\[
UCL = 3.26 \times MR
\]

(Note: 3.26 is always used as the multiplier for R for the individual-moving range chart)

\[
UCL = 3.26 \times 2 = 6.52
\]

4. At a value of 6.52 on the Y axis of the moving range chart, draw a horizontal line. This represents the upper control limit.

5. The lower control limit for the moving range chart will always be “0” (differences can’t be smaller than “0”).

6. Interpret the moving range chart before you calculate the values for and plot the individual values chart.

You’re looking for differences — changes from quiz score to quiz score — which exceed the three standard deviation control limit and thus signal a “special cause” of variation. (See Figure 2.)

If the differences arise from an increase in scores, the student’s performance is improving significantly. To replicate those factors, ask the student to reflect on what was different about study habits, instructor presentation, and/or classroom environment.

If the differences arise from a decrease in scores, this is a clear signal of a “special cause” factor which resulted in a decline in performance. The student and professor should examine study habits, notes, and/or instructor presentation to determine the cause(s) of the decrease.

To create the individual values chart:

1. Calculate the average quiz score from the individual quiz scores:

\[
Average = \text{sum of data points} + \text{number of subgroups}
\]
\[ \bar{X} = \Sigma X + N \]
\[ = 128 + 10 \]
\[ = 128.8 \]

2. Draw a horizontal line at a value of \( \bar{X} \) on the Y axis of the individual values chart. This represents the individual values average and is the center line (CL).

3. Calculate the upper control limit for the individual values chart.
\[ \text{UCL} = \text{average quiz score} + (2.66 \times \text{the average range}) \]
\[ = 128.8 + (2.66 \times 2) \]
\[ = 128.8 + 5.32 \]
\[ = 18.12 \]

(Note: 2.66 will always be the multiplier of the individual values chart for calculating the upper and lower control limits)

4. At a value of 18.12 on the Y axis of the individual values chart, draw a horizontal line and label it UCL.

5. Calculate the lower control limit for the individual values chart.
\[ \text{LCL} = \text{average quiz score} - (2.66 \times \text{average range}) \]
\[ = 128.8 - (2.66 \times 2) \]
\[ = 128.8 - 5.32 \]
\[ = 7.48 \]

6. At a value of 7.48 on the Y axis of the individual values chart, draw a horizontal line and label it LCL.

7. Plot the quiz scores on the chart. (See Figure 3.)

8. Interpret the set of charts.

As noted, the differences in ranges are examined first, before investing the time to calculate the values for the individual values chart. This is done because the average range (R) is used to determine the control limits for the chart.

If one or more ranges is out of control, the reasons for the lack of control must be detected, understood, and replicated (if positive) or eliminated (if negative), before the individual values chart has meaning.

Once the change in student performance from quiz to quiz is understood — or "in control" — then both the professor and the student can use the values displayed on the individual values chart to reliably track the student's performance.

Data from this exercise show that, while the moving ranges are in control, the student's performance on the fourth topic, "graphs of frequency distributions" was particularly exemplary and culminated a rising trend beginning with the first quiz. However, the next six quizzes display a significant downward trend beginning with the material on "statistical notation."

While neither the range data nor the individual values data exceed their control limits, this downward trend highlights an additional rule for interpreting control charts: "six successive points, either increasing or decreasing, signals an out-of-control process" even though the three standard deviation limits haven't been exceeded.

Whether the downward trend results from the failure to present or grasp the "statistical notation" material or an external environmental factor, the student and the professor must investigate it.

---

Once the first 5-10 data points are plotted, the student and the professor need only examine succeeding differences between quiz scores by referring to where that value of the difference falls on the moving range chart. Once the moving range chart signals an in-control process, new control limits don't need to be calculated.

When both ranges and individual values signal an in-control process, the professor and student can monitor learning on a quiz to quiz basis, confident that the charts will reliably signal the status of the learning process for succeeding quiz performance.

For more information, contact: Lawrence Sharp, President and Principal Consultant, Six Sigma Enterprises, 2110 Vickers Drive, Suite 100, Colorado Springs, CO 80918; P:\ 719/598-8393. Ed. note: Sharp specializes in quality improvement consulting for health care and education.

Next month: Control chart
Roberts: I’m the director of business services and the coordinator of TQM at the U. of Missouri System Office. We do a lot of dialoging. We do a lot of talking on how we can push the TQM movement forward while not imposing it upon each campus.

We’ve finally decided that the system must ‘walk-the-talk’ and perhaps then everyone would emulate us. As a result, we’ve done pockets of CQI within the system itself. We’ve had a lot of starts and stops. We have teams going, but I don’t know how that will eventually affect various campuses.

Hammond: William Woods U. is at the very beginning level of implementing TQM. When Jahnae Barnett became president in 1990, she established a participatory management style.

Two years later, she asked me to examine the concept of TQM. We also had some changes in the management, for example, in the vice president of academic affairs. So we’re really just now beginning to pick up on TQM. Bob came and talked to our executive council and our department chairs which really started an active discussion on their part.

Similar Frustrations
Terrell: I think I have the same frustrations as everyone else in starting TQM — either finding the time or convincing people that it’s worth investing the time to do the job right, the first time so they don’t have to go back and redo things.

I also get frustrated in getting people at the top of the organization to understand that they must give their people time to work on teams.

Finally, I get frustrated with our management group who, although very supportive in our TQM efforts, want results too soon.

Although we’ve been into this for a little over a year and the teams are about to make their recommendations, I’m frustrated when I hear middle management say that they want proof that this TQM thing works.

Cornesky: We do live in an instant gratification society which forces us to stumble-the-mumble rather than walk-the-talk. Steve, how is the American Association for Higher Education going to help educational institutions maintain a CQI thrust?

Brigham: Within the past year, we’ve put together a consortium of 22 institutions from around the country from two-year to four-year colleges. These institutions are at least a few years down the road in implementing TQM or CQI.

Their job is to look at the next stage and learn from each other the “best practices,” mistakes, and obstacles they’ve encountered along the way.

We also have a resource clearinghouse which is putting together publications and other resources on Internet.

Cornesky: Anyone have a word for their colleagues about implementing TQM?

Roberts: Although there have been frustrations in implementing the change to a quality culture, all of the employees benefit from it. As the manager of a unit said to me, “Previously, no one has given me the tools nor the understanding of how to manage people. However, TQM has afforded that to me.”

I really do believe TQM works and I’m having a hard time trying to understand what the hesitations are. It puzzles me since it gives all of the employees the opportunity to have a say on what’s going on.

Cornesky: Do any of you see your institution applying for, and possibly winning, the Baldridge award?

Hubbard: Northwest Missouri State U. will be applying for Missouri’s quality award this year. Linda’s institution won the Arizona Quality Award. Both of these awards are based on the Baldridge Award criteria. Missouri’s [award] doesn’t even have any modifications. We’ve said that it’s our intention to have the systems in place, but we don’t expect to see the amount of trend data that’s necessary to apply for the national award.

We don’t believe that we have a chance of winning it [Baldridge] by 1996 since we wouldn’t have the trend data nor the deployment information. But by 1998, who knows? My long-term goal is to have Northwest Missouri State U. apply for and win the Baldridge award.

TQM in the Classroom

Converting a Course to Quality
Jean Lamkin

I made the switch. I wanted to implement TQM ideas and techniques in a graduate course I was teaching. But the thought of starting from zero and re-writing an entire semester of lectures seemed so much like “reinventing the wheel.” A little creativity and planning, and it didn’t take me long to change a traditional course into a quality event.

First, I added a pre-course assessment component. At the start of each course, I find out where the students are with respect to their knowledge of the material and what they expect to learn.

I have the students self-assess their knowledge of the material on a scale of 0-5. I ask them to rate their knowledge as “0” if all they can do is spell the class name, and up to “5” if they have considerable experience but little formal or theoretical education on the subject. I ask them to write that number on a Post-It™ note. (No names, please.)

The students place their Post-It™ notes on the board where I’ve drawn a baseline and marked it with the numbers 0-5. By placing their notes one above the other like a stack of blocks, the students create a histogram.

Then I compute the mathematical average, which gives me an estimate of where to start the class. By re-doing this exercise at the beginning of the last class, I can show the students how much they’ve learned.

Check With Your Customers

Besides just a grade, I need to know what the students want to get out of the course. Using another Post-It™ note, I have the students write their expectations and put them on the board.

I then ask several students to silently group the notes with similar themes, thus creating an affinity diagram. When they’ve finished, I invite the rest of the group to examine the diagram and make changes.

The completed diagram of the students’ expectations is now ready to
The Cause and Effect Diagram

Developed by Kaoru Ishikawa, the cause and effect diagram illustrates the relationship between some “effect” and all the possible “causes.” Since it resembles a fish skeleton, it’s also referred to as either a “fishbone” diagram — with each “bone” being the answer to the question “Why?” — or an Ishikawa diagram (after its inventor).

A cause and effect diagram is used primarily for tracking down the root cause of a specific problem. It provides the answer to the question, “What is causing this problem?”

The diagram can be used in brain-storming sessions in a task force, committee, or action team, or as a method to get input from an entire department, school, college, or university community, since cause and effect diagrams can be posted at various sites around the campus. It’s also a highly effective planning tool.

The cause and effect diagram is rarely used alone. When used with a relations diagram, an affinity diagram, or a nominal group process, it can help an action team or a task force look at the root causes of a problem in many different ways.

Procedure

1. State the Problem

Identify a specific problem or condition contributing to a non-quality result. Make sure all group members agree on the problem statement. Place the problem or condition in a box on the far right-hand side of an overhead, flip chart, or sheet of butcher paper.

2. Record the Perceptions

Draw the backbone with the arrow pointing at the box containing the identified problem or condition. Add the primary causal category boxes — people, equipment, materials, and procedures (some also add environment). You may use any major category that surfaces or helps people think creatively. Then draw arrows from the causal category boxes to the backbone.

Figure 1 is the beginning of the diagram. Some institutions have reusable 3’x2’ boards with the skeleton and primary causal categories painted on permanently. They also have Highland™ sticky note pads attached so that those participating in the analysis can add their written remarks.

The causes and sub-causes (see Figure 2) are written on the sticky note pads and placed in one of the primary causal categories. In some instances, additional levels can and should be added to the sub-causes.

3. Complete the Cause and Effect Diagram

The cause and effect diagram illustrating faculty perceptions as to the causes of poor student evaluations of teaching is shown in Figure 3.

4. Record and Discuss the Results

The results are recorded and discussed to determine the root causes of the unwanted effect or problem. Remember that the cause and effect diagram’s purpose is to generate ideas as to the probable causes of the problem or condition and to get everyone involved in submitting suggestions.

Don’t allow anyone’s intuition about the cause of a problem prevent an objective evaluation of other factors. The group shouldn’t tolerate criticism of any idea or comment. Instead, people should be encouraged to build upon the causes and sub-causes posted by others.

5. Other Suggestions

A major root cause for a problem could become a likely candidate for its own fishbone analysis.
TQM Tools and Techniques

Cross-Functional Process Flow Diagram

In previous issues of TQM/HE, we’ve shown how to use two types of flowcharts — the deployment flowchart (June 1993), and the process flowchart (July 1993).

In this issue we’ll describe how to use a cross-functional process flow diagram. This flow diagram involves more than one department, unit, or function. The beginning and ending points of the diagram flow across the boundaries of each department/unit/function and clearly demonstrate the overlay of different functions. It’s customary to develop a process flow from top to bottom and from left to right.

As in other process flow charts:

1. All work/information flows into process inputs and outputs.
2. The flow depicts the sequential and concurrent nature of the activities.
3. The flow shows all the potential paths an activity can take.
4. All of the decision points are shown accurately.
5. The diagram accurately depicts what really occurs — as opposed to what you think or want to occur.

Some of the standard symbols commonly used to express the steps in a process flow diagram are found in Figure 1.

Using the rules and symbols in Figure 1, the process for ordering classroom supplies might take the route shown in Figure 2 on page 5.

Calculating the Cost of Nonconformance

Ed. note: Not doing the right things right the first time has a direct financial cost which often can be calculated depending upon the complexity of the processes.

Philip Crosby, in his book Quality Without Tears: The Art of Hassle-Free Management, states that the cost of nonconformance (CON) is the cost of not doing the right things right the first time. The CON in service industries has been estimated to range from 20% to 35% of budget. If you’re not measuring what you’re doing, you not only don’t know your CON, but you’re also not managing it properly.

Most colleges and universities don’t know the cost of nonconformance of many routine services. For example, what’s the cost to your institution when:

• the grounds crew improperly lines the football field before a game?
• a faculty member incorrectly places one order for a required textbook?
• the purchasing department orders the wrong supplies for a faculty member?
• the physical plant improperly maintains one car in your fleet?
• the secretary blocked off the incorrect time for a speech by the president?
• the admissions staff complete the wrong form?

Let’s look at the cost of nonconformance when a single student application is improperly handled and the job must be redone. During the final phase of the admissions process, an admissions officer is expected to correctly process 18 completed applications, which each routinely take 11 minutes to examine.

Let’s assume that one of the 18 isn’t processed correctly. Looking at this from a positive viewpoint, 17 of the 18 applications were properly processed, resulting in a 94.5% “good quality” rating. While that sounds good, let’s look at the single error having an error rate of 5.5%.

This error rate doesn’t show the dissatisfaction of the customers — which may include the student, the student’s parents, and others. Actually, the cost of “fixing” may be five to ten times as large as the error rate. It may require up to 10 times the amount of resources to deal with the error as it does to do the right job right the first time.

Since the error rate is 5.5%, the total cost of nonconformance is calculated as follows:

• 17 “good products” x 11 minutes per product = 187 minutes
• 1 “defective product” x 11 minutes to redo the product plus 35 minutes to catch and repair the error and to deal with its impact on other operations
For example, we assumed it took a computer entry technician 10 minutes to identify the error and three minutes to report it to the appropriate manager. We also assumed it took the manager 10 minutes to track down the admissions officer to have the application redone. Other times included the additional handling by other personnel. Therefore: $1 \times (11 + 35) = 46$ minutes.

- Total cost to process 18 good applications: 187 minutes + 46 minutes = 233 minutes
- Percent of resources spent producing the "good product": $198$ (total minutes required if the job was done right the first time) + 233 minutes (total minutes required with one defective application) = 85%
- The cost of nonconformance for fixing (rework) the one error (5.5% error rate) is 15%.

**When Leadership Is Lacking**

The following example actually occurred at a university.

At the beginning of monthly meetings between management (eight individuals) and union representatives (eight individuals), it was customary to determine the time and day for the next meeting. The following is an actual scenario from one meeting:

**Union:** Let's set a time for the next meeting.

**Management:** Good idea.

**Union:** At that meeting we'd like to discuss why management cancelled the previous meeting without notifying us.

**Management:** Why? I thought you were submitting a grievance regarding that event.

**Union:** We are.

**Management:** But we aren't permitted to discuss grievances at the local level, therefore, we can't discuss this matter with you.

**Union:** Before this becomes a grievance, isn't it advisable to discuss this issue?

**Management:** Yes. But we can't negotiate.

**Union:** Aren't we supposed to implement the contract at these meetings?

**Management:** Yes.

**Union:** But grievances are the direct result of the contract not being implemented.

This posturing continued for 35 minutes. Eventually the parties established a meeting time and date. The rest of that and future meetings were just as productive.

The cost to the taxpayers for such meetings is tremendous. There's no way to determine the actual cost of nonconformance and the affect such relationships are having on the effective delivery of instruction.
TQM Tools and Techniques

Process Decision Program Chart

The process decision program chart (PDPC), first described by Shigeru Mizuno in Management for Quality Improvement — The Seven New QC Tools, is frequently used in planning when major changes are recommended.

PDPC reveals unplanned events that might happen if a change is introduced and identifies ways of preventing these events or developing contingencies that will be in place if these events occur.

Properly used, the process decision program chart can outline a chain of events that might happen when a team enters into unfamiliar territory or when a new factor is added to an already implemented plan. However, caution is recommended when using the process decision program chart because of its negative analysis, which has the potential of having teams “point the finger of blame” rather than cooperate.

A team should use a process decision program chart when:

- the plan is either new, unique, or a major new factor is introduced into a routine situation.
- the plan is complex.
- the risk of potential failure is high.
- the time frame is such that efficiency is crucial.
- the contingencies are feasible.

Developing appropriate contingencies requires not only an overview of the entire system, but also intimate knowledge of each part of the system. Thus, for the process decision program chart to work effectively, team membership should reflect that.

Procedure

1. State the Project
   Under the facilitator’s direction, team members should clearly state the project in a precise manner.

2. Record the Potential Problems
   To identify those factors which might go wrong, the team may have to use other brainstorming tools such as the affinity diagram, the relations diagram, the nominal group process, or the force field analysis. Ed. note: These and other tools have been described in previous issues of TQM/HE.

   It’s not uncommon for the team to either prioritize the potential problems or assign a high, medium, or low probability of occurrence to them.

3. Discuss Actions
   After the team records, discusses, and prioritizes the potential problems, it should recommend solutions and/or actions to take to counteract the problems should they occur.

The process decision program chart is unique in that it can be illustrated in two different formats — graphically and outline. A graphic illustration of a flow chart of the PDPC process is shown below.


The Memory Jogger Plus™, Goal/QPC, 13 Branch St., Methuen, MA 01844; Ph: 508/685-3900; Fax: 508/685-6151. Cost: $29.95.
Using the PDCA Model Effectively

Bob Carnesky

To fully implement TQM, higher education must have the commitment of an enlightened upper management, faculty, and staff. These individuals will eventually form action-oriented functional and cross-functional teams, and use one of the many available Plan-Do-Check-Act (PDCA) protocols.

The PDCA models are highly effective when used properly, but when used haphazardly, are ineffective. Despite the tool’s implication of a set number of steps, many PDCA models consist of more than four — for example, both Xerox’s and Florida Power and Light’s improvement processes consist of seven steps.

Let’s examine Florida Power and Light’s PDCA model:

Step 1: Identify a problem area or the opportunity for improvement, the reason for working on it, and an indicator — with an emphasis on the customer — for measuring improvement.

Step 2: Break down the problem area to determine its subparts, identify the components with the most impact on the customer, clarify the problem statement, and set a target for improvement.

Step 3: Evaluate the information gathered, and identify and verify the root causes of the problem. Utilize cause and effect analysis and the questions, “What causes this?” and “Why does this condition exist?” to eliminate the problem’s symptoms and identify the underlying root cause.

Step 4: Identify and select the proposed solutions or countermeasures to correct the root cause of the problem identified and verified in step 3. Evaluate potential countermeasures for effectiveness and feasibility, and support the one chosen for implementation with appropriate data such as cost-benefit analysis, barrier/aid identification, and an action plan to assure any barriers are overcome.

Step 5: Confirm that the problem and its root causes have been identified, countermeasures implemented, and the problem decreased and the target for improvement met.

Step 6: Assure that once a problem and its root causes have been identified and countermeasures implemented, the problem doesn’t recur. Once the data obtained in step 5 confirm that the countermeasures have been successful, the improvement can be standardized, using control charts and/or standards or procedures. Replication should be utilized where the results are successful and can be shared with other areas doing similar work.

Step 7: Decide what will be done with any future problems, evaluate the team’s effectiveness and lessons learned, and develop an action plan for remaining problems. This step identifies the Deming Wheel (see below) as a tool, which should continue to be used to evaluate the problem and any changes in circumstances. By continually turning the wheel, adjustments can be made as circumstances change.

As you can see, the PDCA steps require a substantial amount of data gathering and analysis. Since many teams in higher education haven’t been adequately trained in the PDCA procedure, they either experience limited success or become totally frustrated. Although they believe that they’re following the PDCA model, they’re not.

Instead they do something like the following:

Step 1: Identify a problem area or opportunity for improvement and the reason for working on it — but rarely the indicator for measuring improvement.

Step 2: Evaluate the information gathered, and identify cause(s) of the problem — which may not be the root cause.

Step 3: Select the proposed solutions or countermeasures to correct the perceived cause(s) of the problem identified in step 2. Team members may evaluate potential countermeasures for effectiveness and feasibility, and support the one chosen for implementation, but usually without appropriate data such as cost-benefit analysis, barrier/aid identification, and an action plan to assure any barriers are overcome.

Step 4: They redo steps 1 through 3 when the countermeasures they implemented didn’t reduce or eliminate the problem. I call the above “model” the Plan-Do-Plan-Do activity, or the PP-DODO activity as it’s rarely effective.

---

TQM Tools and Techniques

The Bubble Chart

The bubble chart is used to show interrelationships between forces and the system or project under study. It helps illustrate the "big picture" and is useful when various units and/or organizations outside of your institution are working together. The bubble chart, often considered an organizational tool, can help you determine how others fit into a process.

One nice thing about bubble charts is that it depicts how we all really need the help and support of others in order to succeed.

Remember, since it's a chart of interrelationships, that the bubble chart categories need to be simple in order to be effective. If the chart becomes clustered with bubbles, other tools such as flow charts, tree diagrams, and/or a process decision program chart should be used instead.

Procedure

1. State the main objective, project, process, or system to be examined. (See Figure 3.)

2. Begin adding circles portraying other individuals, organizations, or groups that affect the main objective, project, process, or system being examined. Then interconnect the circles to show how they relate to one another and the "big" picture. (See Figure 4.)

3. Discuss the interrelationships. Your diagram has now become not only an organizational tool, but a communication tool as well.

Figure 3

Start a Capital Campaign

Figure 4

President
Individual Donors
Alumni
Development Office
Start a Capital Campaign
Businesses
Grants Office
Faculty
Secondly, the fundamental concepts of the quality movement are identical to the fundamental concepts in the new paradigm of systemic thinking. There’s a fascinating shift occurring in fundamental areas of our culture that parallels the fundamental tenets of TQL.

It began in physics with the realization that the reductionist model of how we come to know something no longer fits subatomic investigation. The focus of inquiry needs to be on the relationship between the parts rather than on understanding the separate parts.

As this new idea was penetrating scientific models, the ecological question also begged for a different analysis. It became apparent that it was no longer possible to know the whole by knowing the past. Once again, relationship and systemic thinking provided better answers.

Fritjof Capra, in his book Turning Point, has examined the fields of physics, economics, health care, psychology, and ecology, and concluded that “most academics subscribe to narrow perceptions of reality which are inadequate for dealing with the major problems of our time.

