MEng Degree:
Outcomes & Assessment Protocols

Cornell University, January 2012

Preamble

The MEng degree at Cornell differs substantially from the MS and other primarily research degrees, being mostly regarded as a ‘professional masters’ program. It has been the subject of two highly in-depth reports\(^1\)\(^2\) over the past decade which have looked extensively at every aspect of the degree program, many of these having very direct relevance to the current document.

There is significant variation across the 13 subject foci as befits the natural variation in how these fields find expression in the employment opportunities offered today. This plays quite directly into those aspects each field regards as of particular importance in preparing their graduates for successful careers. It should be noted explicitly that a not insignificant number of students can be found using the MEng program in some fields as a way of ‘testing the waters’ for potential future PhD study, so not all students use the program as a springboard into the world of industry directly. This aspect is reflected in the ‘outcomes’ for some of the fields represented. The spread of program size from single digits to over a hundred similarly has great impact on the means by which any given program might choose to evaluate its success. This is important to observe, since one must avoid the natural naive view that a uniform assessment process might work for all. In particular, it becomes very evident how readily the effect of size asserts itself were one to compare the approaches available to the three smaller programs (Geology, Applied and Engineering Physics, and Biomedical Engineering) with the more formalized ones that have to be implemented for those having closer to a hundred students each year.

In assembling the attached summaries of the 13, it should be observed that each program has circulated drafts amongst their colleagues for approval, and each has agreed that over time they can gather the stated data for self-evaluation. The express intent is not that each ‘outcome’ be assessed every year, but that each year one or more ‘outcomes’ will be investigated, the feedback from which can then be used to inform the conduct of the program.

\(^2\) “MEng Ad Hoc Committee Report”, November 2000
All MEng programs having students\(^3\) have responded, and their reports are attached. These are:

- Applied and Engineering Physics (AEP)
- Biological and Environmental Engineering (BEE)
- Biomedical Engineering (BioMed)
- Chemical Engineering (ChemE)
- Civil Engineering (CivEng)
- Computer Science (CS)
- Electrical and Computer Engineering (ECE)
- Engineering Management (EngMgmt)
- Geology (Geol)
- Material Science and Engineering (MSE)
- Mechanical and Aerospace Engineering (MAE)
- Operations Research and Information Engineering (ORIE)
- Systems Engineering (SysEng)

Although there is a broad spread of disciplinary foci represented here, there has been a broad agreement by most fields on somewhat common objectives (learning outcomes) and methods of assessment, with most fields adjusting the precise flavor of these to match their disciplines. In *broad terms* these are:

- Mastery of core knowledge
- Problem formulation and solution
- Collaboration and teamwork
- Communication
- Self-directed learning and professional development

with assessment tools:

- Course deliverables
- Project reviews
- Presentation evaluations
- Student exit surveys
- Job placement statistics and recruiter feedback
- Alumni feedback and involvement
- Student peer evaluation
- Department program reviews

\(^3\) There is a program for Theoretical and Applied Mechanics (TAM) which exists formally, however since there have been no students in their MEng program for a while, they were not asked to submit a report.
Master of Engineering in Engineering Physics
Learning Outcomes and Assessment

Preamble:
Students in the MEng program in Engineering Physics combine a research or design project with electives selected from a variety of applied physics related graduate fields. Thirty credit hours are required, which includes six to twelve credits for the research/design project. Courses include a core curriculum of applied quantum mechanics, statistical mechanics and applied mathematics in addition to electives in areas of applied physics, computer science, engineering, or biotechnology. The flexibility of the curriculum allows students, in consultation with their advisor, to select a program of study to meet their individual interests and educational goals. The research or design project chosen by the student is carried out under the direction of an appropriate member of the Engineering or Science graduate faculty at Cornell.

List of Core Learning Outcomes
1. Demonstrate broad knowledge in the fundamental areas of Applied Physics and advanced knowledge in a sub-discipline
2. Demonstrate the ability to acquire skills to plan and organize an independent study project
3. Demonstrate the ability to successfully complete an independent study project that contributes to an advance in an area of Engineering Physics
4. Demonstrate oral and written communication skills
5. Develop a commitment to life-long learning and professional development

Assessment Tools
1. Coursework-based assessments
2. Evaluation by faculty of AEP7530/AEP7540 MEng/MS seminar presentation and discussion
3. Formal project report
4. Evaluation by project advisor
5. Job Placement, Alumni and employer feedback (5yr survey)

Assessment Feedback / Program improvement
1. Analysis of assessment information by Engineering Physics M.Eng. Faculty
2. Recommendations for revisions in program
Learning Outcome 1: Demonstrate broad knowledge in the fundamental areas of Applied Physics and advanced knowledge in a sub-discipline

Description:
Proficiency in basic physics is in part demonstrated by successful completion of a fourth year or graduate level course in electromagnetism, applications of quantum mechanics or its equivalent as part of the program or as part of a preceding undergraduate degree. Advanced knowledge in a sub-discipline is acquired by completion of at least one advanced (4000 level or higher) two semester course sequence with at least six credit hours.

Assessment:
• Coursework-based assessments
• Evaluation by project advisor
• Evaluation by faculty of performance in the AEP7530/AEP7540 seminar

Learning Outcome 2: Demonstrate the ability to acquire skills to plan and organize an independent study project

Description:
The informal study project (AEP7510) is a major component of the Engineering Physics M.Eng. program. Working with the Project Advisor, the student must generate a Research Plan, comprising (1) background and significance, (2) statement of the specific aim, and (3) identification of the approach to achieve the aim. The student must identify and seek out resources and information and apply these to guide his/her independent study plan development. To achieve the aim the student will need to acquire the ability to master and/or innovate research methodologies and techniques.