“These problems, are systemic problems, which means that they are closely interconnected and independent. They cannot be understood within fragmented methodology characteristic of our academic disciplines and government agencies. Such an approach will never resolve any of our difficulties but will merely shift them around in the complex web of social and ecological relations. A resolution can be found only if the structure of the web itself is changed, and this will involve profound transformations of our social institutions, values, and ideas.”

As one works with total quality learning, the parallels become obvious. Here, too, we’re working with contextuality and interrelationships. The part is defined as it exists in the whole, not as a separate subject.

The final reason I believe that TQL has the potential of changing education in America is that it doesn’t tamper with existing models and philosophies. It challenges and changes them. The 85%/15% concept of Deming’s approach claims that 15% of the problems that occur in the workplace (classroom) are a result of the students, while 85% are the result of the teaching/learning system. It’s the system that won’t allow the student to do his/her best.

For more information, contact: Mark Aamot, Carroll College, 100 N. East Ave., Waukesha, WI 53186; Ph: 414/524-7187; Fax: 414/524-7139; Email: maamot@carroll1.cc.edu

Students Act
As Free Consultants

This year, more than 20 Quebec businesses will get free TQM advice from students from the École des Hautes Études Commerciales.

Students enrolled for a certificate or in their last year of the baccalauréate program in business administration, who’ve acquired the analytical tools necessary to study the different problems of total quality, provide the free consultations. Among the businesses using the free consultation services this year are the Banque Royale, Radio Canada, and Bell Canada.

Teams of four or five students work under the direction of a professor, in collaboration with the school’s center for total quality studies.

“The students are aware that this is an opportunity for them to put into practice the knowledge that they’ve acquired in total quality,” says Louis Bellemare, coordinator of this project and center advisor. “Certain businesses that have participated in this program in the past have asked to participate in the following years.”

The projects vary. They focus, for example, on studying the costs of non-quality, the choice indicators of quality, working with customers, and the evaluation of a training program.

The team conducts a joint analysis of the data gathered and makes recommendations to the business. The success of the partnership depends greatly on the framework provided for the participating businesses and the students, according to Bellemare. “The results of the partnership represent a significant resource for the business that has engaged the students and profited from their intervention to resolve certain problems or clarify a total quality procedure.”

At the end of the school term, during a quality day, “the students present their conclusions and recommendations to the representatives of all the participating businesses.” Prizes are awarded to the three best teams at the École.


Taking the Mystery Out of Quality

Understanding the importance of applying quality in business was the goal of the U. of Sherbrooke’s Quality Week.

Using the theme “Quality ... First,” students in the master’s program in the school of administration and applied sciences organized the event to raise funds for research scholarships for upper division students and to acquire college texts on quality.

The event brought together over 1500 individuals and speakers including Gerald Tremblay, the minister of Industry, Business, Science, and Technology, and Jean Poirier, vice president of Bell Quebec.

“We talk a lot about quality, but many don’t really know what it means,” explains student Jean-François Guertin, who’s preparing to finish his studies in administration. “This week is meant to take the mystery out of the discussions about the notions of quality,” he says. “It’s become a necessity in the heart of a business, which ought to put the idea of quality first among its priorities.”


Quality Assurance and Institutional Evaluation: The Finnish Experience

Ed. note: This article was adapted from papers prepared for the Institutional Management in Higher Education seminar by Markku Linna of the Finnish Ministry of Education and L. of jyoskyl faculty Aino Salminen, Raimo Kontinen, and Mauri Punahainen. Other countries’ perspectives were provided from Australia, Canada, the United Kingdom, and the United States. In addition, a panel discussion highlighted developments in several Central and Eastern European countries.
TQM Tools and Techniques

Activity Network Diagram

Diane Ritter

The Problem

The project is one that you and your team members have faced before: developing and delivering a new course on campus. The project is complex, the subtasks are familiar with known duration, the overall project is a critical institutional goal, the activity paths must be coordinated for simultaneous implementation, and the margin for error is small (actual versus estimated time allowed) for completion. And now those dreaded words: Do more with less!

The Solution

The Activity Network Diagram (AND) is a useful planning tool in the Plan-Do-Check-Act cycle. The AND helps you to plan the most efficient and appropriate schedule for the completion of a task and all its related subtasks. It graphically shows total implementation time, the necessary sequence of tasks, those that can be done simultaneously, and the key tasks that need to be monitored.

What Does It Do?

• All team members have a chance to give a realistic picture of what their piece of the plan requires based on real experience.

• Everyone sees why s/he is critical to the overall success of the project.

• Unrealistic implementation timetables are discovered and adjusted in the planning stage.

• The entire team can focus its attention and scarce resources on the truly critical tasks.

How Do You Do It?

1. Assemble the right team.

   Select people with firsthand knowledge of the tasks. Provide specific information on both the subtasks and the time required to complete them.

2. Brainstorm and record all necessary tasks to complete the project.

   Brainstorm and record each task on a job card: an index card or 3" x 3" Post-It™.

   Note: Leave the lower half of the job card blank for later use. Review how tasks were implemented in the past. Was the task OK or should it be modified or improved?

3. Find the first task that must be done, and place the card on the extreme left of a large work surface. (See Figure 2.)

4. Ask: “Are there any tasks that can be done simultaneously with task #1?”

   If there are simultaneous tasks, place the task card above or below task #1. If not, go to the next step.

5. Ask: “What is the next task that must be done? Can others be done simultaneously?”

   Repeat this questioning process until all the recorded tasks are placed in sequence and in parallel.

   Tip: At each step always ask, “Have we forgotten any other needed tasks that could be done simultaneously?” (See Figure 3.)

6. Number each task, then draw the connecting arrows. Agree on a realistic time for the completion of each task.

   Record the completion time on the bottom half of each card.

   Tip: Be sure to agree on the standard time unit for each task — days, weeks. Elapsed time is easier than “dedicated” time — eight hours over a two-week period (elapsed time).

7. Determine the project’s critical path.

   Any delay to a task on the critical path will be added to the project’s completion time, unless another task is accelerated or eliminated. Likewise, the project’s completion time can be reduced by accelerating any task on the critical path.

Calculation Options

There are two options for calculating the total critical path and the tasks included within it.

1. Longest cumulative path.

   Identify total project completion time. Add each path of connected activities. The longest cumulative path is the quickest possible implementation time. This is the project’s critical path.

2. Calculated slack.

   Calculate the “slack” in the starting and completion times of each task. This identifies which tasks must be completed exactly as scheduled on the critical path and those that have some latitude.

   Tip: Determining the longest cumulative path is simpler than calculating the slack, but it can quickly become confusing in larger ANDs. The calculated slack options determine the total project and slack time and therefore the total project time and critical path are identified “automatically.” (See Figures 4 and 5.)

Source: This article was adapted from The Memory Jogger™ II: A Pocket Guide of Tools for Continuous Improvement and Effective Planning, by Michael Brassard and Diane Ritter, GOAL/QPC, Methuen, MA, 1994, pp. 3-8.

The 164-page guide is available directly from GOAL/QPC for the single issue price of $6.95. Quantity discounts and customization also available. Call 800/643-4316. GOAL/QPC is a nonprofit organization committed to helping organizations achieve excellence through TQM by sharing its research, training, and publications.
Finding the critical path by calculating the slack

1. Determine target audience for new topic
   \[ T = 14 \text{ days} \]

2. Review feedback from similar courses
   \[ T = 14 \text{ days} \]
   \[ 14 \text{ days} \]

3. Assess competitor’s offerings
   \[ T = 21 \text{ days} \]
   \[ 14 \text{ days} \]

ES = The largest EF of any previous connected task
EF = ES + the time to complete that task
LS = LF - the time to complete that task
LF = The smallest LS of any connected following task

When ES = LS AND EF = LF, that task is on the critical path, and therefore there is no schedule flexibility in this task.

"The 'objective' is toudge forward the process of discovering goals along the way to induce the largest number of people possible to quickly change, to try something; to maximize the odds of serendipity."

— Tom Peters
TQM Tools and Techniques

Prioritization Matrices

Diane Ritter

Problem
When it comes to making a decision — either on the project to work on or the solution to implement — many team members argue vociferously for their “pet” project or solution. While a good case could be made for each suggested project or solution, it leaves the team divided and spinning its wheels.

Solution

Prioritization matrices are a useful tool that help a team narrow down options through a systematic approach of comparing choices by selecting, weighing, and applying criteria. The result is a visible, numerical score that represents everyone’s best thinking.

Consequently, consensus is reached and the team can move on to the next step. All team members feel that they have contributed to the decision, and that it’s been reached fairly.

The prioritization matrices:
- Quickly surface basic disagreements so they may be resolved up front.
- Force a team to focus on the best thing(s) to do, and not everything they could do, dramatically increasing the chances for implementation success.
- Limit “hidden agendas” by surfacing the criteria as a necessary part of the process.
- Increase the chance of follow-through because consensus is sought at each step in the process (from criteria to conclusions).
- Reduce the chances of selecting someone’s “pet project.”

Methods

There are three methods for constructing prioritization matrices.

1. Full Analytical Criteria Method
Typically used when:
- smaller teams are involved (3-8 people),
- options are few (5-10 choices),
- there are relatively few criteria (3-6 items),
- complete consensus is needed,
- the stakes are high if the plan fails.

2. Consensus Criteria Method
This method follows the same steps as in the full analytical criteria method except the consensus criteria method uses a combination of weighted voting and ranking instead of paired comparisons.
Typically used when:
- larger teams are involved (8 or more people),
- options are many (10-20 choices),
- there are a significant number of criteria (6-15 items),
- quick consensus is needed to proceed.

3. Combination ID/Matrix Method
This method is different from the other two methods because it’s based on cause and effect, rather than criteria.
Typically used when:
- interrelationships among options are high and finding the option with the greatest impact is critical.

In this example, we’ll only discuss the consensus criteria method. The others are covered fully in The Memory Jogger Plus+®.

Procedure

1. Assemble the right team and agree on the ultimate goal to be achieved.
- Select people with firsthand knowledge of the goal.
- If no other tools are used as input, produce a clear goal statement through consensus. This statement strongly affects which criteria are used.

2. Create the list of criteria and options.

3. Using an L-shaped matrix, prioritize the criteria.
- Each person weighs the criteria by distributing the value of 1.0 among all criteria. The higher the decimal, the more important the criterion.
- Add all the values assigned to each criterion to get the team totals. (See Figure 2.)
- Record the team totals for each criterion in the appropriate box on the matrix constructed in step 2. (See Figure 3.)

4. Rank order options based on each criterion.

- Create a separate L-shaped matrix for each criterion to illustrate how each person rank orders each project option against the criterion. List team members in a row across the top of the matrix, the project options in a column down the left side of the matrix, and the criterion in the corner box at the top of the column of options.
- Each member rank orders each project option against
each criterion, using whole numbers. The range of numbers that the team should use to rank the options depends on how many project options there are. If there are five options, the team should use the numbers 1 through 5.

- Rank in descending order, with the largest number designating the option that best meets the criterion, and the smallest number designating the option that least meets the criterion.
- Add all individual rankings together to determine the total score for each option across all team members. Record the scores for each project option in the “Total” column.
- Compute the end ranking of the project options relative to each other. The option with the highest total score will be assigned the largest number, the option with the next highest total score will be assigned the next largest number, and so on. (See Figure 4.)
- Use the blank L-shaped matrix created in Step 2 to record the team’s ranking of all the options.
- Continue Step 4 for the other criteria.

In our example: “demonstrated community need, attract wide student participation, provides meaningful learning experience,” and “students can control success factors.”

5. Compute the total “importance” scores across all criteria.
- Using the blank L-shaped matrix created in Step 2, record the individual “importance” scores for each option by multiplying each option rank number by each criterion weighing number.
- Total the “importance” scores across all criteria.
- The project option with the largest total “importance” score across all criteria is the most desirable and effective project to implement, according to the numbers. (See Figure 5.)

Conclusion:
Option B, “tutor/mentor high school students,” received the highest total “importance” score across all criteria.
Although the process is more systematic than traditional decision making, the resulting outcome has weighed everyone’s ideas, preferences, and sense of importance. It represents the team’s best thinking. Consequently, consensus is more easily reached and the team is now focused and ready to move on to planning for the selected option.

Ed. note: This article was adapted from The Memory Jogger™ II: A Pocket Guide of Tools for Continuous Improvement and Effective Planning, by Michael Brassard and Diane Ritter, GOAL/QPC, Methuen, MA, 1994, pp. 105-114.
The 164-page guide is available directly from GOAL/QPC for the single issue price of $6.95. Quantity discounts and customization are also available. Call: 800/643-4316.

GOAL/QPC is a nonprofit organization committed to helping organizations achieve excellence through TQM by sharing its research, training and publications.

![Table]

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Achievable With Limited Funds</th>
<th>Demonstrated Community Need</th>
<th>Attract Wide Student Participation</th>
<th>Provide Meaningful Learning Experience</th>
<th>Students Can Control Success Factors</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Clean up the Park</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Tutor/Mentor High School Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Establish a Recycling Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Do an Oral History Project with Senior Citizen Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Renovate a Homeless Shelter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright 1994, GOAL/QPC
### Figure 2

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Person 1</th>
<th>Person 2</th>
<th>Person 3</th>
<th>Person 4</th>
<th>Person 5</th>
<th>Team Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievable With Limited Funds</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
<td>0.25</td>
<td>0.20</td>
<td>1.35</td>
</tr>
<tr>
<td>Demonstrated Community Needs</td>
<td>0.20</td>
<td>0.25</td>
<td>0.10</td>
<td>0.20</td>
<td>0.10</td>
<td>0.85</td>
</tr>
<tr>
<td>Attract Wide Student Participation</td>
<td>0.25</td>
<td>0.10</td>
<td>0.10</td>
<td>0.20</td>
<td>0.10</td>
<td>0.75</td>
</tr>
<tr>
<td>Provide Meaningful Learning Experience</td>
<td>0.25</td>
<td>0.25</td>
<td>0.30</td>
<td>0.30</td>
<td>0.40</td>
<td>1.50</td>
</tr>
<tr>
<td>Students Can Control Success Factors</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.05</td>
<td>0.20</td>
<td>0.55</td>
</tr>
</tbody>
</table>

### Figure 3

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Achievable With Limited Funds</th>
<th>Demonstrated Community Need</th>
<th>Attract Wide Student Participation</th>
<th>Provide Meaningful Learning Experience</th>
<th>Students Can Control Success Factors</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean up the Park</td>
<td>1.35</td>
<td>0.85</td>
<td>0.75</td>
<td>1.50</td>
<td>0.55</td>
<td></td>
</tr>
</tbody>
</table>

### Figure 4

<table>
<thead>
<tr>
<th>Project Option</th>
<th>Criterion</th>
<th>Person 1</th>
<th>Person 2</th>
<th>Person 3</th>
<th>Person 4</th>
<th>Person 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean up the Park</td>
<td>Achievable With Limited Funds</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>14 (3)</td>
</tr>
<tr>
<td>Criteria</td>
<td>Achievable With Limited Funds</td>
<td>Demonstrated Community Need</td>
<td>Attract Wide Student Participation</td>
<td>Provide Meaningful Learning Experience</td>
<td>Students Can Control Success Factors</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------</td>
<td>-----------------------------</td>
<td>----------------------------------</td>
<td>--------------------------------------</td>
<td>--------------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td><strong>A</strong> Clean up the Park</td>
<td>1.35</td>
<td>0.85</td>
<td>0.75</td>
<td>1.50</td>
<td>0.55</td>
<td>9.85</td>
<td></td>
</tr>
<tr>
<td><strong>B</strong> Tutor/Mentor High School Students</td>
<td>5(1.35)=6.75</td>
<td>5(0.85)=4.25</td>
<td>3(0.75)=2.25</td>
<td>4(1.50)=6.00</td>
<td>4(0.55)=2.20</td>
<td>21.45</td>
<td></td>
</tr>
<tr>
<td><strong>C</strong> Establish a Recycling Center</td>
<td>2(1.35)=2.70</td>
<td>3(0.85)=2.55</td>
<td>5(0.75)=3.75</td>
<td>2(1.50)=3.00</td>
<td>3(0.55)=1.65</td>
<td>13.65</td>
<td></td>
</tr>
<tr>
<td><strong>D</strong> Do an Oral History Project with Senior Citizen Center</td>
<td>4(1.35)=5.40</td>
<td>1(0.85)=0.85</td>
<td>1(0.75)=0.75</td>
<td>5(1.50)=7.50</td>
<td>5(0.55)=2.75</td>
<td>17.25</td>
<td></td>
</tr>
<tr>
<td><strong>E</strong> Renovate a Homeless Shelter</td>
<td>1(1.35)=1.35</td>
<td>4(0.85)=3.40</td>
<td>4(0.75)=3.00</td>
<td>3(1.50)=4.50</td>
<td>1(0.55)=0.55</td>
<td>12.80</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{1} \times \frac{1.35}{\text{Step 3}} = 1.35 \]

Quality is not what happens when what you do matches your intentions. It's what happens when what you do matches your customers' intentions.

— John Guaspari
Competency Matrix

A charting technique known as the competency matrix is used to divide topic areas into individual steps for accomplishing specific outcomes. The competency matrix identifies such things as tasks, knowledge levels, and the mastery of the skill/task/topic.

A competency matrix is used when a very complex project needs to be simplified into a clear process of understanding and learning. For example, in the classroom the students will be able to envision what they’ll be expected to know, in addition to how they’ll be able to measure their progress.

How quickly and to what extent learning takes place depends on the student, not the professor. This is extremely useful for students to develop their own portfolio.

Academic departments can use matrices to split behavioral objectives into terminal competencies, including tasks to be accomplished and proof of mastery. Competency matrices save time and frustration, since they give each student the expected terminal competency.

Competency matrices can also be used as a goal setting tool that can stimulate students to show the relationships among various learning objectives. They can also be the way to eliminate grades.

Procedure

1. State the desired objective.
2. List the competencies and other areas as category, knowledge, application, analysis, synthesis, comprehension. These will vary according to the course and with the group you’re working with. Also include a final matrix designating approval and/or mastery. (See Figure 1.)
3. Discuss the acceptable quality standards with your students.
4. After you’ve established the quality standards, the students should shade the appropriate rectangles, indicating that they’ve completed the levels. (See Figure 2.)

### Figure 1

<table>
<thead>
<tr>
<th>Objective</th>
<th>Competencies</th>
<th>Category</th>
<th>Knowledge</th>
<th>Appreciation</th>
<th>Application</th>
<th>Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbiology</td>
<td>Society</td>
<td>Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Skills</td>
<td>Notetaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teamwork</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Figure 2

<table>
<thead>
<tr>
<th>Objective</th>
<th>Competencies</th>
<th>Category</th>
<th>Knowledge</th>
<th>Appreciation</th>
<th>Application</th>
<th>Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbiology</td>
<td>Society</td>
<td>Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Skills</td>
<td>Notetaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teamwork</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• provided a basic orientation to CQI,
• consulted with team leaders and team sponsors throughout the process, and
• arranged for technical assistance for data gathering and analysis.

As a means for closure and celebration, each team's presentation was immediately followed by a luncheon and group photographs. Each team's activities and recommendations are being documented and shared with the campus community through the weekly faculty and staff newspaper. Accountability for implementation of team recommendations lies with the sponsor and the council.

Student Finance Team

Led by the bursar, the student finance team included members from financial aid, undergraduate admissions, and residence life, as well as a representative from the provost's office and an officer from the Student Government Association. The team began its work by gaining a baseline for student perceptions of the financing process captured from those students waiting in financial service areas at the start of the spring semester. Using CQI tools and techniques, the team recommended that the university:
• give greater access to student account and financing process information via workstations in student computer labs;
• expand outreach to parents and students about financial management via summer orientation programs, freshman orientation courses, and public displays in high traffic areas — for example, dining halls and the student union;
• improve advertising, clarify written materials, and create a student financial planner;
• expand site locations to include the residence halls and the student union for bill payment and financial aid application;
• promote alternative student payment options such as workshops and payment plans;
• create a consolidated student financial service center that would combine front desk operations for the bursar's office and the office of student financial aid;
• simplify the late payment and severance policy; and
• implement a centralized withdrawal process to create a single office visit for students who need to separate from the university.

While the team was confident that its recommendations would benefit students, it took the extra step of conducting focus groups to evaluate and refine the ideas. In fact, students who had complained about the process earlier in the year composed one group. Immediate action on several of the recommendations was possible, given the direct participation of key process owners.

Large Classes Team

The large classes team was led by the director of our center for teaching excellence and included faculty from physics, history, English, government and politics, chemistry, as well as staff from the resource planning office and the counseling center.

The team decided to expand its own membership beyond the eight members, to include both undergraduate and graduate teaching assistants who were assisting faculty in large class environments. Large classes were defined as sections with 100 or more students.

The team developed a comprehensive list of issues. With the help of the college of education, the team identified five categories to the problem.

The categories were:
• administration — selection of best teachers, evaluation of teaching effectiveness, rewards and supports for teachers;
• teachers — teaching skills, ability to manage TAs and multiple recitation sections, comfort with using different delivery mechanisms, knowledge of large group interaction techniques, approachability;
• students — transition from small classes in high school to large classes in college, willingness to take responsibility for learning, initiative;
• university context — communicated importance to cover lots of material vs. ensuring proper comprehension, merit recognition, lack of emphasis on teaching in promotion and tenure;
• physical context — adequate space, availability of teaching aids, need for more technologically advanced teaching environments.

The team decided to use these categories as a template for surveying faculty and students. The team surveyed faculty who were currently teaching large classes or had done so in previous semesters. They were asked to identify sub-causes in each of the categories. A separate student survey, which assessed the views of the students and their attitudes toward large classes, was distributed in large classes and in the residence halls.

Faculty identified the five most frequently selected root causes as:
• conflict between the large class format and learning goals, perceived lack of accessibility to students and personal contact, lack of student motivation and preparation for the large class format, lack of reward structure for successful large class teaching, and lack of accountability for student classroom performance.

Student feedback focused on the lack of personal contact with instructors, the lack of structure in lectures, poor discussion sections, problems with classroom facilities, and a desire for more testing and feedback.

Interestingly, the students also reported that they didn't believe they were taking too many large classes or that the quality of instruction was poor. Contrary to expectations, 56% of the students reported that they didn't like to buy lecture notes (from a campus service) rather than attend class. These results, as well as personal conversations with students, alerted the team to the fact that large classes contained many positive features.

Using these data, the team suggested a list of potential solutions and then invited input from the faculty. While the faculty were supportive of the recommendations, they also provided several refinements.

For example, the faculty alerted the team to more closely consider a set of recommendations about teaching facilities, citing problems such as the availability of equipment and lecture
hall maintenance. They also revealed their awareness of techniques for creating more interaction and feedback in the large classes, but asked for assistance in adapting them to specific course content and individual teaching styles.

The large classes team made a series of recommendations to the council:

- that the existing facilities improvement committee systematically assess teaching facilities with the active involvement of the actual classroom and lecture hall users;
- that the transition to large classroom environments as well as the positive aspects of large classes be discussed during freshman orientation;
- that a "large classes" handbook that could be used in student preparation and in advising sessions be developed;
- that new learning assistance workshops about succeeding in large classes be offered;
- that a committee at each college level be created to periodically review the college's assurance of quality in large classes, recitations, and teaching assistant preparation;
- that funding be available to assist individual instructors of large classes with strategies for enhancing learning;
- that a summer seminar on large class teaching techniques be offered for new and returning faculty assigned to these types of courses; and
- that a "large classes" grant fund be established to support faculty who wish to introduce innovations in large class settings.

Faculty are excited about the prospect of improving large classes. The team conducted an additional analysis which identified those colleges and departments offering the most large class sections, the enrollment in such courses, and the academic rank of assigned instructors. These data can be used to focus improvement efforts, rather than undertaking simultaneously an improvement of all large classes across the university.

At the sponsor's request, the large classes team was asked to address the council of deans and appear before the academic planning advisory committee.

Student Employment Team

The director of the physical plant served as the leader for the student employment team. Also on the team were representatives from financial aid, career center, commuter affairs, college of engineering (which supports a large cooperative education and summer student employment program), book center (a large student employer), and faculty from college student personnel and organizational psychology programs.

This team faced the initial task of clarifying whether an improvement opportunity existed, since only one prior data collection effort had directly examined student employment issues.

Student employment had traditionally been regarded as a type of extracurricular activity, mostly undertaken to generate income for "extras." Yet, trends in national data suggested that students were working more hours and also depending more on their incomes to pay for large portions of their essential costs, such as tuition, room, and board.

It appeared that these changes could be interfering with academic progress. Issues about interference with job situations appeared in several campus surveys — usually in the open comments — but the issue had never been systematically explored.

Using CQI tools and techniques, the team defined the problem and proposed three fundamental areas of conflict between academic success and student employment:

1. Students work much longer today because they must help finance their education.
2. The university tends to view student employment as a "necessary evil," rather than as an educational opportunity.
3. Student employment can cause students to withdraw from the university, especially when they work off campus.

To substantiate and clarify these conflicts, the team examined current campus data about student employment and collected data using a mini-

survey distributed to student employees, focus groups with on-campus student employees and employers, telephone interviews with off-campus employers, campus payroll information, and responses to an automated phone-in survey from students calling the on-line registration system. The team also examined several national student employment reports.

These data were used to define improvement gaps that surrounded each of the three issues:

- Sixty-six percent of the seniors held jobs while enrolled and 29% of them held two part-time jobs;
- Students and campus employers recognized that there was a lack of coordination among the numerous on-campus offices;
- Students responded favorably to offering academic credits for structured job experiences, linking jobs to academic majors, and utilizing jobs as a means for career exploration;
- Only 25% of campus departments offered experiential learning credits;
- Longitudinal research showed that students who worked off-campus had higher attrition rates, took longer to graduate, and felt less connected to the campus; and
- There were no systematic campus benefits for student employees and no programs in place to induce students to take on-campus jobs rather than off-campus jobs.

Using the improvement gaps and the issues, the team recommended:

- Creating 24-hour access to information about student job openings on the campus electronic information network;
- Consolidating the currently separate employment centers that post on-campus vs. off-campus job opportunities;
- Requiring all departments to offer credits for experiential learning;
- Designating a lower-division experimental credit course that can be taken by freshmen and sophomores;
- Providing faculty with class profiles that include aggregate data about the average number of hours worked by students in their
courses;
- Developing student employee benefits, such as priority parking, advanced registration, workshops, a competitive wage scale, textbook discounts, and leadership development opportunities.

The team recognized that no one office on campus currently assumed ownership for the student employment issue. As an extension of its recommendation to consolidate job posting services, the team proposed that current job referral services be enhanced to create a comprehensive student employment center (SEC). The SEC would be a centerpiece of the campus career center, which had expertise with experiential learning programs and could assume ownership for student employment issues.

The team developed the SEC's mission and described how it might organize itself around new services, programs, advocacy, and research. Given this mission, the team made a final recommendation that the career center change its reporting to the vice president of student affairs. To support this point, the team conducted brief programmatic benchmarkings against 14 universities similar to UMCP regarding placing the SEC in the student affairs division.

Continuous Improvement of the Process

The very structure of these teams — with the use of deadlines, management presentations, limited membership, and sponsorship — was the outgrowth of prior experiences with CQI projects at the department and division levels. There was an explicit attempt to involve many of the faculty and staff who had participated in past CQI projects and training or had shown an interest in CQI.

UMCP maintained the continuity of learning during the evolution of these projects by using regular meetings of team facilitators to share lessons learned in each of the groups. During those meetings, progress would be shared, techniques evaluated, questions raised, and learning documented for future improvement.

Since each of the teams was launched over an eight-week period, it was possible to pass the advice of an advanced group to a group working in earlier stages. The brief update by all team leaders on the same date at mid-semester also allowed the teams to receive some general feedback and make mid-course corrections.

As the teams began to make their final presentations to the CQI council, the remaining leaders and facilitators who hadn't yet completed were invited to see and learn from preceding teams. This phasing allowed for quick adjustments in the format and process of team presentations.

With all presentations now completed, the office for continuous quality improvement is working with an institutional studies staff member to conduct a multi-method evaluation of the projects. When the evaluation is finished, the CQI council will review the feedback, discuss plans for acting on the recommendations, and prepare a direction for future actions.

For more information, contact:
Geno Schnell, Associate Director, Office for Continuous Quality Improvement, 1131 Engineering Classroom Building, U. of Maryland, College Park, MD 20742; Ph: 301/405-3866; Fax: 301/314-9867; Email: eschnell@umdacc.umd.edu

Understanding the TQM Metaphor in Higher Education
Ray Mines and Frank Williams

Are students workers or are they customers? Depending upon your viewpoint, they can be either, neither, or both. From our perspective, we believe they're both workers and internal customers. Here's why:

The New Mexico State U. mission statement tells us that our products are "education, research, extension education, and public service." For our present purpose we will concentrate on the educational component of our product — our students' education.

The university's mission statement also tells us, "The mission of New Mexico State U. is to serve the people of New Mexico ..." Since the people that we serve are the "people of New Mexico," our customers include the people of New Mexico.

The mission statement goes on to say: "The university seeks to educate each student not only in how to earn a living, but also in how to live a meaningful life." Since our students' education should enable them to "earn a living," our customers also include the employers of our graduates. We see, then, that our external customers, or consumers of our product, are the people of New Mexico and the companies that employ our educated graduates.

Next, we need to determine who the workers are. This is a crucial point in the interpretation of the TQM metaphor, and is one on which many attempts founder.

Workers are those who produce the product. Certainly, the main person involved in a student's education is the student. In fact, the only ones who can actually produce knowledge inside people are those people themselves. Therefore, students are the workers.

This is in contrast to a superficial analysis that identifies students as customers. Careful thinking shows this analogy to be false. Possibly some are misled to this identification because students pay fees and we frequently speak of them paying for their education.

But workers frequently have business expenses such as union dues, uniforms to purchase, and work tools. We should think of the student fees as a business expense. The major portion of the cost of the students' education is paid for by the people of New Mexico, the true customer.

A better way to think of students as internal customers, analogous to production workers in industry. It's also important not to fall into the trap of thinking that because the students are the workers they are necessarily employees.

Students are independent workers. They also play further roles in the process. They serve as intermediaries on both ends of their university experience, bringing their education from the suppliers when they enter the university and taking their product with them to the customers when they leave.

This viewpoint recognizes that the student plays the active role of worker, who expects to produce, rather than the passive role of consumer, who expects to be served.

When students assume the responsibility for their education and become
the logistics and technical aspect, which includes everything from classroom readiness to the delivery of course materials to the students.

Second is the relationship between the professor and the students. Not the personal relationship, but what I call the "envelope" relationship — the mentoring and advising. The most difficult process is the actual teaching.

TQM/HE: Was there any event, course, or person that focused your vision on quality?

Fall: When I look back now, my first influence was in my courses in metaphysics, ethics, and philosophy. These were very strong influences on me.

The second major push came in my engineering education. There one learns that quality is one of the essentials in life, an uncompromising value.

The third impetus came to me in my career in IBM, where I was the head of the IBM Quality Institute. You have to have both the behavioral and the analytical pillars to hold up the total quality roof.

TQM/HE: I believe that every student going through the educational system — from kindergarten to medical school — should have learned about TQM. I don't see this being integrated in any of our curriculums. How can we instill more TQM concepts into our college graduates?

Fall: Well, this is a question that goes beyond higher education. Total quality has to become part of our entire educational system. It has to relate to our individual growth and our quality of life.

It has to instill discipline, trustworthiness, a sense of accountability — those behavioral values that go hand in hand with quality.

In the industrial world, TQM is much more mechanical. In the education setting, there's more of a human behavioral element. It's more than a bunch of tools and techniques and is much more difficult to teach.

Yes, you need to teach TQM tools and techniques, but you should harmonize these with values into the core aspects of all courses.

For more information, contact:
Gabriel Fall, President, Juran Institute Inc., 11 River Road, P.O. Box 811, Wilton, CT 06897-0811; Ph: 203/834-1700; Fax: 203/834-9991.

Student Applications

Learners are responsible for developing and implementing a self-learning plan to increase their knowledge, skills, abilities, and attitudes.

As learners age, their responsibility for self-directed learning increases. Not only must they eliminate deficiencies in their knowledge, they're also responsible for adding to it.

Learners should have an annual or longer-term personal development plan addressing general and specific increases in their knowledge, skills, abilities, and attitudes using a variety of resources — reading, audio tapes, lectures, study groups, mentors.

Deming's Sixth Point

Institute training.

Management

Too often, new employees — even those in higher education — aren't trained in the specifications expected for a new assignment. Many learn their jobs from workers who were never properly trained.

Curriculum guides aren't self-teaching documents; nor should administrators receive their orientation to their new position from the secretary.

Continual training for employees in how to improve their job performance is an essential component to continual improvement.

Instructional Applications

Regularly, consistently, and continually participate in training to increase your knowledge, skills, abilities, and attitudes directly related to your job.

There are opportunities for faculty to increase their skills: seminars, graduate courses, workshops, lectures, professional reading, study groups with other professionals. When the Deming concepts are fully operational, the system will support such training.

Not only should a teacher work with his or her supervisor to draw up an annual training plan that is supported with financial assistance, he or she should also be responsible for developing a significant long-term training plan.

"Business as usual" is unacceptable. A commitment to quality first requires a continual commitment to increase one's knowledge, skills, abilities, and attitudes.

Deming's Seventh Point

Institute leadership.

Management

The supervisor's job isn't to tell people what to do or to punish them. A leader's job is to lead — help people do a better job. A necessary part of this is learning — by objective methods — who's in need of individual help, and then providing it in a non-threatening, positive, cooperative manner.

Instructional Applications

Teaching is leadership.

The teacher's role isn't to tell learners what to do or to punish them, but to lead them. Leadership consists of helping learners do a better job. It also involves learning, by objective methods, who's in need of individual assistance and then facilitating it.

Student Applications

Learning is leadership — leading one's self. Learning is also following or participating with others' leadership.

Learners are responsible for developing a working relationship with their teachers. Such a relationship encourages learners to more effectively follow the path the teacher suggests.

As learners — whether officially enrolled in a course or life-long, self-directed learners — developing a mentor relationship with a significant person is a valuable learning followed by offering profound potential.

For more information, contact:
Peter Loehr, Department of Educational Administration and Supervision, College of Education, Western Illinois U., 99 Horrabin Hall, Macomb, IL 61455-1396; Ph: 309/298-1070.
TQM for Professors and Students

George Bateman and Harry Roberts
Part one of a two-part series

For us, the following definition catches the essence of TQM: Continually serve customers better and more economically, use scientific methods and teamwork, and concentrate on removing all forms of waste. We believe that faculty can successfully adopt TQM efforts because:

- Professors are relatively free to change the way they teach.
- Professors want to be good teachers, and there are ways — even for college presidents, deans, and department heads — to encourage good teaching.

The key TQM idea is customer satisfaction and students play the role of customers.

The TQM movement has already led some faculty to begin thinking of students as customers.

The view of students as customers isn't universal; many faculty often resist or resent this view.

The idea of students as customers can be construed much too narrowly. Students aren't customers in the sense that the customer is always right, nor are students the professors' only customers.

But the idea of students as customers is more healthy than the extreme paternalistic assumptions that faculty have traditionally made, namely, that professors know what's best for students, and that students can't judge their own long-term self-interest and have to be given a lot of medicine they don't like to take.

This traditional professorial paternalism can lead to complacency, stagnation, failure to check how much is really being learned and retained, and the working hypotheses that students' needs coincide with professors' interests. Worse, it can lead to accepting poor student performance.

The idea of students as customers encourages professors to take responsibility for the success of teaching, and therefore become interested in methods of teaching improvement.

We can testify from personal experience that teaching looks very different when you think of students as customers. Professors begin to try to figure out why students perform poorly or challenge the relevance of the material. They begin to think about getting relevant data.

We believe professors need more data than they usually get, and they need it in a more timely fashion.

Role of Course Evaluations in Improving Teaching

If an institution is to achieve a customer focus, some information about customer satisfaction is essential. Since the late 1960s, the Graduate School of Business at the U. of Chicago, where we teach, has used student course evaluations based on questionnaires in all courses, with systematic public reporting of results. Other business schools — for example, Northwestern's Kellogg School — also have used public course evaluations.

Just as grading often makes students uncomfortable, course evaluations make professors uncomfortable. But, in spite of minor technical reservations, the Chicago faculty generally believe that course evaluations provide the best available information we have about teaching effectiveness.

Faculty members don't believe that the evaluations are mere popularity ratings.

Although we can't prove it, we believe that teaching at Chicago is much better than it would be in the absence of public course evaluations because evaluations encourage the faculty to treat students as customers, whether or not the word "customer" is used.

In promotion decisions, a summary of course evaluations is always included in reports and discussions of the Appointments Committee. This, and the fact that, both at Chicago and Northwestern, deans take these evaluations seriously, encourages good teaching.

Inspirations

Unfortunately, course evaluations have limitations:

- They're available only after the course has ended.
- They use general-purpose questions that apply to all courses.
- They can't include course-specific questions.
- The numerically scaled questions tell almost nothing about what worked and what didn't.

Some information can be gleaned from tabulating free response questions to see which themes occurred most frequently, but these highlight pervasive problems rather than specific difficulties.

There have been attempts at many colleges to employ simple feedback questionnaires, typically informal but focused on the specific class, at the end of class sessions. At Chicago, two developments led us to experiment systematically with feedback questionnaires and other TQM methodology:

- In the fall of 1990, U. of Wisconsin-Madison professor Ian Hau was continued on p. 2

In this issue...

- TQM in the Classroom,
  The course portfolio: A CQI teaching and learning tool, p. 2
  Deming in the classroom, p. 3
- The Academy
  Is there hope for TQM in the academy?, p. 6
  Assessment and institutional quality, p. 7
- Voice of the Customer
  Focus on fear, p. 7
teaching a large undergraduate statistics course. From his students, Hau formed a small quality improvement team to help him improve the course while he was teaching it.

- In March, 1991, Andrew Appel, a Chicago M.B.A. student suggested that we use the Chicago "laboratory course" format to help Chicago faculty members apply TQM ideas and tools to improve their teaching, curriculum development, and research.

Originally, the "laboratory course" was a "new product laboratory" where teams of students worked with client companies to develop and implement new product ideas. Faculty and executives from client companies coached the students. The laboratory format has been extended to other kinds of applications such as implementation of TQM.

The Teaching Laboratory
Thus was born "Business 712: The Laboratory to Achieve Organizational Excellence: Improvement of Teaching, Curriculum, and Research" — "teaching lab." In the lab, the clients are usually faculty members, and most student activity during the first year (1991-1992) focused on helping these clients.

For example:
- Eleven faculty members have worked with lab course students or student teams to improve ongoing courses.
- A team of five students worked with the behavioral science group as a unit to design a new required course in behavioral science.
- Two students worked with marketing faculty on curriculum issues in introductory marketing courses.
- A student worked with a faculty member to develop a course on high-tech marketing.
- One student in the lab has benchmarked the performance of two of the school's most outstanding case teachers.

These efforts were generally very successful. For ongoing courses, students developed feedback mechanisms that tell the instructor, continually and quickly, what is and what isn't working — both in class and in the readings — so that the instructor can make appropriate adjustments quickly.

Students used various tools, including focus groups, videotaping, and broader surveys, but the survey tool turned out to be a simple fast-feedback questionnaire, used at all or almost all of the class sessions. The questionnaire evolved from lengthy to streamlined, and the process was simplified so that faculty could do it themselves. Many of them are doing now.

They also designed simple questionnaires (often confined to one side of one page), which faculty could administer and interpret. The use of feedback has become widespread, though far from universal.

In the lab's second year, students have turned to broader issues of curriculum development — benchmarking business efforts in general management training — and administrative facilitation of education — the use of information technology in M.B.A. education.

Ed. note: In part 2 of this article, Beelman and Roberts will focus on what was learned in the first year in developing the fast-feedback questionnaire and offer their suggestions about ways of using TQM to improve teaching.

For more information, contact:
George Beelman or Harry Roberts,
Graduate School of Business, U. of Chicago, 1101 East 58th St., Chicago, IL 60637; Ph: 312/702-7301; Fax: 312/702-0458.

Course Portfolio: CQI Teaching and Learning Tool
Bill Cerbin
Many faculty, deeply concerned about improving education, regularly examine and revise their courses. Some are also experimenting with improvement strategies such as classroom assessment techniques and teaching portfolios.

A tool that focuses specifically on improving teaching and students' performance in individual courses is a "learning-centered portfolio." This course portfolio, created by the instructor, is intended to explain important connections between his or her goals and teaching practices, and students' learning in a single course.

A fundamental question motivates the development of a course portfolio: what, how, and why do students learn or not learn in a course?

The design is fairly straightforward.
ward. A course portfolio begins with a teaching statement that conveys the instructor’s assumptions and beliefs about teaching practices used to address the learning outcomes, and a rationale that connects the course goals to the instructor’s methods. A good teaching statement provides a coherent framework for analyzing and evaluating classroom teaching.

Two Perspectives

The course portfolio also contains two important sources of information about students’ learning.

One is direct evidence of student performance on several key assignments. The instructor’s analysis of student learning provides important information about students’ progress toward course goals, and leads to ideas about assignment revisions and classroom practices that could enhance students’ performance.

The second source of information comes from student feedback. The instructor regularly collects students’ ideas about how teaching affects their learning and progress in the course.

In an analysis of student perceptions of teaching and learning, the professor identifies ways to change the course in his/her teaching in response to student concerns.

A course summary, describing how things turned out, completes the course portfolio. Examples of summary questions include: To what extent did students progress toward the course goals? What explains the gaps between goals and outcomes? What changes would enhance student performance?

The course portfolio prompts improvement of teaching and learning in several ways. First, portfolio development engages instructors in careful self-reflection about their purposes, goals, and connections to teaching practices. Information about students’ experiences and their progress toward course goals provides a basis for making changes that will enhance students’ learning, thinking, and development during that and subsequent terms.

Course portfolios can set the stage for substantive collaboration for improvement of teaching and learning. Portfolios invite students to participate as significant and informed partners in improving a course.

A good teaching statement informs students about the course’s goals and methods. Students become mindful of how teaching is supposed to be connected to course goals, and they’re regularly invited to comment on their experiences.

Students learn to monitor and evaluate their progress toward learning goals in relation to teaching in the class and, when asked good questions in the right context, provide the instructor with pointed information about their experiences.

Fostering Collaborative Problem Solving

The course portfolio also provides a way to foster collaborative problem-solving among colleagues. A portfolio entry can stimulate discussion and brainstorming about particularly tough teaching problems, resulting in not just better teaching in one course, but in several.

Colleagues who teach the same courses might critique one another’s portfolios, not so much to pass judgment as to help one another think through pedagogical issues.

A good course portfolio serves as a map — helping the instructor locate students as they enter a course, chart their progress toward the course destinations, and find alternative routes through difficult territory. And, like all good maps, it can help fellow travelers — students and colleagues — who are making the same journey.

For more information, contact: Bill Cerbin, College of Arts, Letters, and Sciences, U. of Wisconsin-La Crosse, La Crosse, WI 54601; Ph: 608/758-8218; Fax: 608/785-8221.

Deming’s Ninth Point

Peter Loehr

Ed. note: Loehr has applied Deming’s 14 points, seven diseases, and four obstacles to teaching and learning. We continue this series begun in the May 1993 issue of TQM/HE with three more of Deming’s 14 points.

Deming’s Eighth Point

Drive out fear.

Management

Fear reduces creativity, commitment, and initiative.

For better quality and productiv-
cutive to learning. Competition creates a barrier, preventing students from problem-solving and sharing ideas.

As individuals increase their knowledge, skills, and special interests, it's necessary to continuously break down the natural barriers that arise.

Deming's Tenth Point
Eliminate slogans, exhortations, and targets for employees.

Management
Management-initiated slogans don't help people do a better job.

Instructional Applications
Create your own slogans, exhortations, and affirmation statements.

Organizationally-created slogans don't help people do a better job. Creating one's own slogans and affirmation statements can focus attention on individual targets and increase motivation or interest.

Change those slogans that are no longer useful. They should be personal statements and commitments, flexible and unique in order to have significant impact or influence.

Student Applications
Create your own slogans, exhortations, and affirmation statements.

Learning and doing are journeys sometimes inspired or charted by slogans, exhortations, or focus targets. As the slogans serve their purpose or are ingrained, others take their place.

"Study Tuesday, Wednesday, and Thursday" might be relevant for a Friday exam, but after the test, the slogan has served its purpose and it's time for another focus statement.

For more information, contact:
Peter Loehr, Department of Educational Administration and Supervision, College of Education, Western Illinois U., 99 Horabin Hall, Macomb, IL 61455-1596; Ph: 309/298-1070.

The Academy

Is There Hope for TQM in the Academy?
Trudy Banta

In 1989, I received a three-year grant from the Fund for Improvement of Postsecondary Education (FIPSE) to work with institutions, both two- and four-year, to study the implications of TQM for higher education. We met for discussions twice a year for three years and established our own study groups on individual campuses.