Assessment:
• Evaluation by project advisor
• Evaluation by faculty of research plan presentation in the AEP7530 seminar
• Alumni and employer feedback (5yr survey)

Learning Outcome 3: Demonstrate the ability to successfully complete an independent study project

Description:
With the completion of the independent study project the student demonstrates independent thinking and creativity and contributes to an advance in an area of Engineering Physics. The informal study project is completed with a written formal report and an oral presentation of the results in the AEP7540 seminar. With guidance from the Project Advisor, the student must generate a formal project report that covers (1) abstract, (2) background and significance, (3) statement of
the specific aim, (4) description of the approach to achieve the aim, (5) results and outcomes, and (6) critical evaluation of the approach, results, and/or outcomes as appropriate.

Assessment:
• Evaluation of project report and performance by project advisor
• Evaluation by faculty and students of final presentation in the AEP7540 seminar
• Alumni and employer feedback (5yr survey)

Learning Outcome 4: Demonstrate oral and written communication skills

Description:
The ability to effectively communicate the results of a research or design approach and of its outcomes and critical review in written documents and oral presentations is essential. The students are required to present their project proposal or project plan in the AEP7530 MEng/MS seminar. The format is a conference style 12 minute presentation followed by questions from students and faculty and by comments on strengths and weaknesses of the presentation to provide guidance. In the second term the students present the outcome of their project by another presentation in the AEP7540 seminar and a formal written project report must be submitted to the Project Advisor before graduation.

Assessment:
• Evaluation of project report and oral presentation by project advisor
• Evaluation by faculty and students of final presentation in the AEP7540 seminar
• Alumni and employer feedback (5yr survey)

Learning Outcome 5: life-long learning & professional development

Description:
The students should develop a commitment to learning and maintain familiarity with advances in their field. They must understand and maintain ethical standards in their field and in general. They should develop the ability to engage in team work. They should demonstrate the ability to listen, give, and receive feedback effectively. These skills will be developed through mentoring by the Project Advisor and active participation in the MEng/MS seminar as well as other seminars, conferences, group meetings etc.

Assessment:
• Active participation in ethics discussions (e.g. as part of AEP7530)
• Evaluation by project advisor
• Evaluation by faculty in the AEP7530/AEP7540 seminar
• Job Placement, Alumni and employer feedback (5yr survey)
Biological & Environmental Engineering
Master of Engineering Learning Outcomes
and Associated Assessment Methods

Core Learning Outcomes
1. Mastery and Application of Core Disciplinary Knowledge
2. Problem Formulation and Solution
3. Collaborative Problem Solving
4. Communication of Knowledge, Ideas and Decision Justification
5. Professional Development & Career Advancement

Assessment Tools
1. Faculty Advisor’s Evaluation
2. Graduation Exit Survey
3. Job Placement & Career Path Statistics (5 yr survey)
4. Alumni Feedback & Involvement (5 yr Survey)

Assessment Timeline and Impact: Analysis & Feedback
Assessment Tools 1 and 2 will be used annually and assessment results reviewed by the field upon acquisition of data. Tool 3 and 4 are included in a 5 year survey that is part of the broader 5 year BEE department review. Data from all assessment tools will be compiled by the BEE GFA and reviewed annually by the BEE Graduate Coordinating Committee. Feedback recommendations from all assessments will be brought to the graduate faculty for discussion. Implementation of curricular changes resulting from feedback recommendations will be implemented by vote of the BEE Graduate Faculty.
BEE Learning Outcomes and Associated Assessments

Learning Outcome 1: Mastery and Application of Core Disciplinary Knowledge
Description: Ability to demonstrate an understanding and application of engineering fundamentals appropriate for the area of study within the field.

Assessment:
• Faculty Advisor’s Evaluation
• Graduation Exit Survey
• Job Placement & Career Path Statistics
• Alumni Feedback & Involvement (5yr Survey)

Learning Outcome 2: Problem Formulation and Solution
Description: Candidates demonstrate the ability to identify, formulate and solve an engineering problem in their area of study within the field. Candidates effectively utilize appropriate scientific and engineering techniques and methodologies in the problem solving process.

Assessment:
• Faculty Advisor’s Evaluation
• Graduation Exit Survey

Learning Outcome 3: Collaborative Problem Solving
Description: Ability to work productively with others in advisor’s lab group.

Assessment:
• Faculty Advisor’s Evaluation

Learning Outcome 4: Communication of Knowledge, Ideas and Decision Justification
Description: Ability to effectively identify and articulate the pros and cons of potential problem approaches and solutions.

Assessment:
• Faculty Advisor’s Evaluation

Learning Outcome 5: Professional Development & Career Advancement
Description: Graduates are equipped to assume increased technical and personal responsibilities as they advance in their professional careers.

Assessment:
• Job Placement & Career Path Statistics
• Alumni Feedback & Involvement (5yr Survey)
Assessment Rubrics

1. Faculty Advisor’s Evaluation
Faculty advisor’s evaluation will be used to assess outcomes 1-4. This final evaluation of the candidate’s work and project deliverables will be documented on the MEngr checklist that is used by the BEE Graduate Field Coordinator to ‘clear’ each candidate for graduation. The following information will be supplied by the advisor upon submission of the project report and prior to graduation:

**Outcome 1—Ability to demonstrate an understanding and application of engineering fundamentals appropriate for the area of study within the field.** Check the line that applies.

Understanding of engineering fundamentals
- ___________ Understanding clearly demonstrated, surpasses basic expectations
- ___________ Understanding demonstrated, meets basic expectations for program
- ___________ Understanding lacking, does not meet basic expectations

Application of engineering fundamentals
- ___________ Application clearly demonstrated, surpasses basic expectations
- ___________ Application demonstrated, meets basic expectations for program
- ___________ Application lacking, does not meet basic expectations

**Outcome 2—Candidate demonstrates the ability to identify, formulate and solve an engineering problem in their area of study within the field.** Candidate effectively utilizes appropriate scientific and engineering techniques and methodologies in the problem solving process.