In 1989 there was a great need to translate TQM principles from the language of business and industry to that of the academy. Over the course of the project, we produced a brief overview of quality improvement principles as they can be applied to higher education.

Now — nearly 5 years since we wrote the FIPSE proposal — there are hundreds of articles and several books on the topic.

The FIPSE project culminated in a meeting that took place in May 1992 in Knoxville, TN. We invited the quality improvement coordinators of seven research universities that were acquiring some reputation for implementing TQM — Maryland, Michigan, Minnesota, Pennsylvania, Tennessee, Wisconsin, and Virginia Tech.

We considered several topics at that meeting, one of which was our perceptions of the features of a quality-oriented institution. I'd like to share with the TQM/HE readers these features.

Features of a Quality-Oriented Institution

This list will sound simplistic, like a Dale Carnegie recipe. Yet the philosophy underlying TQM is profound. Its implementation requires a cultural change in most organizations.

Such an institution:
1. Is committed to the need for continuous improvement forever. People are always thinking about how to get better.
2. Identifies whom it wishes to serve and what these potential clients want and need — students, recipients of research and service, community.
3. Addresses the needs of the clients in its mission statement.
4. Identifies the values that guide its actions.
5. Develops a vision of what it would like to be in the future.
6. Has strong leadership that communicates continuously to faculty, staff, and students the mission and goals, values, and vision.

7. Identifies its critical processes — teaching, research, and service.
8. Aligns the implementation of its activities with its mission and values.
9. Provides continuing educational opportunities for all employees, both in group process and in job-related skills.
10. Uses cross-functional teams to improve processes. Works with its suppliers, builds quality into each process, and ceases dependence on inspection to achieve quality — which was the chief problem with performance funding in Tennessee.
11. Pushes decision-making to the lowest appropriate level, creating an attitude of interdependence and trust throughout the institution.
12. Bases decisions about the allocation of resources on data. Uses quantitative thinking, along with competence in group problem-solving skills and relevant statistical procedures. These should be in widespread use throughout the institution.
13. Views itself as a learning organization, one that:
   • promotes student learning, research, and service.
   • studies, monitors, and evaluates the processes that produce the products.
   • makes active collaborators in the improvement process of all concerned, including faculty, staff, students, parents, suppliers, employers, and community members.

For more information, contact:
Trudy Banta, Office of the Vice Chancellor for Planning and Institutional Improvement, Indiana U.-Purdue U. at Indianapolis, Administration Bldg. 140, 355 N. Lansing St., Indianapolis, IN 46202; Ph: 317/274-4111; Fax: 317/274-4651.

UCF's Journey — Month 7
Janice Dossey Terrell

Ed. note: We're following the U of Central Florida's progress as it continues implementing TQM.

We've suffered a minor delay in selecting quality improvement pilot projects, due to the hectic and conflicting summer schedules of our
curiosity about it. Many wonder if it’s the latest ‘management philosophy du jour.’”

But the “proof is in the pudding,” he points out. “As you show results, you bring more people on as believers.”

For Lindsey, part of the proof has been the increasing numbers of students the college has enrolled since 1987. This year, Fischer had the second largest number of freshman applications in its history. And the incoming enrollment was the largest ever. Transfer enrollment this year is off only slightly from last year’s record.

Lindsey readily admits that TQM is only part of the enrollment picture and that other factors are involved, such as what competitors are and aren’t doing, and what the faculty is doing.

One success he’s willing to credit TQM for is an office program planning manual. An admissions office team used brainstorming and the affinity diagram to develop a comprehensive manual that allows a new admissions counselor to plan and execute a complex program from start to finish.

The manual was entered in a quality fair held in conjunction with a leadership conference the college sponsored. Three local corporate executives, who had been invited to select award winners, declined to do so because they were impressed with the consistent quality of all Fisher’s projects.

Substantial Investment

Lindsey doesn’t shy away from the fact that, in the short run, TQM is a substantial investment of time. “It’s very time- and labor-intensive. But so is continuously having to go back and revisit a problem.”

“In the long run, you find better solutions and you end up serving people better.”

Lindsey’s advice to institutions thinking about starting a TQM journey — “Think big, start small, and build on success.”

For more information, contact: Peter Lindsey, Dean of Admissions, St. John Fisher College, 3900 East Ave., Rochester, NY 14618; Ph: 716/385-8064.

even hostile student reactions, even when a course is going well. However, it’s more helpful to learn about problems while one can address them rather than encounter them on the end-of-the-course questionnaire.

3. Ordinarily, instructors must rely on subjective impressions as to what does and doesn’t work. Our lab experiences suggest that these impressions are often untrustworthy, and that they tell almost nothing about variations in individual students’ or groups of students’ reactions.

4. Often student feedback has suggested “obvious” problems that weren’t obvious to the instructor. For example:

- In almost every class there were problems hearing or understanding the instructor, reading the writing on the board, or seeing the visuals.

- Almost always, students have wanted more examples and applications to illustrate concepts.

- Students were impatient with fellow students who try to dominate class discussions.

- It was very hard for the instructor to judge whether the pace of the

Editor: Robert Connelly, Sr.D.
Total Quality Management Consultants
Specializing in Educational Institutions,
4802 Oak Park Blvd., Port Orange, FL 32127 Ph: 800/339-6668 FAX: 561/796-6175

Advisory Board:
Larry Bynum, Director, Center for Teaching & Learning, U. of Southern Colorado (CO)
Ellen Earle Chaffee, President, Valley City State U. (ND)
Philip Crosby, Chairman, Career IV (FL)
Mary Ann Hervey, Director of Institutional Research, Delaware County Community College (PA)
John Hilt, President, U. of Central Florida (FL)
Albert Koller, Jr., Dean of Institutional Advancement & Director of International Education, Brevard Community College (FL)
Robert Milam, Dean, College of Business, U. of Wisconsin-Oshkosh (WI)
Rosa Oppenheim, Director, Teaching Excellence Center-Newark (NJ)
Betsy Roberts, Director, U. of Missouri Business Services (MO)
Burton Wittliff, Acting President, Western Illinois U. (IL)
Publisher: Doris Green
Associate Editor: Mary Lou Santovec
Graphic Artist: Jim Condon
Marketing Manager: Mia Melvin
Customer Communications Manager: Mary Burrell
President: William Haight
class is too fast or too slow, and casual student comments weren't a reliable guide.

5. The feedback questionnaires can probe into deeper problems, such as students' understanding of basic ideas, motivation for course preparation, or reaction to outside readings. We've been surprised to find a common student tendency to skip readings that have no potential impact on the course grade.

6. Probing into these deeper problems, however, requires the instructor's intense involvement in the feedback process: s/he must provide reverse feedback. This can be oral, written, or both. It can take the form of course modifications, answers to specific questions, elaboration of obscure points, clarification of the grading system, fuller comments on student papers or cases, additional references, or outside speakers.

7. The processes of feedback and reverse feedback tend to draw students and instructors together to improve the learning experience. An instructor's written reverse feedback can explain points singled out by the fast-feedback questionnaires, and even answer specific questions asked on the questionnaires. Reverse feedback can require substantial time and effort of the instructor, but the payback in avoidance of rework is great.

8. Regarding reverse feedback: students want instructors to provide feedback, preferably fast, not only on the questionnaires, but on all work they hand in. Students aren't happy with a grade on a written assignment that doesn't include comments.

9. Course ground rules should be made explicit: students should understand what's expected of them and what the instructor expects to provide. It's appropriate to discuss the ground rules, and possibly modify them with the aim of a mutual understanding—a course "contract."

10. Instructors should devote some time to "marketing" their courses, including the outside readings, both in advance and during the course.

11. The fast-feedback questionnaire can discover how students are actually using their study time. Instructors can then use this data to help improve students' study efforts.

12. Another useful TQM aid for students may be the personal quality checklist, developed at AT&T. This simple tool applies TQM to personal work processes, and is adaptable to student work processes.

13. There should be some structured instruction, even in courses where faculty are primarily coaches and facilitators, such as laboratory courses.

Experiences and Suggestions

In addition to facilitating and coaching students in the lab, we've also applied some of the lessons to our own teaching in statistics and quality management. Observing what we've learned from the lab, we've made some immediate changes in our own courses. We now:

- Put a copy of the course syllabus and a short background questionnaire into student mail folders before the first class meeting.
- Reduce and focus the outside readings.
- Provide a clear idea of what each reading should accomplish, rather than just the general feeling that it will be interesting or good for the students.
- Try to "sell" the readings.
- Use short fast-feedback questionnaires.

All these steps have proved to be helpful, but the last one was the most important. We make no claim for novelty, because we know of many uses of feedback questionnaires that pre-date ours. The lab however, helped us to develop a systematic approach that others may find useful.

The questionnaire's goal is to get systematic feedback after every class meeting, analyze the results, and make appropriate adjustments. Even without formal questionnaires, instructors can actively seek out feedback on their own.

The time-honored approach to assessing one's work is to evaluate quizzes, problems, and other assignments. Quizzes and problems however, often tap only limited aspects of learning; in particular, it's often hard to tell how well students can make the connection from abstract ideas and highly simplified examples to real-world applications.

Since we teach mainly in the statistics area, we assign projects that require real-world application of statistical tools. Progress reports on these projects provide excellent feedback, especially on pervasive misunderstandings of statistical ideas that students have somehow acquired before reaching our courses.

In the spirit of the lab approach, however, instructors can go further. They can ask questions in class, ask for a show of hands on student experiences or problems, institute a suggestion system, and administer — often to only a few students — very short questionnaires, such as Mosteller's famous, "What was the muddiest point in this lecture?"

Course Strategy

The usefulness of feedback tools stems from the fact that students know when they can't see or hear or are confused or unclear about content, and can tell the instructor when a particular topic seems irrelevant to their interests.

Ideas for course strategy improvement, by contrast, must come from the instructor — from an improved understanding of the subject matter and its connection with other topics. For example:

- Which topics are essential, which can be left out or de-emphasized?
- How can we better exploit what students already know?
- What new topics are needed to keep the course up-to-date?
- Are there simpler and better frameworks for understanding the subject matter? Can one general idea unify several specific ideas, which can then be seen as special cases of the general idea?
- Can process mapping and flow-charting be used to improve course strategy?

TQM can contribute to course strategy. For example, TQM's insistence on continual and substantial improvement is essential to combat the tendency toward simply accepting the slow evolution of textbooks and courses.

TQM encourages instructors to

continued on p. 6
widen their horizons beyond minor issues, such as, "Should we teach the
median before we teach the mean?" TQM tools such as benchmarking,
brainstorming, and focus groups can bring out new opportunities in course
strategy and in curriculum design.

For more information, contact:
George Bateman or Harry Roberts,
Graduate School of Business, U. of
Chicago, 1101 East 58th St., Chicago,
IL 60637; Ph: 312/702-7301; Fax:
312/702-0458.

**Student Observers Provide
Faculty Feedback**

The Classroom Student Observer
Program (CSOP) at Brigham
Young U. provides faculty with a
unique way of obtaining student
feedback.

Offered through the Faculty
Center, CSOP provides students with a
quality education while providing faculty with feedback so they may have a better sense of what's happen-
ing in their classrooms.

The Faculty Center trains student
observers to work in the program.
Center members provide feedback
with feedback.

The program offers a choice of six
feedback methods, but, if the instruc-
tor has preferences, s/he can request
other forms of observation. The six
methods are:

1. Faux student — during the
class, the student observer takes notes
as if a class member and gives them to
the instructor.

2. Recorder/Observer — the
student observer records, in writing, what went on in the classroom in terms of time spent on board work, questions asked, and small group
discussion.

3. Filmmaker — the student
observer videotapes the class for the
instructor to view privately or with
the student observer.

4. Interviewer — the instructor
leaves the class while the student
observer interviews students to assess
how well they're understanding the
concepts.

5. Primed student — the instruc-
tor meets with the student observer
prior to the class to give pointers
about what to look for. After class,
they meet to discuss whether the
instructor met his/her goals.

6. Student consultant — the
instructor asks the student observer to
act as a consultant by noting the class
members' receptivity, attentiveness,
participation, and understanding of a
concept.

**Source:** Brigham Young U., The
Daily Universe.

**Deming in the Classroom**

Peter Loehr

Ed. note: Loehr has applied Deming's 14
points, seven diseases, and four obstruc-
tions to teaching and learning. We continue
this series begun in the May 1993 issue
with two more of Deming's 14 points.

**Deming's Eleventh Point**

*Eliminate numerical quotes.*

**Management**

*Quotes measure only numbers,
not quality or methods. They usually
guarantee inefficiency and high cost.*

**Instructional Applications**

*Eliminate numerical quotes.*

Assigning a book, paper, or speech of a particular length doesn't
guarantee quality. Instead, it usually
produces inefficient learning and
reflects an absence of personal-
incentive quality. Focus work pro-
cesses and products on quality, rather
than on arbitrary length.

Likewise, grading on a "curve"
 isn't an incentive for quality work —
it cultivates destructive competition
and prevents optimum learning. Com-
petition is a highly unfavorable learning
condition, unlike cooperation.

**Student Applications**

*Seek total quality, rather than work
products that "look long."

When seeking total quality, con-
tinuously focus on quality, rather
than on the length or the number of items.
A much greater length may be neces-
sary to produce a total quality prod-
uct, or a very short product may
contain total quality.

**Deming's Twelfth Point**

*Remove barriers to pride of work-
manship.*

**Management**

*Individuals are eager to do a
good job and are distressed when they
can't. Too often, misguided supervi-
sors, faulty equipment, and defective
materials stand in the way of quality
performance.*

Management's job is to remove
barriers to pride and joy in the work-
place and in work produced.

**Instructional Applications**

*Remove barriers to pride in work
and work products.*

Teachers are eager to accomplish
the best they're permitted to do.

Teachers must have joy and pride
in what and how they work. They
should continually look for joy and
pride enhancers for themselves and
for learners.

For example, by being involved
in purchasing, teachers can help keep
faulty equipment and defective materi-
als from entering the classroom.

**Student Applications**

*Joy in one's work and pride in one's
work products are valuable tools in focusing
on quality.*

Joy and pride are essential aspects
in intrinsic motivation. They aren't
add-ons, but the soul of caring about
what one creates. Intrinsic motivation
is a far greater motivator than is extrin-
sic motivation.

The learner shares the responsi-
bility for joy and pride. As such, the
learner must identify and take neces-
sary action when s/he perceives
barriers in joy and pride.

For more information, contact:
Peter Loehr, Department of Educational
Administration and Supervision,
College of Education, Western Illinois
U., 99 Horrabin Hall, Macomb, IL 61455-
1396; Ph: 309/298-1070.

**The Academy**

**UCF's TQM Journey —
Month 8**

Ed. note: We're following the U. of
Central Florida's progress as it continues
implementing TQM.

In late August, our quality council
was faced with 11 excellent nomina-
tions for quality pilot projects. Rather
than select only six for team action,
the council agreed to complete all 11
in two phases:

*Phase 1 projects beginning in
October 1993:*

6
TQM and employee appraisal. These procedures and activities are designed to produce a set of objective working documents that also record an employee's contributions to process improvement (unit optimization), annual planning (vertical alignment), and college-wide activities (horizontal integration).

ISS administrators and staff have worked to develop a system to satisfy the functions traditionally allotted to performance appraisal in a way consistent with Deming’s directives to:

- drive out fear,
- remove barriers that rob people of pride,
- institute a vigorous program of education,
- break down barriers between staff areas,

and adopt the rest of the 14 points.

In addition to supporting DCCC’s overall quality efforts, this pilot project has already provided benefits for ISS units by linking the time and energy previously spent on evaluation with the activities of process analysis and improvement. In this way, we believe that the TQ-linked portfolio evaluation has improved customer service and provided employees with greater opportunities for professional growth.

The supervisor’s role and responsibilities in the TQ portfolio process differ from those in traditional evaluation systems, with the major difference requiring the shift from “judge” to “coach.” Instead of standing outside and above the employee and determining annually, or at regular intervals, whether the employee achieved “results” or met “goals,” the supervisor must work with the employee at every stage of the process.

The supervisor works with individuals and teams to select the portfolio activities for each cycle, construct data collection mechanisms, analyze feedback, and modify the processes to improve customer satisfaction.

This system also requires major changes in the nature and function of the “evaluation document” itself. Since the portfolio records each employee’s participation in process improvement activities inside and outside the unit, it can’t be completed:

- in isolation,
- without the guidance of the supervisor,
- without the interaction of other members of process teams, or
- with only the feedback gathered from customers and suppliers.

In contrast with traditional evaluation systems—where the forms assume a highly charged status as a confidential, legal document—the forms collected in the TQ portfolio must be public, discussed, and developed with the cooperation of the worker, supervisor, co-workers, and customers. The portfolio’s documents help guide work in progress and should be treated as tools or snapshots rather than “permanent records.”

Finally, the portfolio system requires that the employees change from passive to active participation in the evaluation process. In place of the fear and uncertainty that accompany the annual ritual of evaluation, employees must develop an ongoing attitude of involved concern and responsibility for process improvement throughout the year.

The TQ portfolio, although it will still be maintained in a file by each employee, should also produce a shift from a personal definition of “success” to a definition that encompasses process improvement, customer satisfaction, and a “success” shared with other members of the unit and the whole organization. Supervisors and other administrators will review the portfolio periodically during the year, but its major value lies in its use as a reference and guide for the employee.

For more information, contact:
Raymond Yarnuzzi, Dean of Instructional Support Services, Delaware County Community College, Media, PA 19063; PH: 215/359-5000.

TQM in the Classroom

Using Student Teams to Improve Teaching and Learning

Kathryn Baughner

A class in organizational management is studying mission statements. Intrigued by the recently adopted vision statement of their university, they decide that a class mis-
tion statement would help measure course content and student learning.

In addition, a team of students designs a survey to determine which testing styles their classmates prefer and which type of test helps them learn best. The class identifies a combination test — short answer and essay – as the preferred type. The instructor, agreeing that this type accurately measures the elements of the course, uses it and grade averages rise 68%. Has the learning process in the class been improved? The students respond with a resounding “yes.”

For over a year, “Project LEARN” at Samford U. (AL) and Belmont U. (TN) has attempted to answer the question: Can TQM or something similar be applied to the processes of teaching and learning? And if so, what are some helpful methods for applying these principles?

To address these issues, faculty at Samford and Belmont have used the LEARN process in their classes. The process, a form of “classroom research,” uses a team of students to design, administer, and evaluate feedback measures and implement solutions.

The focus of the LEARN process is to improve teaching and learning. Students and instructors concentrate on the constant improvement of a system rather than simply seek out and solve problems.

The quality team uses the LEARN acronym to work through steps in a basic process improvement model:

- Locate an opportunity for improvement.
- Establish a team to work on the process.
- Assess the current process.
- Research the root causes.
- Nominate an improvement and enter the Plan-Do-Study-Act (PDSA) cycle.

The team works through this cycle several times during the course of the term.

Synopsis of the Process

An instructor decides that using a LEARN team might improve one or several of his/her courses. This is the “L” phase, or the “buy-in phase.” During an early class session, the instructor takes five to 10 minutes to discuss the LEARN process with the students and lists the reasons for forming a team. If the students are interested in previewing the materials, the instructor may pass around some of the supporting materials.

Team selection and introduction are parts of the “E” phase. Once the team is selected — either by appointment, election, or through volunteers — members identify and review roles, becoming familiar with the process, their responsibilities, and the tools and worksheets available.

If the team and/or the instructor determine there’s a need for a facilitator, an individual with experience in LEARN or continuous improvement is invited to meet with the team regularly or as-needed.

During the “A” phase, the team assesses the current state of the class, using simple brainstorming techniques, and identifies improvement. The team then surveys the class to determine which issues are most significant or present the greatest opportunity for improving learning. The team designs, administers, and evaluates the survey and communicates the results to the instructor, if he/she isn’t a member of the team.

The “R” phase begins once team members have assessed and identified the issues of greatest importance. Using brainstorming and a cause-and-effect diagram, the team researches the root causes of the barriers that they’ve uncovered and methods for improvement. The team may use a second cause-and-effect diagram to brainstorm possible solutions or courses of action.

With this data, the “N” phase begins. The team must reach consensus on a potential project for improvement, using the PDSA cycle for the pilot project.

Recently, we’ve begun developing a method to help teams identify barriers that are systemic problems throughout the university. For example, one LEARN team uncovered a problem with computer facilities that wasn’t unique to that single class; a communication tool would help this team provide feedback to the university, bringing benefit to many students. Characteristics of LEARN

The LEARN team provides insights and suggestions for designs and provides team surveys for the class. The LEARN process seeks to address root issues for course improvement. This approach is more effective than end-of-the-course evaluations or even teacher-administered questions and papers because the students interpret their own answers with the instructor.

The LEARN team focuses on process improvement rather than problem-solving. Because the team is looking for ways to improve learning within a specific course, even the most competent, well-respected faculty member can use a team.

The LEARN team implements its own improvements, rather than merely dropping suggestions in the lap of the instructor. A wonderful synergy that includes both students and the instructor must be present for full learning. As students attempt to implement improvements, they begin to accept responsibility for their own learning. They also understand other barriers of the campus system that prohibit maximization of instruction.

The LEARN team does not dictate course content to the instructor. Although it’s the instructor’s responsibility to know what content needs to be taught, the LEARN team is responsible for designing improvements in the teaching and learning process.

The LEARN team does not deal with individual students. It’s not the purpose of LEARN to specific students on an individual basis. If a problem affects these students, it’s up to them.

The LEARN team equates improvement with satisfying student needs.

One of the greatest concerns of instructors and students is time. They believe assessment means sitting down with “customers” and always taking time. That’s an incorrect assumption. The LEARN process has been in operation at Samford for half a term, and we begin to regularly identify the issues that must be uncovered and addressed.

continued on p. 6
What We've Learned
Samford U. conducted the pilot project for LEARN during the summer term of 1992. The following fall, over 30 classes used the process at Samford and Belmont. It's currently in use in over 50 courses in a variety of institutions.

Here are some projects LEARN teams have undertaken:
- Obtaining enough left-handed desks for students.
- Improving retention through better organization of class material.
- Reassigning grade values to more accurately reflect the work required in specific assignments and its contribution to learning.
- Changing dates of tests/assignments to provide for better feedback to students.
- Organizing study sessions and study groups.
- Helping the computer center provide training to lab assistants on all programs used by students within particular labs.
- Developing "buddy" assignments to improve class preparation and participation.