Ability to identify, formulate and solve an engineering problem
- ___________ Ability clearly demonstrated, surpasses basic expectations
- ___________ Ability demonstrated, meets basic expectations for program
- ___________ Ability lacking, does not meet basic expectations

Utilization of appropriate scientific and engineering techniques and methodologies
- ___________ Clearly demonstrated, surpasses basic expectations
- ___________ Demonstrated, meets basic expectations for program
- ___________ Not well demonstrated, does not meet basic expectations

**Outcome 3—Collaborative Problem Solving**

Ability to work productively with others in advisor’s lab group.
- ___________ Clearly demonstrated, surpasses basic expectations
- ___________ Demonstrated, meets basic expectations for program
- ___________ Not well demonstrated, does not meet basic expectations

**Outcome 4—Communication of Knowledge, Ideas and Decision Justification**

Ability to effectively identify and articulate the pros and cons of potential problem approaches and solutions.
- ___________ Clearly demonstrated, surpasses basic expectations
- ___________ Demonstrated, meets basic expectations for program
- ___________ Not well demonstrated, does not meet basic expectations
2. Graduation Exit Survey

The graduation exit survey will be used to assess outcomes 1 & 2. Each candidate completes an exit survey near the end of their final term. Surveys include additional questions regarding academics, facilities and climate. Questions specific to outcomes 1 & 2 follow:

**Outcome 1—Ability to demonstrate an understanding and application of engineering fundamentals appropriate for the area of study within the field. Check the line that applies.**

The BEE Mengr program allowed me to demonstrate my understanding of engineering fundamentals

- [ ] My understanding was clearly demonstrated, surpassing my program expectations
- [ ] My understanding was demonstrated, meeting my expectations for program
- [ ] I was unable to demonstrate my understanding to the extent I had planned

Commentary: MY suggestions for program improvement is this area-

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

The BEE Mengr program allowed me to apply engineering fundamentals

- [ ] My application of engineering fundamentals clearly demonstrated, surpassing my expectations
- [ ] My application was demonstrated, meeting my expectations for program
- [ ] I was unable to demonstrate my understanding to the extent I had planned

Commentary: MY suggestions for program improvement is this area-

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
Outcome 2-- Candidate demonstrates the ability to identify, formulate and solve an engineering problem in their area of study within the field. Candidate effectively utilizes appropriate scientific and engineering techniques and methodologies in the problem solving process.

Ability to identify, formulate and solve an engineering problem

[ ] I was able to clearly demonstrate my abilities, surpassing my program expectations

[ ] My abilities were demonstrated, meeting my expectations for program

[ ] I was unable to demonstrate my abilities to the extent I had planned

Commentary: MY suggestions for program improvement is this area-
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Utilization of appropriate scientific and engineering techniques and methodologies

[ ] I was fully able to utilize techniques and methodologies, surpassing my program expectations

[ ] I was able to utilize techniques and methodologies, meeting basic expectations for program

[ ] I was not able to utilize techniques and methodologies to the extent I had planned

Commentary: MY suggestions for program improvement is this area-
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
3. **Job Placement & Career Path Statistics**

Job placement information is collected from each graduate as part of the graduation survey. The department maintains an alumni database that includes career path information. This information is also requested as part of the 5-year alumni survey.

- **Data relevant to Outcomes 1 & 5:**
  - First professional position/Grad school acceptance as an indicator of success in attaining Outcome 1.
  - First position/Grad School acceptance as first step in successful career path-Outcome 5

4. **Alumni Feedback & Involvement (5 yr Survey)**

The BEE program conducts regular surveys of alumni as part of ABET and required department reviews. The following alumni questions will be used in assessment of outcomes 1&5.

- **Information relevant to Outcomes 1 & 5:**
  - Alumni self-assess their personal and professional success attributed to Outcome 1.
  - Alumni self-assess their career path and professional development
  - Documentation of BEE alumni involvement in the program, service on department review panels, advisory committees, seminar presentations, and personal feedback to the department
Biomedical Engineering Learning Outcomes and Assessment Tools

Core Learning Outcomes
1. Mastery and application of biomedical engineering knowledge
2. Problem identification, analysis, solution and presentation of results
3. Communication of knowledge, including data analysis and presentation of results
4. Self-directed learning and professional development

Potential General Assessment Tools
1. Grades for MEng coursework
2. Evaluations from project advisors
3. Student exit surveys
4. Student self-evaluation of learning outcomes from design project
5. Intra-project team cross evaluations
6. Job placement statistics
7. Recruiter feedback
8. Alumni feedback
9. Annual program review by BME external Advisory Council
10. Annual faculty review of program and assessment analysis

Learning Outcome 1: Mastery and application of biomedical engineering knowledge

Description:
Students will demonstrate an understanding of the core subjects in biomedical engineering and demonstrate the ability to apply core subjects to biomedical engineering applications.

Assessment:
- Student exit surveys
- Coursework grades
- Job placement statistics
- Outside experts’ feedback (visiting faculty, lecturers, consultants)
- Alumni feedback
- Project advisor evaluations

Learning Outcome 2: Problem identification, analysis, solution and presentation of results

Description:
Students will demonstrate the ability to use appropriate biomedical engineering techniques, tools and methods to solve biomedical engineering problems in the context of courses and independent projects. They will be able apply those tools to the identification of problems, analysis of data
and presentation of solutions to broadly defined problems. Lastly, the students will demonstrate the ability to critically evaluate their results and present them either orally or in written format.