Evaluating the Process
These attempts to use and refine the process have generated the following requirements:
1. It's very important, if not imperative, that the instructor be a member of the LEARN team, serving as team leader when possible.
2. Student teams should have a communication mechanism to provide feedback to the system, to maximize the scope of improvements.
3. Since this process takes time outside of class, there must be a strong commitment from those involved.
4. After working with LEARN, students want to continue this program in other classes and learn more about continuous improvement. It's important to develop some means for educating students on TQM principles and a campus support structure for LEARN teams.
5. Working with a LEARN team awakens in students a sense of responsibility for learning.

6. No matter how simple the manual and process are to follow, many instructors and teams lack confidence in undertaking the process. They need encouragement to work as a team.

As we continue to use and track the LEARN process, new opportunities for improvement continue to surface. For example, we've begun a pilot project for high schools and we're developing a program to enable students to become certified in continuous improvement theory and techniques.

For more information, contact: Kathryn Baugher, Dean of Admissions, Belmont U., 1900 Belmont Blvd., Nashville, TN 37212; Ph: 615/386-4554.

Hooked on Success: Team Testing
Joyce Elaine Gowan
Many of the students who enter my intermediate algebra classes are afraid they won't succeed. This fear increases when they learn that, unlike elementary algebra where they have an unlimited number of attempts per test to pass at the mastery level, in intermediate algebra they're allowed only two attempts per test.

Many of these same students also suffer from math and test anxieties. Since I want my students to succeed, I started allowing them to team test on about half of their exams.

Here are the guidelines I use for team testing:
1. Teams, which consist of three to five students, must be formed one or two class periods before the exam.
2. Each student on a team should become an expert in some area of the material to be tested.
3. Teams should make a backup plan in case a team member doesn't show up for the exam or comes to the exam unprepared.
4. The team should try to come to agreement on the answers. A member who disagrees may write on the exam and submit his/her answer to that specific question for the instructor's consideration.
5. Team members must remember that each student is responsible for each problem on the exam. This means they should check that the expert is doing it correctly.

Deming in the Classroom
Peter Loehr
Ed. note: Loehr has applied Deming's 14 points, seven diseases, and four obstacles to teaching and learning. We continue this series begun in May with two more of Deming's 14 points.

Deming's Thirteenth Point
Institute a vigorous program of education and retraining.

Management
Both managers and workers need
to be educated in the new methods—
teamwork, statistical techniques, 
research methods, and assessment 
skills.

**Instructional Applications**

*Continue learning to improve your 
knowledge, skills, abilities, and attitudes 
in both job-related and other areas.*

Teachers must continually and 
vigorously update their knowledge 
and skills. It's not enough to depend 
on infrequent college courses, spor-
adically held employer-provided workshops, 
and easy-to-read journals.

Essential components of continuing 
development are evaluation, as-
se ssment, statistical methods, study 
design, and group process skills. You 
should also regularly increase your 
knowledge in the arts, sciences, eco-
nomics, and other realms.

Problem-solving is a work-site 
activity; thus, instructors must be 
able to conduct systematic studies to 
create, for themselves, knowledge 
applicable to their specific problems 
or issues.

**Student Applications**

*Learners must vigorously improve 
their knowledge, skills, abilities, and atti-
itudes to prepare for future opportunities.*

You can’t only depend on 
the learning that others consider impor-
tant. Rather, you should also decide 
what you consider important, using 
and constantly updating a written 
learning plan.

**Deming’s Fourteenth Point**

*Take action to accomplish the transforma-
tion.*

**Management**

It will take a special top manage-
ment team with a plan of action to carry 
out the quality mission. Workers or 
managers can’t bring about system-
wide transformation on their own. 
A critical mass of people must understand 
Deming’s 14 points and take action.

**Instructional Applications**

*Take action to accomplish the transforma-
tion.*

Teachers, as managers of their 
classroom, can implement Deming’s 
principles in an instructional setting. 
They should take the initiative to 
make change, either individually or in 
small or large groups, to create joy in 
the workplace, and experience success.

**The Academy**

**UCF’s TQM Journey —
Month 9**

*Janice Dossey Terrell*

**Ed. note: We’re following the U. of Central Florida’s progress as it continues implementing TQM.*

During the first two weeks of Octo-
ber, we held team-building re-
treats for pilot quality improvement 
project teams, facilitated by profes-
sional staff from the office of quality 
management. During the course of 
these "get acquainted" team sessions, 
we learned a lot about the team 
members’ personal styles and observed 
the initial forming of "team" personalities.

Common questions our pilot 
teams asked were:

- Who do we report to?
- Will our recommendations for im-
provement really be seriously con-
sidered?
- Will we be given the time we need 
to do a good job with this project?
- Are we expected to complete the 
project by a specific deadline?
- Why were we selected for the 
team?
- To allay team members’ anxieties,

we spent considerable time in each 
session encouraging team members to 
voice their concerns and then dealing 
honestly and openly with each spec-
ific question. It appeared to be time 
well-spent. At the end of several ses-
sions, team members said they felt 
much better and less anxious about 
participating in a project team.

During these team-building meet-
ings, we discovered that team mem-
bers were all eager to discuss their 
chosen process for improvement and 
quick to share "solutions" to the prob-
lems. Yet some members seemed over-
whelmed by the scope of the projects 
and/or anxious about being able to 
really define the underlying causes of 
the problems.

A quick overview of the quality 
 improvement model helped members 
realize the importance of saving their 
"solutions" for later discussion. Other 
fears associated with identifying root 
causes of the process problems dissi-
pated during the overview as well.

At the end of every session, we 
asked each team to let us know what 
the members liked and what we could 
improve for next time. Many of the 
comments were complimentary, but 
we also received helpful feedback con-
cerning the level of individual and 
group activities, length of discussion 
time for specific agenda topics, and 
suggestions for additional topics.

For more information, contact: 
Janice Dossey Terrell, Director, Quality 
Management Initiatives, U. of Central 
Florida, Orlando, FL 32816-0020; 
Ph: 407/823-6165; Fax: 407/823-5533; 
E-mail: jterrell@ucfvm.cc.ucf.edu.

**FYI**

*Everyone’s a winner in a contest 
sponsored by DePauw U. (IN). All full-
time students are eligible to submit 
proposals for improving campus life. 
They can present ideas in any area, 
including academic life, residence life, 
cultural programs, health and safety*
continued from p. 3
and the dean are notified and the
process is complete.

If, however, deficiencies are noted, the faculty member and the chair work
together to design a mutually satisfac-
tory improvement plan. Services to sup-
port this plan may include assistance
from a peer development committee or
an allocation of financial resources. For
those who contest the decision, an ap-
peals process is available.

In the first cycle of reviews, 245
tenured faculty were notified that
their academic profile would be
reviewed. The following actions re-
sulted: 37 faculty decided to retire
prior to chair review; 144 faculty were
reviewed and met the evaluation crite-
rion; and, 46 professors were found to
be deficient and agreed to write pro-
fessional development plans.

Sixteen negative decisions were
disputed and appealed. In those, the
chair was overruled in three cases and
affirmed in 13. Seven deficient faculty
agreed to work out a plan, five de-
cided to retire, and one professor was
reassigned.

A measure of faculty activity oc-
curring during this period showed the
number of research and grant propos-
als rose by 5.7% and the volume of
new funding increased by 17.4%, as
compared with a growth of less than
3% during the previous year.

I suggest that colleges and univer-
sities may also incorporate periodic
measurement of effectiveness through-
out the departments by having self
and team evaluations on topics such
as mission achievement and program
quality, in addition to the traditional
evaluations on teaching, research, and
service.

An improvement-oriented evalu-
ation process, which concentrates on
the comparisons between department
expectations and faculty performance,
is inherently valid, logical, and justi-
fied. The feedback process becomes
the road map for continuous improve-
ment, education, and self-develop-
ment as well as for institutional and
departmental planning. TQM can pro-
vide the philosophical framework for
college evaluation.

For more information, contact:
Jean Lamkin, P.O. Box 11094, Norfolk,
VA 23517; Ph: 804/660-0415.

To order, Post-tenure Faculty Eval-
uation: Threat or Opportunity?, contact:
ASHE-ERIC, George Washington U., 1
Dupont Circle, Suite 630, Washington,

X

A "Graffiti Needs
Assessment"

Ed. note: Excellence in teaching re-
quires leadership from the instructor. To
achieve excellence, instructors must create
strategies, processes, and systems. Instruc-
tors should also commit themselves to the
growth and development of all students
and should encourage participation and
creativity in them.

The following article demonstrates such leadership as the instructor helps stu-
dents understand her mission and the
CQI process.

Harnessing the energy of the
first class session is a continuing
problem for faculty," writes
Barbara Goza, a faculty member in the
department of behavioral sciences at
California State Polytechnic U.-
Pomona, who has designed "The
Graffiti Needs Assessment," an
intriguing activity that introduces stu-
dents to each other and to the course.

Gozza writes 10 partial sentence
beginnings at the top of large news-
print pages, which she then posts on the
walls of the classroom. A sample of
the sentence stems she uses are:

- "My greatest concern this quarter
  is ..."
- "In three years I will be ..."
- "The greatest challenge facing the
world today is ..."
- "Personnel psychologists do ..."
- "Organizational research is ..."
- "The most useful question I've
been asked is ..."
- "I learn the most when ...

During the first 15 minutes, stu-
dents wander around the room complet-
ing the sentences on the newprint.

Gozza then uses the student responses to
help answer several questions:

- Who is in this class and what are
  their goals?
- What and how will we study?

- Why should we study industrial
  and personnel psychology?

Gozza saves the newsprint pages
and reposts them on subsequent days
when certain topics are discussed. The
sheet with completions of the state-
ment, "Organizational research is ...
" provides a bridge between students' early orientations to the topics and the
expanded perspectives of the course.

"This technique is more work than
the standard operating procedure for
the first class. To me, the extra effort is
worth the results. I demonstrate organ-
izational behavior principles in a dra-
matic way. I use students' sentence
endings to support and make explicit
my philosophy of education. Perhaps
most important, I feel more comfortable with my ... class when I have a sense of
students' feelings."

Ed. note: This article first appeared in
the Journal of Management Education,

For more information, contact:
Barbara Goza, Behavioral Science
Dept., California State Polytechnic U.,
3801 W. Temple Ave., Pomona, CA
91768; Ph: 909/869-3888.

Deming in the Classroom
Peter Loehr

Ed. note: Loehr has applied Deming's
14 points, seven diseases, and four obsta-
cles to teaching and learning. We continue
this series begun in May with three of
Deming's seven diseases.

Disease #1
Lack of constancy of purpose is a dis-
ease to organizational improvemen

Management
An organization without con-
stancy of purpose has no long-range
plans for staying in business. Manage-
ment and employees are insecure. For
Deming, the number one purpose is to
improve quality.

Instructional Applications
Consistency of purpose for quality
improvement is the number one priori-
ty.

Quality is Job #1. Anything less
creates inconsistency of purpose.
Quality is a continuing purpose rather
than a one time action.

Student Applications
Inconsistent focus on quality improve-
ment is a disease.

For students, continually improv-
Student Applications

Students shouldn’t rely on test scores as the sole indication of what they know.

Knowledge is a growing, developing, changing, interrelated body. Test scores reflect what one knew, not what one knows, or how one will apply knowledge.

For more information, contact Peter Loehr, Department of Educational Administration and Supervision, College of Education, Western Illinois U., 99 Horrabin Hall, Macomb, IL 61455-1396; Ph: 309/298-1070.

Innovators

College Sets Benchmarking Standard

Rio Salado Community College (AZ) recently received the first Arizona Governor’s Award for Quality. Over 70 public and private organizations competed for the honor which included a rigorous review by a board of examiners from the Arizona Quality Alliance.

In 1991, the college implemented TQM to better serve its students, primarily working adults, and the community.

Rio Salado President Linda Thor reports that the results of employee TQM training and empowerment are positive. Over the past two years, an additional 10% of the employees now feel their work contributes to the success of the college. The number of employees who feel they’re involved in decisions affecting their own jobs has risen from 56% to 82%.

One of the first colleges in Arizona to use TQM administratively, Rio Salado also was one of the first in the nation to use TQM as an educational methodology in the classroom.

“One key factor about the application of TQM principles, tools, and process improvement in the classroom is that each of the three focus areas — curriculum, teaching, and learning — can be addressed from instructor-initiated actions and from student-initiated actions,” says Thor.

“The goal is to have the students and instructor involved in shared decision-making, by creating a climate of trust and increased participation.”

Thor adds, “The result of practical applications of TQM in Rio’s classrooms is, and will continue to be, increased student achievement within the parameters of our college vision, mission, and purposes.

“Our students who understand quality and who are skilled in process improvement will be prepared to take their place in the workforce of the future, which will be driven by TQM principles.”

For more information, contact Linda Thor, President, Rio Salado Community College, 640 N. First Ave., Phoenix, AZ 85003; Ph: 602/223-4220; Fax: 602/223-4144.
“center.” That’s a tough thing for them to do. I’m sure, like anything else, there will be a certain segment of our faculty who will find a way of not participating.

We’re conducting a lot of workshops for them on this approach. We’re doing a lot of team-building between our old and new faculty members. For this to work, there needs to be as much team-building between faculty members as there is with students and, in some respects, even more.

In fact, we had some faculty drop out of the training because they didn’t like the process. But the overwhelming number who’ve tried this — over 96% — love it and stay with it. In fact, over the past five years, I can remember only three or four who dropped out.

TQM/HE: Which faculty are most in favor and most against?

Quinn: Our humanities faculty have been the most enthusiastic about this — we’ve enjoyed good support from them. Our engineering faculty have also been very supportive. Most of the science faculty are in favor. However, aside from three fine mathematicians in our program, the faculty in our math department is against it.

TQM/HE: How about the college of business?

Quinn: It appears this concept is perfect for them, since it exposes students to their majors right up front. I think they’ll accept this program almost immediately.

Let the Dust Settle

TQM/HE: Any recommendations for those institutions that would like to try this?

Quinn: I’ve been in this business for a long time, and anytime you make a change, dust will fly and then it will have to settle.

But if you say that education should be student-centered, you have to think a lot about what that means. Most educational experiences aren’t student-centered. It’s hard for someone who’s been in the business for a long time to admit that.

Anyone who tries the “learning community” approach will discover this. After a while, all kinds of things happen to you when you make the student the center of attraction. Although each change seems small, the total change is dramatic. And there’s no way to explain that to someone unless they try it.

Since their kids are doing so well, we’ve had people say: “Hell, it’s no wonder they’re doing so well since you’re paying so much attention to them.” And they say that with a straight face.

Although I don’t think you can make a mistake by trying the “learning community” approach, I’d suggest you initially keep the project small. This can’t be done across the board.

For more information, contact: Robert Quinn, Professor of Engineering, Department of Electrical Engineering, Drexel U., Philadelphia, PA 19104; Ph: 215/895-6631.

TQM in the Classroom

Student Apply Quality to “Real-Life” Problems

Carol Lucchesi

I use TQM formally in the “Decision Analysis” course I teach at Wittenberg U. (OH). I’ve tried both providing selected articles and using a short introductory text. I also lecture briefly on the history and principles of TQM, with a heavy emphasis on Deming and the measurement of quality.

The first time I did this I was surprised to end up in an extended discussion of variance. My classes have had statistics, but they seem to think of variance as something completely unrelated to anything in the “real” world.

To make this class seem part of the “real” world, I ask my students to conduct their own quality projects. This requires they learn two skills that, to them, appear to be unrelated — a computer-based statistical package and research methods.

To provide them with data to work with, I administer a little survey on quality and computers, thus enabling them to work with self-generated data. Although I don’t tell them until later, the survey includes an example of each question type I require them to include in their quality project.

The research methods module is standard fare. The twist is a continuing focus on quality.
Asking the Questions
Before letting them begin their projects, I present a list of guiding questions for their analyses:
- What are the goals of the unit?
- Who are the customers?
- What do the customers want or need?
- What are the important processes for responding?
- Where are they successful and where not?
- What can be done to improve the processes?

Each student team of four is required to identify a campus or community department to analyze. Employing classic research methods, they attempt to answer the quality questions. Using this framework, we cover the scientific methods, theory building, measurement concepts, interviewing, questionnaire design, and sampling.

The students are also required to research relevant secondary data, which I use as an opportunity to introduce them to electronic information searches.

So far, teams have analyzed the residence hall advisor system, the health center, campus security, registration system, the campus radio and newspaper, the perception of decision-making on campus (this one required the input of the provost), student social life (particularly drinking), and social sororities and fraternities.

Each team interviews the principals involved, to assess the department’s goals and perceived processes. Then, they conduct a customer satisfaction study, sampling at least a hundred “customers” and reporting the results in standard APA format with one variation.

If I Could Do This Again ... 
Because this project is intended as a learning experience, I require students to identify what they would do to improve their projects if they could repeat them. All reports require my approval before being shared with the university community.

In a number of cases, the "clients" for whom the studies are done ask to attend the oral class presentations. I’ve noticed that whenever this happens, the students involved seemed to take special care with their reports.

Because the project is done in a team, I require peer evaluation. I’ve found it’s helpful to give them a copy of the peer evaluation form before they begin their projects, so there are no surprises. Team members usually agree with one another, but when there’s a clear problem, I call in the individual team members for a conference. In the worst case scenario, I fall back to individual test scores.

In addition to the team research project, I base the grading on two or three in-class tests (primarily short-answer), and a journal. All journal entries must be typed and tightly focused on course content.

Typically, students start the course complaining loudly about the journal, but come to realize that it’s not an irrelevant add-on; they can use it to study, prepare drafts, or communicate with me directly. The journal also provides me the chance to help with writing where needed.

Students seem to have responded favorably to the new focus; student evaluations have moved from being about average for the university to well above average. The most heart-warming comment was by a student who noted that “she acted as a coach rather than an expert; meaning she showed us the way and helped us along.” For me personally, the biggest success is that the students seem to sense that the experience is “real life,” not just an academic experience.

For more information, contact: Carol Lucchesi, Business Administration, Wittenberg U., Ward St. at N. Wittenberg Ave., P.O. Box 720, Springfield, OH 45501; Ph: 513/327-6231; Fax: 513/327-6340.

Deming in the Classroom
Peter Loehr

Ed. note: Loehr has applied Deming’s 14 points, seven diseases, and four obstacles to teaching and learning. We continue this series begun in the May 1993 issue with four of Deming’s seven diseases.

Disease #5
Mobility of a classroom is a disease.
Management
Job-hopping managers never understand the organizations they work for and are never there long enough to follow through on long-term changes necessary for quality and productivity.

Instructional Applications
Mobility of teaching locations or subjects is a disease that thwarts productivity.

Constantly switching jobs or subjects doesn’t encourage following through on long-term changes necessary for quality or productivity.

Student Applications
Lack of follow-through is a disease.

Not completing projects is a major disease. When repeated, such behavior sets a pattern having a far-reaching, negative impact on quality and productivity.

Disease #6
Excessive medical costs are a disease.
Management
Loehr has no commentary here.
Instructional Applications
Excessive absences or health impairments impact teaching effectiveness.

continued on p. 6
The Academy

Medical School Takes Pulse With TQM

Jane Erwin

Several years ago, TQM began making its way into health-related businesses and institutions. Last year, the U. of Texas-Houston Medical School joined in. John Ribble, dean of the school, sounded the call.

"I spent a good deal of time learning about the quality movement and talking with others about their experiences with it," says Ribble. "I became convinced of its merits and its applications to the medical school."

Ribble established a quality council consisting of the school's vice dean, three department chairs, and the health science center's executive vice president for administration and finance. They were charged with recommending areas for pilot programs.

The council initially established steering committees for six clinical and administrative areas: • academic affairs, • administrative affairs, • research affairs, • mental sciences institute, • neurology clinic, and • the medical practice income plan.

Next, the medical school faculty and staff were introduced to the principles of continuous quality improvement (CQI) through day-long seminars. Abby Mitchell, former executive associate to the dean, was named assistant dean for quality improvement.

The following are our experiences in implementing CQI in two endeavors — the medical practice income plan and the faculty appointment process under academic affairs.

Medical Practice Income Plan

One area under examination is the medical services research and development plan, also known as the practice plan. The practice plan, which delivers clinical services, is funded by patient fees, generating over $100 million in gross charges annually.

"The situation, more and more, in the science centers, is increasing pressure due to our being squeezed financially from every side," explains L. Maximilian Buja, professor and chair of the department of pathology and laboratory medicine and co-chair of the CQI practice plan steering committee.

"With cuts in National Institutes of Health funding and national and state government cutbacks, more of the budget has to be derived from patient-care activities. There’s less room for the inefficiencies. ... It’s extremely critical not to lose clinically generated dollars, and that’s the main motivation to improve the business operations of our practice plan," he says.

Six teams studied various aspects of the plan including, for example, customer assessment. These teams met for approximately six months, gathering information through surveys, interviews, and focus group sessions with key customers, identifying their needs and expectations. All members reconvened for a day-long workshop and presented reports.

Since then, the teams have met weekly. Among the elements already being implemented are new claims tracking software, reorganization of accounts by insurance coverage instead of the amount of the account, and an automated process for dis-counting certain accounts receivable by financial class.

Faculty Appointment Process

For almost a year, the CQI team on faculty appointments studied the process of selecting new faculty. After identifying and evaluating customer requirements, the team recommended redesigning the process. Flowcharting the appointment process helped the team identify where a few minor changes could streamline the handling of paperwork.

Team members concluded that many of the difficulties and confusion surrounding the process could be resolved if:

• A formal training session and handbook were developed for all employees involved in faculty appointment.

• Departments performed a CQI review of the process in their area and took steps necessary to initiate improvements.

• More accountability was established at all levels of the process.

The team also recommended placing a personnel office in the medical school, requiring the submission of an appointment packet 30 days prior to the faculty member’s date of employment, and better communication to the new faculty member about licensure, international affairs, and human relations requirements. One of the outcomes of the team’s efforts was a checklist for assembling an appointment packet that’s currently being tested by several departments.

"The team used a very methodical process in approaching this," says Mitchell. "They were data-driven and worked well together."

For more information, contact: Jane Erwin, Office of Community Affairs, The U. of Texas Health Science Center at Houston, 6431 Fannin, Suite G004, P.O. Box 20708, Houston, TX 77225; Ph: 713/792-5070; Fax: 713/796-8570.

And the Winner Is ...