**Assessment:**
- Evaluations from project advisors
- Recruiter feedback
- Student self-evaluation of learning outcomes from design project

**Learning Outcome 3: Communication of knowledge**

**Description:**
Students will demonstrate the ability to describe effectively the identification, analysis and solution of specific biomedical engineering problems. They will be able to explain in oral and written format the technological importance of the problems and the results they obtained.

**Assessment:**
- Evaluations from project advisors
- Intra-project team cross evaluations
- Recruiter feedback

**Learning Outcome 4: Self-directed learning and professional development**

**Description:**
Students will demonstrate the ability to assimilate information from multiple sources to solve original biomedical engineering problems of technical importance. They will demonstrate the ability to work with fellow students in individual and team environments. They will acquire an awareness of professional roles in biomedical engineering practice. They will recognize that involvement in the biomedical engineering profession involves a commitment to life-long learning, continuing development of skills and abilities, and that ethical practices are paramount in the profession.

**Assessment:**
- Student exit surveys
- Job placement statistics
- Alumni feedback

**Feedback into Program Improvement**
The results of the assessment analysis will be used to modify and improve current curriculum and programs and to create new activities, courses and projects. When areas for potential improvements are identified based on the assessments listed above, the faculty who teach Masters of Engineering students and advise Master of Engineering projects will advise the biomedical engineering faculty as to lessons, assignments, and activities that should be
improved. The results of improvement efforts will be reviewed by the entire faculty periodically throughout each academic year.
Chemical Engineering Learning Outcomes and Assessment Methods

Core Learning Outcomes
1. Mastery and application of chemical engineering knowledge
2. Problem formulation, analysis, solution and presentation of results
3. Communication of knowledge, including analysis and design
4. Self-directed learning and professional development

Potential General Assessment Tools
1. Student exit surveys
2. Evaluations and grades from project advisors
3. Grades for chemical engineering coursework
4. Job placement statistics
5. Recruiter feedback
6. Alumni feedback
7. Annual program review by the chemical engineering department’s Advisory Council
8. Annual review by faculty at the chemical engineering faculty retreat

Learning Outcome 1: Mastery and application of chemical engineering knowledge
Description: Students will demonstrate an understanding of the core subjects in chemical engineering and the ability to apply core subjects to technological applications.
Assessment:
- Student exit surveys
- Coursework grades
- Job placement statistics
- Recruiter feedback
- Outside experts’ feedback (visiting instructors, lecturers, consultants)
- Alumni feedback

Learning Outcome 2: Problem formulation, analysis, solution and presentation of results
Description: Students will demonstrate the ability to use appropriate chemical engineering techniques, tools and methods to solve engineering problems in the context of courses and independent projects. They will be able to apply those tools to the formulation, analysis and solution of broadly defined problems. They will demonstrate the ability to critically evaluate results.
Assessment:
- Evaluations from project advisors
- Recruiter feedback
- Student self-evaluation of learning outcomes from project work

Learning Outcome 3: Communication of knowledge
Description: Students will demonstrate the ability to describe effectively the formulation, analysis and solution of specific problems in chemical engineering. They will be able to explain the technological importance of the problems and the results they obtained.
Assessment:
- Evaluations from project advisors
Learning Outcome 4: Self-directed learning and professional development

Description:
Students will demonstrate the ability to assimilate information from multiple sources to solve original engineering problems of technological importance. They will demonstrate the ability to work with fellow students in individual and team environments. They will acquire an awareness of professional roles in chemical engineering practice. They will recognize that involvement in the chemical engineering profession involves a commitment to life-long learning and continuing development of skills and abilities.

Assessment:
- Student exit surveys
- Job placement statistics
- Alumni feedback

Feedback into Program Improvement

The results of the assessment analysis will be used to modify current curriculum and programs and to create new activities, courses, and projects. When areas for potential improvements are identified based on the assessments listed above, the faculty who teach Master of Engineering students and advise Master of Engineering projects will advise the chemical engineering faculty as to lessons, assignments, and activities that should be improved. The results of improvement efforts will be reviewed by the entire faculty periodically throughout each academic year and at the department’s annual faculty retreat.
Civil and Environmental Engineering – MEC
Learning Outcomes and Associated Assessment Methods

Core Learning Outcomes

1. **Mastery and Application of Core Disciplinary Knowledge**
   Ability to demonstrate technical problem-solving. Ability to connect important concepts of design project

2. **Problem Formulation & Organization**
   Understanding the process of moving from data and theoretical concepts to engineering design. Structuring problems so that effective decisions can be made, and organizing people to address these problems.

3. **Collaborative Problem Solving and Issue Resolution**
   Ability to recognize one’s own strengths and weaknesses within a team dynamic. Ability to recognize the strengths and weaknesses of others in a team. Ability to lead a project and help the project team accomplish its objectives.

4. **Communication of Knowledge, Ideas, & Decision Justification**
   Ability to describe different potential solutions to design problems, and to discuss their pros and cons. Ability to listen effectively to others, and evaluate the pros and cons of other’s solutions or approaches. Ability to help others recognize the trade-offs and risks inherent in a potential solution or approach.

5. **Preparation for Self-Directed Learning & Professional Development**
   Demonstrate ability to acquire information from multiple sources and integrate it in pursuit of an effective solution to a problem. Demonstrate ability to seek new knowledge and develop new applications of taught knowledge to solve untraditional and real-world problems. Recognize the importance of continued development of skills and abilities.

Assessment of these Learning Outcomes

**Learning Outcome 1: Mastery and Application of Core Disciplinary Knowledge**

The core disciplinary knowledge is included in required core courses. These courses are listed under Learning Outcome 3 below. Thus, measurement of a student’s mastery of these ideas is provided by the grades earned in these core courses.

A useful measure of the effectiveness of these three courses from a student perspective is the overall score for the instructor and the course (questions 8 and 13, respectively) on the end-of-term student evaluations.

**Assessment:**
- Average GPA in each of core courses for all Master of Engineering students
- Average score on questions 8 and 13 of the student course evaluation for each of the core courses

This assessment will be measured annually.

**Learning Outcome 2: Problem Formulation & Organization and Planning of the Solution Process**

The project activity required in the program is focused on having students work in groups to address what is a structured problem. Over the course of a semester, the groups must organize the problem so that it is amenable to analysis, formulate an approach to the problem, and organize the process of coming to a solution. Thus, a student’s performance on the project is an effective measure of this learning outcome.

**Assessment:**
• Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project
• Student peer evaluation of individual performance on the project teams

This assessment will be measured annually.

**Learning Outcome 3: Collaborative Problem Solving and Issue Resolution**

Collaborative problem solving is a focus in the required team project in the program, and is also emphasized in of the core courses. Each concentration in CEE has its own core(s). These are: Transportation: CEE 6620, 6650; Geotechnical Engrg: CEE 7400; Environmental Processes: CEE 6530, 6560, 6570; Environmental Fluid Mechanics/Hydrology: CEE 6550; Environmental & Water Resources Systems Engineering: CEE 5390; Structural Engineering: 6720.

**Assessment:**
• Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project
• Student peer evaluation of individual performance on the project teams
• Grades earned in the core course(s)
• Grades earned on the team design projects

This assessment will be measured annually.

**Learning Outcome 4: Communication of Knowledge, Ideas, & Decision Justification**

An important element of the required project activity in the program is a combination of written final report and oral presentation by the team at the end of the projects each semester. These offer an opportunity to assess communication, presentation and writing skills of the students in the program. The oral presentations by the project teams are normally attended by faculty who have not been involved in supervising the efforts.

**Assessment:**
• Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project
• Evaluation of project oral presentations by faculty who have not been involved in project supervision
• Student peer evaluation of individual performance on the project teams

This assessment will be measured annually.

**Learning Outcome 5: Preparation for Self-Directed Learning & Professional Development**

In addition to focusing on problem formulation, collaborative problem solving and communication skills, the required project in the program is also a major opportunity for students to develop and practice the skills of acquiring information from multiple sources and integrating various pieces of information in pursuit of an effective solution to a problem. This ability to seek new knowledge and develop new applications of taught knowledge is the key to career-long, self-directed, learning and professional development.

**Assessment:**
• Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project

This assessment will be measured annually.
Analysis of Assessment Information and Feedback into Program Improvement

The assessment methods listed for each of the learning outcomes will be collected on a yearly basis, and once collected and organized, the assessment material will be analyzed as part of an annual review. This annual review will include members of the faculty who are directly involved with the offering of the core courses and projects in the program, as well as other faculty associated with the program. Individual courses and the entire curriculum will be analyzed. The result of this analysis will not only be identification of opportunity areas to improve upon, but also highlight current successes and best practices in an effort to not only strengthen the overall program but take full advantage of our current strengths.
Computer Science Learning Outcomes
and Associated Assessment Methods

List of Core Learning Outcomes

1. Mastery and Application of Core Disciplinary Knowledge
2. Problem Formulation & Organization and Planning of the Solution Process
3. Collaborative Problem Solving and Issue Resolution
4. Communication of Knowledge, Ideas, & Decision Justification
5. Self-Directed Learning & Professional Development

Potential General Assessment Tools

1. Student Exit Surveys/Interviews
2. Project Advisors Evaluation
3. Project Sponsor’s Evaluation
4. Job Placement Statistics
5. Recruiter Feedback
6. Alumni Feedback & Involvement (Syr Survey)
7. Student Peer Evaluation
8. Major Course Deliverable Evaluation

Assessment Impact
Analysis of Assessment Information
Feedback into the Program Improvement

Learning Outcome 1: Mastery and Application of Core Disciplinary Knowledge

Description:
Ability to demonstrate a coherent and fluent understanding of some specialization subarea within the field of Computer Science (for example; systems, graphics, machine learning, artificial intelligence, computer networks, databases, computer vision, robotics, programming languages, security, theory, etc.), and to demonstrate the ability to apply that understanding to solve real problems in an effective way. Ability to connect related concepts, which may span multiple courses, as part of an overall process of “computational thinking” and problem solving. Ability to reason about correctness and efficiency of solutions, to debug and evaluate solutions, and to participate in a quality-engineering process yielding effective technology.

Assessment:
- Student Exit Surveys/Interviews
- Job Placement Statistics
- Recruiter Feedback
- Alumni Feedback & Involvement (Syr Survey)
- Student Peer Evaluation
- Major Course Deliverable Evaluation

Learning Outcome 2: Problem Formulation & Organization and Planning of the Solution Process

Description:
Ability to translate general problem statements or user requirements into computer science problems of a rigorous and clear form. Capacity to develop a structured approach leading to the decomposition of large problems into smaller sub-problems and to map those sub-problems to a component or modular style of software. Ability to plan a step-by-step development approach in which sub-problems are tackled in isolation, solved, the solution analyzed for correctness and efficiency as well as other properties, such as performance or scalability, and then implemented. Ability to properly document work so that teams can cooperatively solve problems by breaking them into component parts that will be solved separately and independently but then combined. Testing and integration skills.
Assessment:
- Project Advisors Evaluation
- Recruiter Feedback
- Major Course Deliverables performed by teams and evaluated as a team work-product
- Student Peer Evaluation

**Learning Outcome 3: Collaborative Problem Solving and Issue Resolution**

**Description:**
Each team member brings unique skills, knowledge and experience, and an effective team must select a leader and work in a collaborative way that assigns appropriate tasks and responsibilities, then provides mutual support to carry out the needed activities. To this end students should show an ability to recognize their own strengths and weaknesses within a team dynamic as well as the ability to recognize the strengths and weaknesses of others within a team dynamic. Ability to lead a project, when needed, to aid the team in evaluating options and coming to a decision. Ability to perform the above in order to help produce a more effective solution than would be possible by any one team member alone.