Belmont U. President William Trout recently accepted an award for quality achievement from Tennessee Gov. Ned McWherter. Belmont was one of 78 businesses and institutions receiving Tennessee Quality
into the concept and give it support and resources.

Next, the education and training process must prepare people to use TQM techniques and work as a team. If the training period can include time spent in helping the team understand their "real world" problems and doing planning, that will boost initial efforts.

Participants should be told what’s expected of them and what their team’s charter will be before they make a full commitment. Most important, the administration should practice quality on its own processes before asking the faculty to adopt the philosophy.

For more information, contact: Jean Lamkin, President, Park Institute, Ltd., P.O. Box 11094, Norfolk, VA 23517; Ph: 804/640-0415.

TQM in the Classroom

TQM Empowers Students
John Kachurick

As a TQM practitioner and business professor at College Misericordia (PA), I look for opportunities to incorporate TQM into the classroom.

Believing that colleges must meet or exceed customer expectations, I recently allowed my students to participate in the delivery of their education.

I explained to each of my classes that they weren’t the only customers of the education process, since business and industry, social agencies, and all levels of government, as well as society as a whole, are stakeholders in the same process.

With this thought in mind, the students and I — who was designated as “facilitator” — developed their course goals and objectives using brainstorming and affinity diagrams. After I taught them decision-making through consensus, I allowed each class to develop its own mechanisms for performance appraisal.

I also permitted each student to move 10% of his/her total grade among the various options of appraisal — tests, papers, projects, presentations. Each class also designated the type and style of test I’d administer.

After the first test in “Introductory Finance,” I realized I needed to know what was happening in this system.

Although I had “empowered” the “workers” (students), most of their grades were below expectations.

To analyze the teaching/learning system, I used a variables control chart to determine stability and control limits. I chose the chart because I needed to know how the system was operating and what it could produce. After that, I could look for ways to improve the system, test improvements, adapt those processes that worked, and discard those that didn’t — a PDCA cycle.

Using “SPCExpert,” a shareware program that generates control charts, Pareto diagrams, and other tools, I developed a control chart for test grades. Immediately, I saw that the system exhibited four “special cause” variations: one above the upper control limit (UCL) and three below the lower control limit (LCL).

The one score above the UCL indicated that one student did well on the test. I made a note to investigate that student’s method of studying.

For the three students who fell below the LCL, I looked for reasons — the assignable causes — for this. One student didn’t purchase the textbook or auxiliary aids, a second wasn’t in class over half the time, and the third student missed a large number of classes due to illness.

Since I was aware of how these special causes came about, I discarded them and plotted the control chart again. I had a stable system, but the mean score was 73. To improve the system, I looked for ways to understand the causes and raise the mean to 78, the average grade of the college scale.

I took the control chart into class, discussed the results, and asked for input. Using a cause-and-effect diagram, the students identified a number of potential causes for low performance, isolating one — the instructor covered the material too quickly. (While I believed that other-causes were influencing grades more than the “instructor” problem, I agreed to slow down my presentation.)

Since I attributed the poor performance to student laziness and lack of motivation, I was surprised when I found that the test scores did increase substantially. In fact, the mean score rose to 79.8. (This also represents the typical “jumping to conclusions” before examining the data since TQM requires data-driven problem solving.)

I discussed with the students whether it was the slower pace of instruction or some other reason that influenced the increase in test scores. They believed the slower pace was a major influence in improving performance, but some noted that after taking the first test, their anxiety level decreased, possibly influencing the outcome of the test.

It appears that the course attempted to cover too much material in too short of time. I intend to re-evaluate the “required” material before the course is offered again, with an eye toward reduction. It now doesn’t seem as important that I cover everything, as it is that the students understood and retained everything I covered.

For more information, contact: John Kachurick, Department of Business, College Misericordia, 301 Lake St., Dallas, PA 18612; Ph: 717/674-6301; Fax: 717/675-2441.

Deming in the Classroom
Peter Loehr

Ed. note: Loehr has applied Deming’s 14 points, seven diseases, and four obstacles to teaching and learning. We conclude this series begun in the May 1993 issue with Deming’s four obstacles.

Obstacle #1
Management
Neglect of long-range planning is an obstacle that thwarts productivity.

Instructional Applications
Neglecting long-range planning thwarts productivity.

One-year, ten-year, and lifetime goals require continual planning, monitoring, and adjusting.

Student Applications
Neglect of long-range planning thwarts productivity.

If you don’t know where you’re going, how will you get there? Actions should purposely lead to desired directions, including preparing for unforeseen possibilities.

Obstacle #2
Management
Relying on technology to solve problems thwarts productivity.

Instructional Applications
continued on p. 6
continued from p. 3

Productivity is thwarted when one relies on technology to solve problems.

Technology doesn’t solve problems; people solve problems. As we continually gain quality improvement knowledge, each of us becomes more capable of solving more of our own problems. Technology is useful as a tool, but not as the solution.

Student Applications
Relying on technology to solve problems thwarts productivity.

Think of technology as a toolbox for solving problems. Technology doesn’t solve problems; students using their emotional, physical, and mental abilities solve problems.

Obstacle #3
Management
Seeking examples to follow rather than developing solutions is an obstacle that thwarts productivity.

Instructional Applications
Following examples rather than developing solutions is an obstacle that thwarts productivity.

The teaching (content and process) problems that one faces are personal, job-site relevant, and unique. Seeking quick fixes will only frustrate long-term improvement.

Developing solutions to problems requires personal understanding and involvement. Simply following the others’ examples doesn’t increase employee understanding of the problem’s complexity or increase buy-in to the solution.

Student Applications
Depending on others to solve one’s problems thwarts learning.

Students must make personal, individual commitments to develop solutions for their own problems. Assistance from others is certainly necessary, but relying solely on others in lieu of solving one’s own problems doesn’t improve problem-solving skills.

Obstacle #4
Management
Excuses such as “our problems are different,” and “Deming’s principles aren’t relevant here,” thwarts productivity and organizational improvement.

For over 40 years, Deming’s principles have been the only proven, successful management principles in the multi-billion dollar international arena. They work.

Instructional Applications
Excuses such as “my problems are different,” when this implies that your problems aren’t solvable using Deming’s principles, thwarts improvement.

Your problems may be different, but that doesn’t mean solutions can’t be found. When others have solved their problems using Deming’s principles, you can too.

Student Applications
Excuses such as “my problems are different,” thwarts achievement when this implies that the problems aren’t solvable using Deming’s principles.

Nearly everyone is capable of learning almost everything. Solutions to most problems are possible. They take work, but so does anything worth achieving.

For more information, contact Peter Loehr, Department of Educational Administration and Supervision, College of Education, Western Illinois U., 99 Horrabin Hall, Macomb, IL 61455-1396; Ph: 309/298-1070.

The Academy

Internalizing External Requests
Burton Witthuhn

Numerous external influences seem to impose alien demands on the culture of an institution. As with any alien demand, these outside requests often generate reactions of resistance, defensive posturing, and even feelings of disbelief.

To be considered responsive, leaders must cause these external demands to be seen as part of the institution’s organizational culture. A strategy for influencing the introduction of outside demands follows.

First, articulate the external demands. Point by point these can be listed on one axis of a matrix. Next, develop a second list of institutional objectives or goals for changes well known to the members of the organization. This list of actions forms the secondary axis of the same matrix — also called the action matrix.

Having listed both external and internal objectives on the same matrix, it’s often possible to convert the alien agenda to one of internal control.

In a sense, the matrix acts as a mechanism to show that the external requests are simply a different way of listing internal objectives. Where discrepancies exist, it’s necessary to generate an internal objective to cover the external expectation. Converting an action strategy from an external to an internal direction is important to achieve a positive response.

The proposed paradigm for re-focusing external requests to an internal schedule works more often than not because every organization has individuals within it who have introduced similar ideas into the institutional culture that parallel the external ideas.

The real issue isn’t the list of ideas but who owns them. The conversion matrix hopefully will help you internalize the requests of outsiders and move forward without wasting time attempting to overcome the rejection of other demands.

Here’s an example of a matrix in use. The Board of Governors University System (BGU) has identified four priority goals for the five schools under its control. These goals become the horizontally listed components of the action strategy matrix.

- (a) Emphasize undergraduate education with a demonstrated concern for students.
- (b) Provide a quality education at an affordable price.
- (c) Provide access for a diverse faculty and student body through both traditional and flexible programming.
- (d) Serve as a community resource and service.

Five institutional Western Illinois U. (WIU) priorities making up the vertical components of the matrix urge:

- (A) Support for quality undergraduate and graduate education,
- (B) Support for laboratory, computer, and telecommunications technology,
- (C) Support for achievement of justice, equity, and diversity,
- (D) Support for maintenance and improvement of the physical plant,
- (E) Support for extended and con-
colleagues than I can handle. On the surface, that would appear to be good. But I'm sure there's cynicism.

One president (who's a friend) and I were talking about what we were doing — particularly in trying to improve general education. That's our core product.

He said that he would not go near that [TQM] with a 10-foot pole — the faculty would just beat the heck out of you. The good news is that, since he's been exposed to TQM, he's requested a sabbatical from his board to study it.

The culture in higher education, which has built up over centuries, is very resistant to the kind of leadership described in the Baldrige award.

Deming once told me that the trouble with higher education is the turnover rate in the top management. Lewis Mayhew, emeritus professor of education at Stanford U., said: "You show me an institution that has emerged as significant, and I'll show you a leader that was determined and stuck around long enough to change the culture."

The first thing the faculty will ask when a new president talks about improving quality is, "You're saying we're doing a bad job, therefore you don't love us, so we can't follow you." It may take a couple of years to get over this issue.

The second thing faculty say is that the president doesn't have the right to ask questions about quality teaching — "You can't ask if we are measuring or tracking student performance because you're an administrator." But we got over these issues.

If you're not ready to confront those issues, you're probably better off not starting on a TQM journey.

For more information, contact: Dean Hubbard, President, Northwest Missouri State U., Maryville, MO 64468; Ph: 816/562-1212.

Voice of the Customer

Always Room for Improvement

Ed. note: We received this letter in response to an article.

Jean Lamkin's article, "Reviewing Faculty Performance: A TQM Approach" (TQM:HE, December 1993), bothered me for two reasons: (a) the discussed evaluation system established "good enough" standards rather than a commitment to continuous improvement, and (b) it revealed an underlying bias that improved quality can be achieved by searching out defective people.

At the U. of Hawai'i, people were told they were either satisfactory or needed improvement. The essence of TQM, however, is the notion that no matter how good an individual may be, there's always room for improvement. The system discussed doesn't acknowledge this, and in fact, will generate behavior that settles for the minimum. It does nothing to promote continuous improvement among the vast majority of faculty who are already doing a "satisfactory" job.

The measure of "success" mentioned by Lamkin included the number of faculty who chose to retire prior to review and the number of "deficient" faculty discovered.

Clearly, the underlying assumption is that only the deadwood could be cleared out, the university could improve. This type of attitude will promote fear and sow distrust. Faculty will soon learn how to game ["fix"] the system in order to make themselves appear non-deficient.

I suggest a totally different approach to continuous improvement. Instead of looking for "bad apples," start providing faculty with the tools that can lead to continuous improvement.

There are many tools out there. I will share one that I've developed in my economics classroom over the past year. After every class, I ask the students the following:

1. Was the class worthwhile?
   Yes No Barely

2. Any comments or suggestions regarding this class?

3. Did you read the assignment and/or do any homework for this class?
   Yes No Partially

4. If "yes" or "partially," did you find the reading and/or homework worthwhile?
   Yes No Barely

5. Any questions you want me to answer?

6. How many hours of study/reading for this course did you put in since the last class?

The student feedback is anonymous, in order to reduce their fear of my retribution. By the same token, the feedback goes to me, not to the department chair or the academic dean.

If the feedback could be used in a negative fashion against me, I would be fearful of it and would undoubtedly game the system by either "forgetting" to hand out the forms, "misinstructing" students, or simply denying the results.

If faculty want to win more grants, they need similar continuous improvement tools that allow them to learn, not just from their own experience, but from others as well.

Deming stressed that "driving out fear" should be the first action of organizations adopting TQM. This applies to faculty as well as everyone else. Using evaluations as a continuous improvement tool is doomed if those evaluations increase fear, decrease trust, and are based on the misbegotten assumption that, "We could do a pretty good job around here if we simply got rid of the scrap."

For more information, contact: Ronald Turner, Economics Instructor, Eastern Maine Technical College, Bangor, ME 04401; Ph: 207/941-4600.

TQM in the Classroom

Exam Technique Promotes Competence, Not Competition

Jennifer Lind

Most medical students have spent 16 years trying to out-do their classmates. They find out later in life, however, that such competition overshadowed the main objective of learning, which is to be competent in their field of practice.

A hypertension course for medical students at the U. of Wisconsin-Madison offers an exam technique designed to promote learning and "eliminate the fear and anxiety" commonly associated with medical school.
Theodore Goodfriend, professor of the course, says the goal of his testing method is to “get students to absorb the information,” since the medical practice requires competence, not competition.

In general, he says, professors pay more attention to teaching the material, whereas “students are focusing on the exam.” In order to accommodate students’ preferences, Goodfriend’s course inverts the traditional scheme of syllabus, lecture, and exam.

The Students’ Choice

At the beginning of the course, Goodfriend hands out the questions — without the answers — to the multiple-choice exam, which covers the important points on hypertension. He says students have the choice to listen to his lectures merely for the answers or for additional points of interest. Either way he doesn’t mind, he adds, because his goal is to make sure they know the essential areas of hypertension.

His course also differs in that students can take the exam at any point in the semester. He encourages students to study together, but “trusts them not to tell each other the answers, since they are on the honor system.”

The results, he feels, are that “students are less stressed during the semester. They feel less pressure to absorb every detail.” Even with these techniques, however, Goodfriend says the grades still follow a traditional curve.

Ironically, at first students didn’t agree with Goodfriend’s style. “The students weren’t receptive to innovative teaching methods because they felt it detracted from learning for the exam,” he says.

Although students are now more comfortable with the course, some still feel they would learn more, and would be recognized as “A” students, in a traditional environment. Considering the amount of competition in the traditional classes, this isn’t surprising.

What Goodfriend finds as astoundingly, though, is that the students often don’t realize he’s doing this for their benefit. Although the grade curve hasn’t significantly changed, he says, “I could care less if all of my students got A’s. I just want them to be good doctors.”

The negative reaction among some of his students extends to his colleagues. “They feel stress was a stimulus for them when they were students,” he explains. He notes, however, that some faculty have incorporated the “exam-first technique,” while others incorporate cooperative learning techniques.

Goodfriend feels his emphasis on cooperative learning rather than competition may produce more interactive doctors in the end. And designing a program to include different teaching and learning techniques may take the pressure off in a field highly regarded for its intensity and rivalry.

For more information, contact: Theodore Goodfriend, M.D., Research Officer, Veterans Hospital, 2500 Overlook Terrace, Madison, WI 53705; Ph: 608/262-7007.

The Academy

University Business

Officers Reward Quality

Significantly improving the quality of its student services garnered the Université du Québec à Montréal (UQAM) the $10,000 first prize in the 1993 Canadian Association of University Business Officers (CAUBO) Quality and Productivity Awards Program.

UQAM’s award-winning submission was one of 72 received by the CAUBO. Over its six-year history, the projects have represented $27 million (CDN) in total savings.

UQAM established a way to computerize the grade consulting system for all of its 43,000 students, which permits the students to obtain their grades by telephone.

The $5,000 second prize went to the U. of Regina (Saskatchewan) for being the first Canadian university to implement TQM in its administrative practices. UR hopes to have all of its staff trained in TQM by December 1994.

Both Trent U. (Ontario) and Mount Allison U. (New Brunswick) received a $1,500 CAUBO award. Mount Allison U. won for replacing its full-service bookstore with a “bare-bones” textbook-only warehouse operation. Trent U. was recognized for its installation of 24 free, outdoor safety phones across campus that accommodate not only emergency calls, but also other services, such as access to student walk-home service, taxis, the Canadian Automobile Association, or entry into residence hall buildings.

Doing More Than the Job Requires

As part of his plan to make Syracuse U. more student-centered, Chancellor Kenneth Shaw introduced TQM in February 1992. Since then, more than 800 administrators and staff have attended TQM seminars in a continuing effort to immerse the campus community in its principles.

TQM, according to Shaw, “asks far more of us as employees than simply doing our jobs. In order to reap the benefits of the system, we must come together to study our customers’ needs, examine our present operations, cull unnecessary and time-consuming steps, and become willing to take risks as we try new methods.”

UCF’s TQM Journey — Month 13

Janice Dossey Terrell

Ed. note: We’re following the U. of Central Florida’s progress as it continues implementing TQM.

The growing interest in using quality teams for process improvement is causing a higher demand for trained team facilitators. To meet this need, our second round of training for quality team coaches began in mid-January. Fourteen additional UCF staff and faculty members will be ready to work with quality improvement teams following completion of their nine week training in March.

UCF’s first cross-functional quality planning team was formed in January. This team is using quality planning tools to plan and implement a new student identification, debit, and information access card system.

UCF’s director of business services is serving as the team leader. Team members represent computer services, library, campus bookstore, student government, finance and ac-
als have always set higher aspirations for themselves than companies do. This absolute wipes out the mindset that error is inevitable and teaches management that they must insist on getting things done right the first time.

The measurement of quality is the price of nonconformance (PONC). Graduate schools of business should incorporate this calculation in accounting and other classes. There's no reason case histories can't include hidden information that can be translated into PONC. After all, it's part of reality.

My personal experience with hundreds of organizations shows that 25% of revenues is a typical expense in PONC. There's no need to spend more than 2-3% (for education and monitoring). This absolute keeps management focused on quality: money is their prime measurement.

When M.B.A. students graduate, they need to understand the concepts that cause quality management to become routine. They need to have objectives to help them and their companies succeed. They need to be able to be useful.

If I were teaching M.B.A.s, I would teach three core objectives:
- Cause employees to be successful,
- Cause suppliers to be successful, and
- Cause customers to be successful.

For more information, contact: Philip Crosby, Career IV, Inc., P.O. Box 941990, Maidland, FL 32794-1990; Ph: 800/223-3932; Fax: 407/629-0858.

TQM in the Classroom

Characteristics of Faculty Who Use Quality in Classroom Instruction

Burk Peachy

Ed. note: The following was developed and adopted by the faculty at Richland College (TX).

The following are the characteristics of a faculty member who uses the quality philosophy in the classroom.

A quality faculty member promotes continuous improvement by:
- continually revising teaching methods and curriculum,
- engaging in self-development, demonstrating a willingness to be evaluated and to correct his/her own deficiencies,
- sharing successes and failures with colleagues,
- applying research-based instructional strategies, and
- leveraging resources.

A quality faculty member facilitates students' learning by:
- empowering students and encouraging them to become risk-takers,
- rewarding students and sharing their successes,
- maintaining a sense of enthusiasm for teaching and learning, and
- eliminating students' fears about learning and the learning environment.

A quality faculty member breaks down student-faculty barriers by:
- involving students in planning learning activities,
- using an appropriate mix of instructional methodologies including team learning approaches, and
- using student expertise when appropriate.

A quality faculty member ceases dependence on "mass inspection" by:
- employing a variety of evaluation strategies, including individualized evaluation,
- providing frequent feedback, and
- engaging students in self-evaluations of their learning.

A quality faculty member constantly monitors the learning process by:
- collecting, analyzing, and using data for improvement,
- using research strategies within the teaching-learning process and monitoring and adjusting to feedback,
- using diagnostic tools to discover students' learning strengths and weaknesses, and
- understanding the theory of statistical variation as it applies to classroom/learning processes.

Characteristics of a Student in a CQI Classroom

A student in a CQI classroom assumes responsibility for his/her own learning by:
- reading, taking notes, and doing homework,
- preparing for, attending, and participating in class activities,
- telling the teacher when he/she is confused about a topic,
- reflecting outside of class on assignments and tasks, and
- demonstrating a willingness to learn.

A student in a CQI classroom demonstrates an affinity for the class objectives by:
- doing more than the required assignments and actively displaying interest and appreciation for the subject matter,
- thinking, questioning, and being inquisitive,
- being diligent, involved, and demonstrating enthusiasm, and
- sharing information with others in the class.

A student in a CQI classroom is process-focused because he/she:
- gives honest feedback to the teacher/class on his/her learning, is willing to speak up when needs are not being met, and suggests changes to improve the class,
- acquires knowledge and learns how to use CQI process tools,
- collaborates with the instructor and others in the class, and serves as a positive, cooperative classroom team member,
- needs to know the lesson plan in advance of the class,
- is focused on self-improvement, not on grades, and is able to assess his/her own progress,
- after reaching a predefined level of skills, knowledge, and critical thinking — by the teacher — ceases being dependent upon the teacher for inspection of his/her work and develops the ability to self-evaluate,
- supports his/her peers and demonstrates sensitivity to experiences and outlooks of others.

A student in a CQI classroom demonstrates and understands the concepts of lifelong outcomes and self-evaluation by:
- being lucid and willing to accept

continued on p. 6
A Tight Definition of Customer

"Top broadly defining customers," says William Nowlin, associate dean at Rochester Institute of Technology College of Business, "Make tight definitions."

Nowlin offers his definitions of higher education's "customers" in Table 1. "I don't consider the customer grid perfect, but it reminds us of who is out there, what they need, and who our lost customers are."


UCF's TQM Journey — Month 14

Janice Dossey Terrell

Ed. note: We're following the U. of Central Florida's progress as it continues implementing TQM.

In late February, the staff in the office of quality management and UCF's director of personnel and training manager attended a one-day workshop, "TQM on Campus: Trends, Trials, and Results," sponsored by the National Quality Academy.

Although the workshop was designed for educators who are considering implementing TQM in their organizations, it was helpful for those of us who've already begun our journey and who are constantly looking for strategies to ease our quality transformation.

Stan Spanbauer, former president of Fox Valley Technical College (WI) and one of the early leaders in bringing quality to higher education, led the workshop.

Of particular interest to us was the professional development model that Spanbauer suggested to replace the more traditional approach to employee training. This model includes not only academic and technical training, but also TQM training, personal and family enrichment training, and an individualized professional development plan for all employees.

We also learned to:

- begin customer service training early in the implementation phase to involve more employees in the quality enhancement effort;
- complete a formal pre-assessment of the institution before beginning quality implementation to ensure institutional readiness for quality management, and
- train middle management — department chairs and unit directors — before beginning team improvement studies, to avoid "threatening the middle."