**Assessment:**
- Student Exit Surveys/Interviews
- Project Advisors Evaluation
- Student Peer Evaluation
- Major Course Deliverable Evaluation

**Learning Outcome 4: Communication of Knowledge, Ideas, & Decision Justification**

**Description:**
Ability to effectively describe and discuss the pros and cons of potential Computer Science techniques, algorithms, protocols, or approaches. Ability to evaluate and discuss the pros and cons of others’ solutions or approaches in a constructive, non-confrontational manner that provides support and encouragement without losing focus and vision. Ability to help others recognize the trade-offs and risks inherent to a potential solution or approach.

**Assessment:**
- Project Advisors Evaluation
- Project Sponsor’s Evaluation
- Recruiter Feedback
- Student Peer Evaluation
- Major Course Deliverable Evaluation

**Learning Outcome 5: Self-Directed Learning & Professional Development**

**Description:**
Computer Science is a large and expanding field with a vast array of existing tools, technologies, programming languages and systems that often must be “learned” as the developer works: no student can possibly learn everything, just as no professional in the field can possibly know everything that may be important within the field. Thus the ability to sit down in front of a new system, or a new language, and rapidly master its features is a central aspect of computational thinking and a key skill. Computer Science seeks to teach this skill of mastering new computational tools, in addition to teaching a wide array of powerful existing tools, and expects its students to graduate both with a substantial arsenal of proven competences with the tools we teach, but also the broader ability to learn new tools as the need may arise.

**Assessment:**
- Student Exit Surveys/Interviews
- Project Advisors Evaluation
- Job Placement Statistics
- Alumni Feedback & Involvement (5yr Survey)
- Major Course Deliverable Evaluation
List of Core Courses and Most Common Electives

- CS 4300 Information Retrieval
- CS 4302 Web Information Systems
- CS 4410 Operating Systems
- CS 4700 Foundations of Artificial Intelligence
- CS 5150 Software Engineering
- CS 5300 Architecture of Large Scale Information Systems
- CS 5320 Database Systems
- CS 5410 Intermediate Computer Systems
- CS 5414 Distributed Computing Principles
- CS 5430 System Security
- CS 5740 Introduction to Natural Language Processing
- CS 5780 Machine Learning

Table of Learning Outcomes Strongly Targeted by Core Courses and Most Common Electives

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<thead>
<tr>
<th>Core Learning Outcome</th>
<th>CS 4300</th>
<th>CS 4302</th>
<th>CS 4410</th>
<th>CS 4700</th>
<th>CS 5150</th>
<th>CS 5300</th>
<th>CS 5320</th>
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<th>CS 5410</th>
<th>CS 5414</th>
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Additional Assessment

- Cornell Computer Science periodically engages in dialog with representatives from major industry vendors and solicits recommendations concerning program coverage, quality of our graduates and reputation of the program.
- An ongoing effort is underway to revamp our courses as the field grows and evolves. In a typical two year period at least one of our core courses is fully reviewed by the relevant faculty members and, often, extensively revised to ensure currency of the material.
- The Computer Science BOOM projects fair offers an opportunity for students to present their best work to visiting industry representatives, government researchers and other interested professionals. Although BOOM is not a course and is not required, we’ve listed it above because so many of our students participate, organizing their own demonstrations and explaining their work to our visitors and judges.

Analysis of Assessment Information

The assessment methods listed for each of the learning outcomes will be implemented by each of the courses targeting each learning outcome as listed in the table above. Our table is structured so that assessment tasks identified in the table ("T") leverage features fundamental to the courses and activities we’ve singled out. For example, CS5310 encourages MEng students to work on groups and to select projects through a group dialog; presentation of the thought process leading to the project is part of the grading criteria for the course. Thus, the associated assessment criteria are achieved through the very nature of the course itself.

For the courses selected to be included in the table, the Computer Science field will ensure that this assessment process continues irrespective of the faculty member actually teaching the course. Thus, for example, if a new faculty member were to teach CS5410, that person would still preserve these aspects of the collaborative project structure. The effect is to preserve the elements of the course required to satisfy the table shown above.
Moreover, we’ve selected a set of courses taken by the overwhelming majority of our MEng students. Thus, while Computer Science will not require documentation on a per-student basis for each assessed criteria (our concern is that the costs of a manual tracking process would be prohibitive, and also that such a process would be hard to maintain over time as our offerings evolve), we are confident that the process is one that will ensure that every Computer Science MEng graduate has achieved the full range of learning objectives. Many will do so redundantly, through multiple courses.

Periodically but not on a fixed time schedule, the department as a whole will evaluate the quality and status of the MEng program in Computer Science, with respect to the assessment criteria. The result of this analysis will not only be identification of opportunity areas to improve upon, but also highlight current successes and best practices in an effort to not only strengthen the overall program but take full advantage of our current strengths.

**Feedback into Program Improvement**

The results of the assessment analysis will be used to not only redesign both current curriculum and programs but also aid in the creation of new ones. For each identified area of improvement, recommendations will be made by both the executive committee and the faculty of the learning outcome targeted courses as to the lessons, assignments, and activities that should be improved, along with suggestions as to the improvement method. These recommendations will be implemented in specific curriculum and programs during the next year and before the next assessment cycle. Special attention will be given to those areas that were recommended for improvement in the assessment analysis of the next assessment cycle.
List of Core Learning Outcomes

The focus of this degree is to prepare students for a degree in industry, but the education gained honing oneself for a potential job in industry also is a superior preparation for advanced degrees in research, business, and professional disciplines. Hence the learning outcomes affect the placement and careers of a broad segment of graduates of electrical and computer engineering. The main thrusts are:

1. Gain Advanced Technical Knowledge
2. Master Critical Professional Skills
3. Gain Project Design Experience

Assessment Tools

1. Job placement record of graduates over past 5 years
2. Project Advisor’s evaluation
3. Recruiter feedback
4. Corporate review of projects annually
5. Major Course Deliverable assessments

Learning Outcome 1: Gain advanced technical knowledge

Students are required to take at least 17 credits of technical course work at the advanced level, and show that the courses form a coherent program. Assessment of progress in the students gaining advanced technical knowledge is derived from:

- Overall GPA of the technical courses, and comparison of the MEng students GPAs with those of advanced Cornell undergraduates and Cornell MS/PhD students
- Assessment of faculty who instruct MEng students in these advanced courses.
- Job placement statistics of students, which indicate if the students are learning skills that are recognized by industry as being useful.

Learning Outcome 2: Master Critical Professional Skills

- ECE 5010 individually assess each student oral and writing skill, and provides direct feedback where necessary.
- Technical writings, in particular project proposals and final reports, are reviewed by faculty and returned for revision and edits.
- Poster presentations are required at an annual review of projects in the Spring, and are judged by faculty from within the college and school, and from industrial representatives for creativity, oral and written presentation, and effectiveness in communication.
- All projects are posted on the web for outside access. Recruiters are asked for feedback on these websites.
Learning Outcome 3: Gain Project Design Experience

- Faculty advisors provide direct feedback on quality of project.
- All projects are competitively reviewed for awards at the end of the Spring semester. We use college faculty, school faculty, and specially invited industrial representatives to review all projects and make recommendations on awards.
- Most projects are posted on the website and hits are tracked. From this record we are able to develop a metric for the immediate impact of the projects. Some projects have 1000s of hits, others just a few.
Engineering Management Learning Outcomes and Associated Assessment Methods -- DRAFT

Core Learning Outcomes

1. Mastery and Application of Core Disciplinary Knowledge
   Ability to demonstrate a coherent and fluent understanding of the interplay between management and technical problem-solving. Ability to connect important concepts of project management, business analytics and risk analysis to the engineering process.

2. Problem Formulation & Organization and Planning of the Solution Process
   Understanding the process of moving from data to decisions within an organizational context. Structuring problems so that effective decisions can be made, and organizing people to address these problems.

3. Collaborative Problem Solving and Issue Resolution
   Ability to recognize one’s own strengths and weaknesses within a team dynamic. Ability to recognize the strengths and weaknesses of others in a team. Ability to lead a project and help the project team accomplish its objectives.

4. Communication of Knowledge, Ideas, & Decision Justification
   Ability to describe different potential solutions to problems, and to discuss their pros and cons. Ability to listen effectively to others, and evaluate the pros and cons of other’s solutions or approaches. Ability to help others recognize the trade-offs and risks inherent in a potential solution or approach.

5. Preparation for Self-Directed Learning & Professional Development
   Demonstrate ability to acquire information from multiple sources and integrate it in pursuit of an effective solution to a problem. Demonstrate ability to seek new knowledge and develop new applications of taught knowledge to solve untraditional and real-world problems. Recognize the importance of continued development of skills and abilities.

Assessment of these Learning Outcomes

Learning Outcome 1: Mastery and Application of Core Disciplinary Knowledge

The core disciplinary knowledge is included in three required core courses: CEE 5900 (Project Management), CEE 5930 (Engineering Management Methods) and CEE 5970 (Risk Analysis and Management). Thus, measurement of a student’s mastery of these ideas is provided by the grades earned in these three core courses.

A useful measure of the effectiveness of these three courses from a student perspective is the overall score for the instructor and the course (questions 8 and 13, respectively) on the end-of-term student evaluations.

Assessment:

- Average GPA in each of the three core courses for all Master of Engineering (Engineering Management) students
- Average score on questions 8 and 13 of the student course evaluation for each of the three core courses

This assessment will be measured annually.

Learning Outcome 2: Problem Formulation & Organization and Planning of the Solution Process

The project activity required in the program is focused on having Engineering Management students work in groups to address what is initially a vaguely structured problem. Over the course of a semester, the groups must structure the problem so that it is amenable to analysis, formulate an approach to the problem, and organize the process of coming to a solution. Thus, a student’s performance on the project is an effective measure of this learning outcome.
Assessment:

- Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project
- Student peer evaluation of individual performance on the project teams

This assessment will be measured annually.

Learning Outcome 3: Collaborative Problem Solving and Issue Resolution

Collaborative problem solving is a focus in the required team project in the program, and is also emphasized in two of the core courses. In the Project Management course (CEE 5900), there is a series of exercises in both collaborative problem solving and issue resolution within teams. In the Engineering Management Methods course (CEE 5930) there is a major term project done in teams of three. These program elements offer the opportunity to assess this learning outcome.

Assessment:

- Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project
- Student peer evaluation of individual performance on the project teams
- Grades earned in the Project Management core course (CEE 5900)
- Grades earned on the Team Project within the Engineering Management Methods course (CEE 5930)

This assessment will be measured annually.

Learning Outcome 4: Communication of Knowledge, Ideas, & Decision Justification

An important element of the required project activity in the program is a combination of written final report and oral presentation by the team at the end of the projects each semester. These offer an opportunity to assess communication, presentation and writing skills of the students in the program. The oral presentations by the project teams are normally attended by faculty who have not been involved in supervising the efforts.

Assessment:

- Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project
- Evaluation of project oral presentations by faculty who have not been involved in project supervision
- Student peer evaluation of individual performance on the project teams

This assessment will be measured annually.