We also stumbled upon another great idea: when traveling to an off-campus workshop, take the participants together in a van; then, on the way home, you can brainstorm how to apply what you've learned. Our brainstorming after the workshop generated so many great ideas that we'll be busy the next few months just trying to plan and implement them.

During March, UCF hosted a presentation by Bernard Sergeskeret, vice president, Central Region, for AT&T. Sergeskeret recently co-authored Quality Is Personal: A Foundation for Total Quality Management (Free Press, 1993), along with Harry Roberts, the Sigmund Edelstone Professor of Statistics and Quality Management at the U. of Chicago's Graduate School of Business. For those of you who aren't familiar with the book, it's a real gem.

Sergeskeret's message to UCF's quality coaches and the administrative group centered around his philosophy that quality, as practiced by the individual, is the foundation upon which TQM is built. His personal quality checklist process can be used by anyone seeking to make quality a personal commitment.

Other areas of activity for us include coordinating "quality" planning with our institutional effectiveness efforts and becoming more involved in planning and writing institutional improvement grant proposals and in our university accreditation review. More about these activities next month.

For more information, contact: Janice Dossey Terrell, Director, Quality
American Association for Higher Education going to help educational institutions maintain a CQI thrust?

Brigham: Within the past year, we've put together a consortium of 22 institutions from around the country from two-year to four-year colleges. These institutions are at least a few years down the road in implementing TQM or CQI.

Their job is to look at the next stage and learn from each other the "best practices," mistakes, and obstacles they've encountered along the way.

We also have a resource clearinghouse which is putting together publications and other resources on Internet.

Comesky: Anyone have a word for their colleagues about implementing TQM?

Roberts: Although there have been frustrations in implementing the change to a quality culture, all of the employees benefit from it. As the manager of a unit said to me, "Previously, no one has given me the tools nor the understanding of how to manage people. However, TQM has afforded that to me."

I really do believe TQM works and I'm having a hard time trying to understand what the hesitations are. It puzzles me since it gives all of the employees the opportunity to have a say on what's going on.

Comesky: Do any of you see your institution applying for, and possibly winning, the Baldridge award?

Hubbard: Northwest Missouri State U. will be applying for Missouri's quality award this year. Linda's institution won the Arizona Quality Award. Both of these awards are based on the Baldridge Award criteria. Missouri's [award] doesn't even have any modifications. We've said that it's our intention to have the systems in place, but we don't expect to see the amount of trend data that's necessary to apply for the national award.

We don't believe that we have a chance of winning it [Baldridge] by 1996 since we wouldn't have the trend data nor the deployment information. But by 1998, who knows? My long-term goal is to have Northwest Missouri State U. apply for and win the Baldridge award.
Plan Together

Since the students already know their peers’ level of knowledge and expectations, they can contribute to the planning. I ask how their expectations can be met and sometimes use a “cause and effect” diagram as the planning tool.

If we’re to meet the Shakespeare expectation, what activities could occur to ensure that this will happen? What materials would be needed? Flowcharts, affinity diagrams, and force field analysis tools could all be helpful in deciding how to meet expectations.

Replace the Old

I constantly look at my old lecture notes to see where I can replace my lectures with a student panel, debate, role play, team reports, or data gathering. Rather than talk about the question of whether or not Shakespeare really was the author of the plays, I have students do research and use a quality tool to report their findings.

To determine which play is the most popular, they might find out how many times during the last year of the plays were performed and graph the results. Students could use a Pareto diagram to categorize the themes and graph the results.

Find Opportunities

For Team Work

Rather than just lecturing, I prefer to let the students debate each other. They’ll challenge each other’s position, learn from the dialogue, and be thoroughly engaged in the learning process.

Every time I assign a paper, we talk about quality benchmarks for that assignment. We develop the grading criteria based upon the established expectations. I make it clear that I expect all papers to meet the quality standard. After the students have turned in the assignments, they trade papers and critique each other’s ideas.

Although it’s not always easy, I try to reduce my lecturing to 25% of the time. I believe that lectures should cover material which hasn’t surfaced in the class discussions.

Because of this, the responsibility for learning shifts from me to them.

They’re far more engaged in the process and interested in the outcomes. And I continue to be amazed at how meaningful work becomes when students contribute and share rather than just show up, occupy a seat, and take notes.

Evaluate Continuously

With a Goal of Improvement

At least once in each class, I ask the students to evaluate my work, their work, and the class’s progress. When deciding how to grade performance, I work to build meaning into the assessment and make it relevant to the course objectives.

I ask the students to state the most important learning they gained or what I should review in our next meeting. I have each of them write a one sentence “memo” concerning a question they find confusing. I ask for a brief “liar letter” with a statement of what I did that worked and what needs to be changed. Periodically, I ask them to rate the class on a scale of 1-10, and then I graph the results.

I encourage students to keep a record of their self-assessment graphs. These data can include how they studied for class, how well they were prepared, how much effort they put into the session, and how well they believe their work contributed toward reaching expectations.

All of my assignments are aligned with the class goals and expectations as well as being meaningful. Far too many students memorize facts but really never learn anything.

Five years ago I stopped giving formal, objective tests. It’s much more valuable, in my experience, for students to be involved in rating the progress of their work than for me to tell them what I think.

They can fool me in so many ways. I never know how much effort someone has put into studying or how much information s/he will retain a week after the class has ended. However, when students evaluate their own work, there’s no way to deceive the evaluator.

I also try to assign projects which will build new skills. Rather than wait until the assignment is completed, I get involved up front as a “coach” to ensure that the final
product will be a quality result.

The old lectures are the backbone of my new, quality course. I add pre-assessment, student responsibility, and self-evaluation to the traditional program. More importantly, I’ve taken myself out of the center of the course and placed the focus on the students. What they learn in the class depends more on their performance, than on mine.

For more information, contact: Jean Lamkin, President, Park Institute, Ltd., P.O. Box 11094, Norfolk, VA 23517; Ph: 804/640-0415.

The Academy

UCF’s TQM Journey — Month 15

Janice Dossey Terrell

Ed. note: We’re following the U. of Central Florida’s progress as it continues implementing TQM.

The office of quality management has been fortunate in attracting very capable student interns to support our TQM efforts. This semester, Melissa Smith, working with Professor of Education and UCF quality coach Robert Lange, has developed a survey to assist us in analyzing how effective our quality improvement orientation and training efforts have been during the past 18 months.

We plan on sending the survey to all those who attended our initial quality planning retreat, those who’ve completed any of our training programs for senior administrative staff or team coaching, all active team leaders and team members, and faculty and staff who’ve attended our quality management workshops.

Some questions included in the 20-item survey are: “Do you think quality management concepts can be adapted for use in higher education?” “Has UCF benefited as a result of the implementation of quality management strategies?” “Was the quality management training you received sufficient enough to support your use of quality strategies in your work environment?” and “What quality management tools have you found most useful in your work environment?”

We will share the survey results in a later edition of TQM/HE.

Listening To the Voice of the Customer

Thanks to the support of UCF’s Southern Association of Colleges and Schools accreditation review preparation team, we were able to attach an optional response questionnaire to the self-study survey, which was sent to a large sample of UCF faculty and staff in March. To date, we’ve received 82 in-depth responses to the following items:

- Please describe any activities, programs, or procedures at other institutions that could enhance what we do at UCF if they were implemented here. Include the name of the institution.
- In order of priority, please indicate what the university could do that would help you accomplish your job and enhance the results of your efforts.

The information we’re gathering is currently being reviewed to identify benchmarking opportunities and quality enhancement ideas. We’re also busy developing a survey instrument to measure student satisfaction with UCF’s academic offerings, instruction, institutional facilities, and services.

We hope to administer the survey during the 1994 fall semester. These surveys will supply us with baseline data against which we may measure our quality transformation progress in two to three years.

For more information, contact: Janice Dossey Terrell, Director Quality Management Initiatives, U. of Central Florida, Orlando, FL 32816-0020; Ph: 407/823-6165; Fax: 407/823-5533; Bitnet: JTerrell@UCF1VM.ac.ucf.edu.

Innovators

Mountain Empire Community College: Pursuing Profound Change

Sharon Fisher

The question was rhetorical: “How can we provide TQM training to local businesses if we don’t practice it ourselves?”

Several Mountain Empire Community College (VA) faculty and staff asked this question of MECC’s new president, Robert Sandel. It came as part of a position paper asking that he support a systemic approach to the college’s efforts to learn and apply TQM principles and techniques. That was in 1992, in the first months of his administration.

Although MECC was his first college presidency, Sandel had previous experience with business and community college partnerships in South Carolina. He was familiar with that state’s TQM training and responsive to the idea of adapting the concept to an educational institution.

MECC’s TQM implementation strategy is to customize a generic model to the college’s existing structure and environment. Key aspects of this model include: training top management to ensure commitment and support and using a systemic approach to cause fundamental, profound change and collegewide alignment — one that’s not simply limited to problem-solving applications.

During the past two years, MECC has moved forward in its TQM efforts. All employees participated in an initial activity — a one-day orientation to TQM principles. Responses ranging from “may have possibilities” to “the best thing I’ve heard in a long time,” demonstrated that this was a positive step in the right direction.

Raising Expectations

However, providing this “right-to-know” activity in the beginning has had a down side — it raised expectations too quickly. When we’re used to quick fixes, it can be difficult to grasp the slower process of acquiring and applying TQM skills in lieu of former management styles.

The first step in implementing TQM required Sandel and his immediate staff — two deans and a director — to work through a 10-step plan. The plan began with the college’s mission statement and ended with the management of a continuous improvement pilot project.

Sandel and his staff clearly stated the college’s mission, vision, and values and identified the major processes. Their effort built a foundation from which each unit identifies its specific mission and processes that support the college’s overall mission.
encouraging students to stand up for themselves — and the standards the floor has developed.

"Initially," Piper says, "students won't confront each other — their identities are too caught up in acceptance. It takes awhile for students to recognize that they're being denied something they want — like sleep or quiet — because of someone else.

"But once they reach that level, then it becomes very easy for students to sit down and talk to each other, because by then they have a vested interest in how things turn out."

Experience Breeds Insight

Now that the program is established, Piper says residential life officials have a better idea of what problems to expect during the year and when to anticipate them. That makes it easier to prepare students and gives residential life staff a chance to make modifications to the model.

Piper admits the Floor Standards program isn't solely responsible for the improvements in UNLV residential life over the last three years. But he says it has played a major role — and will continue to do so.

"What we're trying to do is teach students that solving problems is not much harder than having honest dialogue with each other if you respect each other," Piper says. "Some people have accused us of being rather idealistic. But if we can teach students that they can get their needs met without using the power system, in the long term we'll be better off."

For more information, contact:

Initial Results

I first offered the course during the summer of 1991. The first phase, comprising 5% of the course, was an overview of modern quality philosophies that combined lecture and discussion with no graded assignments.

The second segment reviewed the seven quality control tools within the context of a single case study — a contrived synthesis of previous experience from work, consulting, and research.

The object was to cover the tools within the context of sequential knowledge-building, with the goal being the development of a short-term process improvement recommendation for the case company. This segment, which comprised 45% of the grade, finished with an interim written and oral report for each group.

The development of a long-term improvement plan for the same company — using the seven management and planning tools — constituted the third segment. This brought the focus from reactive to proactive improvement.

The case study's details ended with the second segment. The student

TQM in higher education

Experimental Course Satisfies Students

D. L. Kimbler

In 1990, after returning from the Second National Symposium on TQM

Editor: Robert Comely, S.C.D.
Total Quality Management Consultants
Specializing in Educational Institutions,
493 Oakland Park Blvd., Port Orange,
FL 32127 Ph: 800/598-6862
FAX: 904/776-6755

Advisory Board:
Larry Byrnes, Director, Center for Teaching & Learning, U. of Southern Colorado (CO)
Ellen Earle Chadie, President, Valley City State U. (ND)
Philip Crosby, Chairman, Career IV (FL)
Mary Ann Haven, Director of Institutional Research, Delaware County Community College (PA)
John Hill, President, U. of Central Florida (FL)
Albert Koller, Jr., Dean of Institutional Advancement & Director of International Education,
Brevard Community College (FL)
Robert Milam, Dean, College of Business, U. of Wisconsin-Oshkosh (WI)
Rose Oppenheim, Associate Dean, Rutgers U. (NJ)
Betty Roberts, Director, U. of Missouri Business Services (MO)
Burton Wittbank, Provost and Vice President for Academic Affairs, Western Illinois U. (IL)

Publisher: Dore Green
Associate Editors: Mary Lou Santowec
Graphic Artist: Jim Condon
Marketing Manager: Ma Melvin
Customer Communications Manager: Mary Burnell

President: William Haight


Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by TQM in Higher Education for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that $1.00 per page is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923; Ph: 978/750-8400. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged.
teams were required to read between the lines of the case and consult the instructor for additional information. While the first segment was primarily lecture, the second and third heavily emphasized team work, with brief lectures at the beginning of each period.

The third segment ended with a brief review of quality function deployment, a final report, presentations, and the final exam. Students turned in the final report for my critique, which I returned with comments for improvement. I assigned grades based on the improved final submission.

All work — except the final exam — was team-based, and most of it was done during class. Each team submitted a brief report for every exercise as well as a peer evaluation.

A Balancing Effect

My initial intention was to use continuing peer evaluations to correct for team imbalances. However, I found that the evaluations had little variation. At the time, I suspected that the proximity of peer evaluation to assignment forced a balancing of effort on the teams.

One surprisingly common comment was a request for more individually graded assignments. Apparently, the team concept was too new within the culture of achieving good grades to be competitive when job or graduate school hunting.

Student course evaluations were highly enthusiastic, and I still find former students who cite the course as one of the most useful of their undergraduate programs. Since the initial offering was a success, I submitted a formal course proposal based on this syllabus, which was then approved.

I changed little in subsequent offerings, although I added — with some misgivings — a mid-term exam, and decreased the frequency of peer evaluations. Otherwise, the course kept the same structure and content. It became one of the most popular senior electives in industrial engineering, and attracted students from other programs.

While the initial class had restricted enrollment and required a prior course in statistical process control, the prerequisite was changed to senior standing and class size was increased to 30. None of these changes, either by observation or in student evaluations, appeared to have any negative effect.

Using the University As A Case Study

The current offering, which I modified somewhat, was first offered this spring. I found it difficult to cover both sets of seven tools without excluding other important topics, such as benchmarking and ISO 9000. Since quality function deployment was moved to the sophomore design course, an opportunity arose to revise and improve the course.

The first and second segments remain the same. The third segment now uses Peter Scholtes’s The Team Handbook and has a different focus. Rather than continuing the case study, the students spend this segment working on real problems within the university.

Each student team has a project, which they pre-arrange with me. I expect that the approaches taken in the projects to vary substantially, so I make no attempt to teach a common set of tools in this segment. Instead, I devote the brief lecture period to a discussion of readings on ISO 9000, benchmarking, Shiba’s WV problem-solving model (from The New American TQM) and Hoshin planning. These topics are supported by locally-produced lecture notes.

There are now no written examinations. The final examination is oral — one student at a time.

Typical student projects focus on college computer operations, which seem to have chronic customer satisfaction problems on all campuses, and the physical plant — which always has a broad variety of processes to improve and never enough budget to get it all done. The receptiveness of these and other campus organizations has been excellent.

The student teams used almost half of the semester to work on these projects. Since their approaches were quite different, all team reports were duplicated and distributed to the entire class. The teams also presented oral reports, and the final report continued to be critiqued without a grade before the final revision.

Another aspect of this semester’s experiment was the participation of several technical and administrative staff members. The college is embarking on implementing TQM, and some of the staff involved have enrolled as students in the course. Other staff will be trained through a course offered by a local engineering company. The comparison of these approaches will be interesting.

Feedback and Results

Overall, this course has been highly successful, both in student response during the course and in alumni feedback. The grading scheme still requires work. I find that the compromise between team focus and individual interest is difficult to resolve before the overall culture has changed. The mixture of lecture and learn-by-doing seems to be highly effective, and certainly keeps the students enthusiastic.

The critical factors with the revamped course will be an evaluation of the oral final exam, staff involvement, and campus projects. As the course has matured, however, it’s become a solid base for experimentation without jeopardizing the educational content. In the spirit of TQM, our aim is to continuously improve it and transfer our learning to other courses.

For more information, contact D.L. Kimble, Department of Industrial Engineering, Clemson U., Clemson, SC 29634; Ph: 803/656-5645; Fax: 803/656-0795. To order The Team Handbook, contact: Joiner and Associates, 3800 Regent St., R.O. Box 5445, Madison, WI 53705-0445; Ph: 608/669-8326, Fax: 608/238-2908. Cost: $39 plus $3.50 s/h. To order The New American TQM, contact: Productivity Press, R.O. Box 13390, Portland, OR 97213-0390; Ph: 800/394-6868. Cost: $49.95.

The Academy

The Seven Habits of Fundraising

Most of us are so caught up in the crises and deadlines of the moment that we can’t see the forest for the trees. This means we’re not focusing on what’s really important to the long-term purpose of our
toward the improvement and refinement of that process, and it's been sensitive to new developments in the field. Benchmarking represents an enhanced approach toward institutional effectiveness.

Benchmarking is an ongoing, systematic process for measuring and comparing the work processes of one organization to those of another for the purpose of identifying best practices that can then lead to improvements in operations and customer service.

To benchmark is to ask:

- How well are we doing compared to others?
- How good do we want to be?
- Who is doing the best?
- How could we adapt what they do to our institution?
- What do we need to do to be better than the best a few years from now?

Benchmarking provides direction and clear targets in a time of cost pressures and market uncertainty. In addition, benchmarking provides objective measurements for baseline, goal-setting, and improvement tracking.

Consequently, institutional effectiveness and benchmarking can be perceived as compatible and mutually supportive.

Understanding the Need for Continuous Improvement

Our quest for quality assurance in higher education doesn't end with institutional effectiveness and benchmarking. In the very near future, I'd predict that additional models and strategies will be developed, and that the academy will realize the need for even more sophisticated approaches to quality assurance. After all, what's important isn't necessarily what approach is used, or how close a particular strategy comes to perceived perfection, but that we understand the need for continuous improvement.

Our National Policy Board is engaged in this very discussion. The board, a coalition of nine regional accrediting boards and seven higher education associations, is attempting to define and focus on quality in higher education — what it is and how an institution will know whether its programs and services are of comparable quality to, or better than, other institutions.

The board's initial proposals create a ladder for institutional improvement and quality. Some institutions, especially those striving for recognition through the attainment of institutional excellence, will find benchmarking to be an especially valuable enhancement tool.

Like the implementation of an effectiveness system of planning, evaluation, and research, benchmarking pushes institutions to engage in continuous improvement — to seek new and better ways of doing things. Benchmarking is one additional tool that institutions can use in showing the public that they can sustain and enhance quality and productivity even in the face of acute financial problems.

Specific benchmarking examples for improved effectiveness include:

1. Business office and admissions office — NACUBO list.
2. Recruitment — cost.
3. Retention — check with institutions with highest percentage.
4. Compare scores on nationally normed tests and review curriculum to determine similarities to your own.

5. Remedial programs — who's performance is best?

All change, however initiated, requires strong leadership. An institution must have active leadership to allow questions to be asked; to support new ideas; to implement change; and to support an ongoing, continuous method for institutional self-examination and improvement.

For more information, contact: James T. Rogers, Executive Director, Southern Association of Colleges and Schools, 1866 Southern Lane, Decatur, GA 30033; Ph: 800/248-7701.

TQM in higher education

Feedback From Everyone, All At Once!
Jean Lamkin

Ed. note: Jean Lamkin, president of Park Institute, Ltd., consults with schools, colleges, and public sector organizations on quality issues.

The ability to gather immediate feedback is critical to the process of continuous improvement. Instantaneous responses allow professors to
make mid-class corrections in their lectures. As class size increases, the professor's ability to check for understanding and learning of individual students decreases proportionately. Imagine trying to collect feedback from 240 physics students simultaneously.

It can be done. In this particular physics class, the professor starts each day by lecturing for about 10 minutes. Then he asks a set of questions that he describes as a concept test. Students record their answers on palm top computers distributed throughout the lecture hall. Once the computer records the individual answers, the professor directs the students to talk with the other three students on their team about the question.

As these discussions occur, the professor participates by listening to their misconceptions as well as their correct answers. As he roams around the room, he learns how the class members are perceiving the material. After a few minutes, students are asked to record a second answer to the question. They're free to change the response they gave earlier. Then the professor often asks them to express their level of confidence in the rightness of their answer.

Matching the Lecture to Knowledge Level

After the computer records all of the responses and creates a histogram on his monitor, the professor explains the subject at a level appropriate to the class comprehension. If the class has done well on the concept quiz, he passes along to the next topic quickly. When their responses indicate confusion or misunderstanding, he takes time to slow down and lecture thoroughly. By involving all of the students in learning teams and matching the lecture to the class's level of knowledge, the professor is meeting the customers' needs minute by minute.

How does he do it? The professor's first step was introducing a model of interactive teaching several years before the computers were available. He increased student in-class participation and began listening more to what he heard.

Step two was the creation of a new software and computer network system to record student responses and provide feedback. When the students answer questions, the professor's monitor depicts each seat in the room with a color code. It shows immediately how everyone answered — green for right and red for wrong.

By noticing the color groupings, he can also learn if students in a particular section of the room are having difficulty. Then he can direct his roaming among the 240 students toward that section to determine the cause of the confusion.

After the peer discussion, the new responses are recorded, and the professor observes how many of the seats are now green instead of red and how the answer histograms have changed. Based on that feedback, he adjusts the lecture accordingly.

There's more — self-appraisal. The classroom monitor displays a color histogram with the number of responses to each possible answer and an indicator of the correct one. Class members can assess for themselves whether or not their answer was right and how their performance compared to others.

If this sounds like a scenario for the future, then the future is now. The physics students are taught by Eric Mazur of Harvard U.

This interactive classroom communication system is also being beta-tested at Carnegie-Mellon U. (PA), the U. of Massachusetts, Ohio State U., Christopher Newport U. (VA), Glenbrook High School (IL), and Mercer Island High School (WA). The project is in its infancy, but its potential for quality instruction appears to be tremendous.

The professor and students use Classstalk, an electronic communication system product from Better Education, Inc., in Yorktown, VA. It's designed as a contemporary model of the Socratic method for the lecture hall. Classstalk is a marriage of high technology and an ancient instructional technique.

Interactivity and feedback work. Just ask Professor Mazur and his physics students. They wouldn't be without it.

For more information, contact: Jean Lamkin, President, Park Institute, Ltd., P.O. Box 11094, Norfolk, VA 23517; Ph: 804/640-0415; Eric Mazur, Professor of Physics and Applied Sciences, Pierce Hall 225, Harvard U., Cambridge, MA 02138; Ph: 617/495-8729, Better Education, Inc., 4822 George Washington Memorial Hwy., Suite 205, Yorktown, VA 23692; Ph: 804/898-4846.

High-Tech at Virginia Tech
Aaron R. Conklin

In the days of the old brick schoolhouse, getting help with homework used to mean staying late after class for an extra session with the teacher.

But when a student needs help with an assignment at Virginia Polytechnical and State U., he or she may not even need to leave the couch — here, all it takes is a tap of the remote control.

That's because every residence hall room at Virginia Tech has access to a neat little piece of video technology called the "Help" Channel. Located at channel 9 on the university's cable system, the Help Channel features instructors giving tutorial sessions and answering questions about material covered in the classroom.

It's simple: all the student needs to provide is a television.

According to Edward Spencer, director of Virginia Tech's residential and dining programs, walking through the residence hall is the best proof that the Help Channel is reaching at least some of its target audience.

"It's very common to see students gathered around the TV," explains Spencer, who notes that the university's 4300 freshmen are the channel's biggest users. "It's a great place for them to get tips on homework, and many of them videotape the sessions for later use."

The Big Picture

At Tech, the Help Channel is only one part of a much bigger technological campus picture. In 1988, the university launched a $15 million technological make-over of its residence halls, installing an IBM Rolo phone (with modem), voice mail, and Internet access in each room. Also included as part of the deal was complete cable television access.

The cost to each student for this high-tech package? About $230 per year, included in the standard room fee.

Cable access on campus allows Virginia Tech to essentially operate as its own cable company: currently, the
continued from p. 3

University utilizes 35 of its 60 available channels, offering everything from the major networks to instructional channels to a student-run channel to CNN and MTV — and, of course, the Help Channel.

During the Help Channel’s first five years of operation, Spencer says, “It’s been instructors from the sciences — math, chemistry, and engineering fundamentals, for example — that have made the greatest use of this video outlet. The fact that faculty in other disciplines aren’t using it nearly as much may help explain why Spencer, while still characterizing the Help Channel as a success, also describes it as “underutilized.”

“A small percentage of students and professors have been really delighted with the way this has worked out,” he says. “But the majority are not using it.”

Improvements in the works for Tech’s 25 spare cable channels might help get the word out and change that. Possible upgrades include the addition of more informational channels and broadcasting actual classroom lectures over the video network.

Still, caution will be the key word: “We’ve been hesitant about creating a total ‘sit in your room, never leave your room’ educational model,” notes Spencer. “We’re really trying to avoid that.”

For more information, contact: Edward Spencer, Director of Residential Services, Virginia Polytechnic and State U., Blacksburg, VA 24061-0428; Ph: 703/231-6204; espencer@vt.vmi.cc.vt.edu

The Academy

UCF’s TQM Journey — Month 18
Janice Dossey Terrell

Ed. note: We’re following the U. of Central Florida’s progress as it continues implementing TQM.

This will be the last of the monthly series. However, we will check on UCF’s progress every three months for the next year.

Two more of the original five UCF quality improvement pilot teams made presentations to the quality council in June. The administrative and professional hiring process team recommended streamlining the existing hiring process, shortening cycle time, and providing clearer instructions and additional explanations of the process to hiring officials and position candidates. This team will continue to pursue additional improvement opportunities suggested by the quality council, and will distribute a follow-up survey to process customers during Fall 1994.

Our student accounts team, which investigated the student refund process, identified a potential savings of $16,800, which could be achieved from process improvements and substantially decreased cycle time.

UCF has already implemented many of the student account team’s recommendations, such as its suggestion that the computer center create software for a new refund system. It’s also encouraged options for streamlining the process of electronic information transfer with students and local banks.

The campus was selected to participate in “Campus Leadership and American Pluralism,” hosted by the American Commitments Initiative of the Association of American Colleges and Universities and supported by the Ford Foundation.

UCF’s proposal was based upon its use of quality management principles and methodology in creating a work plan for advancing diversity on campus during the next year. The provost, directors of multicultural affairs and quality management, and the associate dean of arts and sciences will attend the institute and work with an assigned consultant to create our diversity advancement plan.

Plans for advancing quality management in the upcoming months include three-three day training sessions for our administrative department directors and academic department chairs, and the following monthly workshops:

- conducting effective meetings,
- dealing with change,
- quality improvement tools,
- developing personal quality,
- quality management overview,
- team building,
- quality planning tools, and
- communication in the workplace.

Quality management facilitators will also help our personnel training staff conduct both the Connections® and Partners® programs for staff and student employees. These Noel-Levitz programs focus on delivering quality customer service. We’re also working with several administrative and academic departments to clarify mission, vision, and strategic plans for quality improvement.

Thanks to all the TQM/HE readers who stopped by our poster display at the recent AASHE Quality and Assessment conference. We really enjoyed sharing our ideas about quality reward and recognition initiatives.

For more information, contact: Janice Dossey Terrell, Director, Quality Management Initiatives, U. of Central Florida, Orlando, FL 32816-0020; Ph: 407/823-6165; Fax: 407/823-5533; Bitnet: JTerrell@UCFIMX.cc.ucf.edu.

CQI in Mexico

Daniel Meade

To achieve excellence in education, the Monterrey Institute of Technology has developed a continuous quality improvement program based on advanced qualitative methods. This process-oriented program has created a significant impact on the institution in a relatively short time span.

Using the mission statement as the basis for a policy deployment plan, quality multifunctional improvement teams operate at all levels of the organizational structure. The seven management tools are used as the graphical means to coordinate the process.

The program is being applied simultaneously to the academic, administrative, and service areas of the organization, under the active leadership of 128 department directors who were previously trained as CQI facilitators. A substantial number of case studies and several success stories are being used as instruments for further deployment on the campus.

For more information, contact: Daniel Meade, IITESM, Centro de Calidad, Sucursal de Correos J.
Essentialism: Common Sense Quality Improvement

Desna Wallin, president of Clinton Community College (IA) and Jon Ryan, director of the small business development center at Eastern Iowa Community College maintain that the search for quality has become too cumbersome, too expensive, too time-consuming, and too complex for most colleges to implement successfully. What they advocate is a practical, bare-bones, do-able approach to quality improvement, which they call essentialism.

In a session at the American Association of Community Colleges' conference, they presented two guiding principles of essentialism. The first is Deming's constancy of purpose, which Wallin and Ryan suggest is synonymous with a well-thought-out mission statement, and which the activities of the organization must support.

The second guiding principle is that of customer satisfaction. Wallin and Ryan maintain that whether the customers are students, clients, business and industry, governing boards, government agencies, or taxpayers, the principle of meeting and exceeding the needs and expectations of customers is critical to success and continued viability.

These two guiding principles are supported by essentialism's three basic elements. The first, accepting regulatory mandates suggests that institutions define those activities that they are required to perform — by accrediting agencies or legislation — as narrow and specifically as possible, and then refine systems to accomplish those requirements efficiently and effectively.

Attending to the needs of current customers — the second basic element of essentialism — advocates knowing who your current customers are, their real and perceived needs, and then suggests ways to assure that those needs and expectations are not only met, but exceeded.

Finally, essentialism involves anticipating the needs of future customers. Only through systematic environmental scanning and proactive planning can leaders begin to know and plan for the needs of future customers — the life-blood of any organization.

The speakers supported their theory with specific examples using both traditional TQM tools and ones they label as new — such as stairstepping, wallpapering, and the repetitive "why." Wallin and Ryan conclude that every college must keep quality and continuous improvement as the highest organizational imperative. They also believe that few institutions have the human and fiscal resources to implement a full-blown industrial model TQM program.

Essentialism is a practical, common sense approach to implementing meaningful quality improvement. With emphasis on the few critical elements of TQM — the essentials — this simplified approach can be effectively used by any quality-conscious organization.

For more information, contact: Desna Wallin, President, Clinton Community College, 1000 Lincoln Blvd., Clinton, IA 52732; Ph: 319/242-6841; Fax: 319/242-7868.

---

TQM in the Classroom

TQM's Interrelationships

Mark Aamot

After becoming intrigued with the principles of TQM, I came across David Langford's work and his efforts in applying the concepts of TQM in the classroom. I decided to implement his ideas in an upper division music education class, in part to better understand the problems TQM might have in both the classroom and the overall educational system.

I decided in the spring of 1993 to present the basic concepts and history of TQM to a small class of music education majors. After some discussion, they were willing to try this new pedagogy. Through my readings of Deming and Langford, I had decided on six principles that would operate in my class.

Total Quality Learning Principles
- The student defines quality in this class.
- Any evaluation or testing decreases efficiency.
- You cannot teach anyone to learn. (Students will only learn when they want to, the motivation must be internal.)
- No learning can take place with coercion. (Tests put fear into the students.)
- 85% of the problems are with the system, not the student.
- Every student wants to do the best he/she can, but the system won't allow it.

Having set aside the traditional course outline and syllabus, I invited a veteran secondary teacher, a third-

---

September 1994 Vol. 3, No. 9

In this Issue...
- TQM Abroad
  Students Act As Free Consultants, p. 5
  Quality Assurance and Institutional Evaluation, p. 5
- The Academy
  Throwing Out the Old Paradigms, p. 6
  Ten Reasons Why TQM Doesn't Always Work, p. 6
- Future Trends
  Defining and Measuring Quality, p. 7
year teacher, and a current student teacher to join my class and me for our first meeting to plan the competencies for the course.

The students and I then spent the next six class periods defining and assigning our semester’s work. Our first task was to develop a mission statement. Through discussion, writing, and rewriting, we worked toward a consensus as to what we wanted to learn from this class.

While no ideas were ignored, we felt we needed a focused and rather specific statement. The following mission statement was the result — To identify and explore skills and concepts that will help us to be “impact” teachers.

Our next task was to create an affinity diagram. After phrasing the question — “What are all the issues involved in managing a secondary choral music education program?” — for brainstorming, the class was given Post-it™ notes and asked to write as many responses to the question as they could think of. In working with an affinity diagram, it’s important that a very clear question be phrased and that the replies are short and precise.

After brainstorming, we randomly placed individual notes on a large sheet of paper. Without talking, everyone began reading and moving the notes into vertical columns of similar ideas, moving some of them multiple times. This procedure allows themes to emerge from the wide variety of ideas.

Finally, the group identified those themes — planning the music competencies, choosing literature, grading, planning and presenting concerts — and placed each of them as a header on top of their respective columns. (See Figure 1.)

Once the categories became clear, we ran a gap chart and an interrelationship diagram, whose combined scores prioritized the main topics of our course. This process took about six one-hour meetings.

I was frustrated because it seemed that we weren’t “learning any content.” What I came to realize, however, was that the students were doing very important work. They were identifying what they needed and wanted to know in this course, and were planning how to learn.

---

**Figure 1: An Affinity Diagram**

<table>
<thead>
<tr>
<th>Management</th>
<th>Internal Relations</th>
<th>Grading</th>
<th>Planning Music Curriculum</th>
<th>Choosing Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budgeting</td>
<td>Working with guidance</td>
<td></td>
<td>Types of classes</td>
<td>Good quality</td>
</tr>
<tr>
<td>Fund raising</td>
<td>Working with faculty</td>
<td></td>
<td>Program goals</td>
<td>How difficult</td>
</tr>
<tr>
<td>Fighting for funding</td>
<td>Custodians</td>
<td></td>
<td>Class objectives</td>
<td>Literature</td>
</tr>
<tr>
<td>What to order</td>
<td>Professional development</td>
<td></td>
<td>Sequencing of experiences</td>
<td>Sacred/Secular</td>
</tr>
<tr>
<td>Where to order</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Budget justification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choral Skills</td>
<td></td>
<td></td>
<td>Planning and Presenting Concerts</td>
<td></td>
</tr>
<tr>
<td>Seating the choir</td>
<td></td>
<td></td>
<td>How many concerts</td>
<td></td>
</tr>
<tr>
<td>Auditioning</td>
<td></td>
<td></td>
<td>Logistics of a concert</td>
<td></td>
</tr>
<tr>
<td>Blending</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching aesthetically</td>
<td></td>
<td></td>
<td>Outside concerts</td>
<td></td>
</tr>
</tbody>
</table>

---

**TQM in higher education**

Editor: Robert Comersey, Sr. D., Total Quality Management Consultants, Specializing in Educational Institutions, 489 Oakland Park Blvd., Port Orange, FL 32127 Ph: 800-389-8682 FAX: 904/756-9795

Advisory Board:

Larry Byrnes, Director, Center for Teaching & Learning, U. of Southern Colorado (CO)
Ellen Easte Chaffee, President, Valley City State U. (ND)
Philip Crosby, Chairman, Career IV (FL)
Mary Ann Haverly, Director of Institutional Research, Delaware County Community College (PA)
John Hilt, President, U. of Central Florida (FL)
Albert Koller, Jr., Dean of Institutional Advancement & Director of International Education, Brevard Community College (FL)
Robert Milan, Dean, College of Business, U. of Wisconsin-Oshkosh (WI)
Rose Oppenheim, Associate Dean, Rutgers U. (NJ)
Betty Roberts, Director, U. of Missouri Business Services (MO)
Burton Wittnauer, Provost and Vice President for Academic Affairs, Western Illinois U. (IL)

Publisher: Dori Green

Associate Editor: Mary Lou Sartowac

Graphic Artist: Jim Congdon

Marketing Director: Lisa Collins

Customer Communications Manager: Mary Burrell

President: William Haight


Authorization to reproduce items for internal or personal use, or the internal or personal use of specific clients, is granted by TQM in Higher Education for users associated with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that $1.10 per page is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923, Ph: 508/750-8400. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged.
look at funding alternatives.

The Theodore Cooper Surgical Research Institute, a division of the surgery department at St. Louis U. Health Sciences Center is no exception. Founded in 1951, research in the Institute was historically funded by clinical revenue — dollars generated from the delivery of patient care.

Recently, significant cuts in Medicare reimbursement, increased competition from private hospitals for patients, increased competition for insurance company and HMO contracts, along with impending health care reform have led to a significant reduction in the availability of these types of funds for research and development. In an effort to become more competitive for the dwindling supply of extramural research dollars, the Institute began a TQM program in 1990.

A Cutting-Edge Philosophy

We chose TQM because it seemed illogical for an institution performing cutting-edge research to be burdened with a management system that employed archaic, outdated, and disapproved management techniques.

We first established a scientific advisory board and chose a scientific director and associate director to bring the management structure to a level appropriate to the breadth and intensity of the department research activities.

As a basis for implementing TQM throughout the Institute, we adopted a new mission statement, which would clearly articulate our vision. Our mission became: to perform clinically-relevant research, which will improve surgical care of patients; to provide research opportunities and training to clinicians and students; and to develop financial resources to support research activities.

Next, we began a process of cultural assessment — determining where we were, what we did best, and where we wanted to be. Using the scientific advisory board and the Institute’s management structure as a leadership tree, we began communicating the following philosophy throughout our organization:

- have mutual respect,
- share responsibility,
- criticize ideas, not people, and
- practice constructive listening.

We established cross-functional teams consisting of both faculty and staff, and empowered them with responsibility and authority. Teams included: safety facility teams (to run common use facilities such as cell culture rooms and surgical suites), and teams to review marketing, publications, proposal development, and technology transfer.

We used team-building techniques, including role clarification and group feedback to enhance their effectiveness. At monthly meetings of faculty and staff, each team reports on issues related to their responsibility, and receives prompt feedback.

Every team is charged with establishing measurable, agreed upon, and realistic goals with timed implementation of such. Teams focus on their own set of internal and external customers and suppliers, utilizing TQM techniques to attain continuous improvement and to meet their customers’ expectations.

For example, the quality team responsible for making sure that research equipment is operational and calibrated, uses run and control charts to ensure that the equipment is operating within acceptable levels.

When it’s not, a flowchart establishes procedures to be followed to correct the problem. As a result, the customer — the user of the equipment — can expect the equipment to be operative.

Results

Results of our TQM strategy have been impressive. In our animal surgical facility, the utilization rate (days used/days available) increased from 26.9% in 1991, to 56.7% in 1992, and to 71% in 1993. From 1992 to 1993, there was a 24% increase in the number of procedures performed. The average cost of supplies for each procedure decreased from $71 to $39.

Between FY92 to FY93, our animal care expenses were reduced by $86,000 as a result of:

- more effective communication between scientists,
- piggy-backing experiments, and
- switching from the use of animal models to in vitro models.

One of our goals of the TQM process was to depend less on clinical funds and more on grants and revenues from other sources, such as contract research.

In the four years since we implemented TQM, the percentage of clinical funds used for research purposes dropped from 91% to 50% of expenses, while the percentage of grant funds increased from 6% to 42%. Contracts and other revenues have increased from 3% to 8%.

In addition, a research endowment, which began in 1990, has increased by $1 million.

The implementation of these concepts wasn’t without challenges, for example, turf battles that had to be overcome and faculty perceptions of loss of academic freedom that had to be changed. However, the process has provided numerous opportunities to gain a further understanding of the research environment.

Along our TQM journey, we’re continuing to study ways to improve our employee evaluation and compensation system, improve purchasing practices, develop more effective training programs, and find additional sources of benchmarking.

We’ve concluded that TQM is adaptable to the scientific research environment and results in increased quality, productivity, cost savings, and improved employee morale. Key to the implementation of TQM is a leadership tree supportive of the mission and the environment in which the mission is carried out.

To learn more, contact: Mike Kurtz, Associate Director, Surgical Research Institute, Department of Surgery, St. Louis U. Health Sciences Center, 3635 Vista and Grand, St. Louis, MO 63110; Ph: 314/268-5310; Fax: 314/268-5180.

TQM in the Classroom

A New Tool for Teachers and Students

John Huntley

Quality judgments and continuous quality improvement opens Pandora’s box for many classroom teachers:

- How do you motivate students to recognize and desire top quality in their work?
• How can you continuously raise the standards of quality so that student learning can be nudged upward and judged fairly?

• Can you involve students in evaluation without going soft and superficial?

• Can you give grades without appearing autocratic, feeding students’ hunger for approval, or soliciting their dependency on your sole, authoritative, hard-nosed judgments?

Whether your subject is music, painting, mathematics, or marketing, these problems often confuse the relationships between learners, teachers, objectives, and the quality of individual achievement. In a word: Can you effectively measure quality and quantify the quality of creative work done by creative people?

After 25 years of thought and experiment, I'm convinced the answer is yes, but not with traditional tools. An alternative is the *Quality Evaluator* (QE), a Macintosh HyperCard, network-compatible, groupware program that involves students and instructors in cooperative evaluation of students' academic work by intrinsic standards and consolidated group judgment.

The copyrighted program was developed over a two-year period with support from the Weeg Academic Computing Center of the U. of Iowa. It's been tested on local campuses in diverse situations and disciplines.

Interestingly, QE doesn’t require computers or networks. If you don't have a lot of student computers available, you can also use pencil, paper, and a copy machine to gather participants' judgments, assemble the results, and distribute the feedback. The concepts are more useful than the machinery.

I'd like to recruit a larger group of teacher-users for QE. I'll send to the first 100 individuals who request them, copies of the documentation (66 pages with illustrations, explanation of concepts and procedures, and instructions for using HyperCard Windows) and a program diskette.

All I ask in return is feedback from you and your students — your responses, suggestions for improvement, problems. If you have questions during this test period, I'll answer them directly and personally by e-mail. I'd like to hear from you by the end of the Fall semester.

For more information, contact: John Huntley, Dept. of English, 308 E.P.B., U. of Iowa, Iowa City, IA 52242; Ph: 319/335-0468; e-mail: john-huntley@uiowa.edu

---

**Voice of the Customer**

**Is Individualism at the Heart of TQM Resistance?**

*Joseph LeFevre*

Jim Clauson, director of quality training programs at Roane State Community College (TN), wrote in part: “Are there cultural, societal, or educational tendencies that cause us to be inclined to look at details rather than systems?”

“Are we so caught up in the analysis of things that we forego the synthesis? ... And if ‘either of these is even partially true — could this begin to explain the reason we resist the systems focus of TQM/CQI?”

I think there are such factors. The primary one is our cultural emphasis on individualism. The theory seems to be that pursuit of individual self-interest will automatically and without further management, make the "system" work for the good of society. We don’t attend to the system, just to individuals.

In fact, in economics we have Adam Smith telling us that individuals in selfish competition will automatically accomplish the societal need for the distribution of goods and services.

In higher education, this individualism is perhaps most rampant. The tradition of higher education in this country, under the rubrics of tenure and academic freedom, reward people for individual accomplishments, primarily for pursuing individual research interests. The assumption is that the pursuit of these individual interests will, without further management, see to societal needs to advance truth and educate young people.

There are ample reasons to question that assumption. The crisis in education is increasingly evident.

There’s another crisis in research, I believe, that’s not as evident. That is, there’s reason to believe that our system of research isn’t much more effective in advancing truth than it is in educating students.

To manage the system of education, it will be necessary to overcome this tradition of individualism. It will be necessary to make individual interests match systemic interests, giving at least as much attention to the system as to individual pursuits — but this goes against the grain of tradition in higher education.

For more information, contact: Joseph LeFevre, Assistant to the President for Planning and Administration, Xavier U. of Louisiana, New Orleans, LA 70125; Ph: 504/483-7566; e-mail: jlefevre@mail.xula.edu

---

**TQM Abroad**

**Survey Seeks Student Feedback**

What do graduates of Canadian postsecondary institutions think about the quality of their education? That's what the National Graduates Survey inquired of 36,000 students (11,000 of them with bachelor's degrees) who graduated in 1990.

The National Graduates Survey, conducted in 1992, is the first national survey to ask students about their satisfaction with their schooling after two years in the labor force.

The survey found that 70% of the university graduates with a bachelor's degree would select the same field again, and 80% would return to the same institution.

Generally, graduates rated general self-improvement as the most important reason for enrolling. Business graduates rated improved chances of a good income as the primary reason for enrolling, whereas education, engineering, and applied sciences graduates rated development of job skills as the most important reason for enrolling.

Graduates of all programs reported about the same level of satisfaction with faculty availability, institutional facilities — libraries, laboratories, and computers — class size, and quality of teaching.

Regarding the quality of teaching, 85% of the graduates were satisfied with the quality of instruction in their program. Satisfaction was highest.