Learning Outcome 5: Preparation for Self-Directed Learning & Professional Development

In addition to focusing on problem formulation, collaborative problem solving and communication skills, the required project in the program is also a major opportunity for students to develop and practice the skills of acquiring information from multiple sources and integrating various pieces of information in pursuit of an effective solution to a problem. This ability to seek new knowledge and develop new applications of taught knowledge is the key to career-long, self-directed, learning and professional development.

Assessment:

- Project advisor’s evaluation of the team performance on each project, as well as the evaluation of each student’s individual performance, as reflected in a one-page summary to be completed by each project advisor at the end of the project

This assessment will be measured annually.
Analysis of Assessment Information and Feedback into Program Improvement

The assessment methods listed for each of the learning outcomes will be collected on a yearly basis, and once collected and organized, the assessment material will be analyzed as part of an annual review. This annual review will include members of the faculty who are directly involved with the offering of the core courses and projects in the program, as well as other faculty associated with the program. Individual courses and the entire curriculum will be analyzed. The result of this analysis will not only be identification of opportunity areas to improve upon, but also highlight current successes and best practices in an effort to not only strengthen the overall program but take full advantage of our current strengths.
Geological Sciences Learning Methods and Associated Assessment Methods

Background
The MEng program in Geological Sciences has operated since 1990. Until this past year it had two options: Hydrology and Applied Geophysics. This year we added a third option in Ocean Science and Technology, a joint program with The Woods Hole Oceanographic Institution (WHOI).

The program has been small (0 to 2 students per year) and this has allowed us to tailor the options to each student’s interests. Our educational goal has been to add a solid year of graduate education for students entering from the geological sciences, or the equivalent of a second undergraduate geology major for students coming from other disciplines (for example engineers interested in acquiring geophysical or hydrological skills). Success has been evaluated by appraising how well we met these goals, the quality of the student’s MEng Project Report (we require a written report of all students), and the quality of the job or academic program entered following graduation.

Applications to the Geological Sciences MEng program have increased recently as interest in energy and sustainability has grown. A new Masters program in Subsurface Energy Systems in The Earth and Atmospheric Sciences Department and a new program in Sustainable Energy in Chemical and Biological Engineering have created new courses that augment current MEng offerings. We anticipate that our MEng program will continue to be small—a few students a year in Hydrology/Applied Geophysics and a few students a year in Ocean Technology.

Strategy for Improvement and Evaluation
Our improvement goals over the next several years are to develop a smoothly running Ocean Science and Technology program with WHOI and apply the faculty resources needed to run the MEng and other new offerings. We will proceed by designing student programs and evaluating how well the program works at the end of each year. Each graduating student will be asked to indicate in writing any operational difficulties and how they might be corrected. Based on this and faculty assessment, corrective modifications will be identified and made.

The improvement evaluation cycle will be: Each year (1) assess whether a solid year of graduate instruction or the equivalent of an undergrad major has been conferred, (2) evaluate the quality of the students’ Project Report, and (3) note the quality of the job or academic program the student enters upon graduation. The student advisor and the Geological Sciences MEng director will prepare a written evaluation of each student’s program that, together with the graduating student evaluation, will be filed in the Department Office. Periodically, a committee consisting of the MEng Director, the principle participating faculty, and the Department Chair will review these and formulate improvement goals and plans to achieve them. We will then work to achieve these goals, while simultaneously identifying new ones.

L. M. Cathles
Director MEng Geological Sciences Program
October 23, 2011
Materials Science and Engineering M. Eng. Program

Learning Outcomes and Assessment

Preamble:

The Materials Science and Engineering M.Eng. program is intended to be flexible and interdisciplinary, allowing students to tailor coursework to their personal interests and different backgrounds. One main constituency comprises students with a firm background in MS&E who wish to pursue a specific area in more depth, often incorporating an explicit minor in Management. A second main constituency comprises those who enter the M.Eng. program after receiving a B.A. in another field; these students therefore focus on developing their core expertise in materials science. In both cases the M.Eng. Project usually involves participation as a member of a faculty research group.

At least one course in Engineering Management is required; MSE5870 can serve to meet this requirement, although a wide range of alternatives is available through the Johnson School of Management as well as the Engineering Management Program in Civil and Environmental Engineering.

List of Core Learning Outcomes
1. mastery of broad core topics in the discipline and in-depth knowledge of a subfield
2. problem formulation; organization and planning of research approach
3. working as part of a team
4. communication
5. self-directed learning & professional development

Assessment Tools
1. coursework-based assessments
2. student exit interview
3. evaluation by project advisor
4. alumni feedback & involvement (5yr survey)

Assessment Feedback / Program improvement
1. analysis of assessment information by MSE M.Eng. Faculty Committee
2. recommendations for revisions in program
Learning Outcome 1: mastery of core topics in the discipline and in-depth knowledge of a subfield

*Description:*
Demonstrate a coherent and fluent understanding of the field of Materials Science and Engineering. Demonstrate ability to connect concepts between courses and relate them to basic concepts in Materials Science. Demonstrate deep knowledge in a particular subfield, such as materials chemistry, polymer materials, electronic materials, etc.

Students with an undergraduate degree in MS&E must take specialized courses in a subfield of interest. Students with an undergraduate degree in a field other than MS&E have already developed deep knowledge in specialized areas, and must take core MS&E courses to broaden their understanding of the multidisciplinary relationships inherent in Materials Science.

In both cases the student will work with the M.Eng. Coordinator and the student’s M.Eng. Project Advisor to construct an appropriate selection of courses.

*Assessment:*
- coursework-based assessments
- evaluation by project advisor

Learning Outcome 2: problem formulation; organization and management of a project

*Description:*
The M.Eng. project is a major component of the MS&E M.Eng. program. Working with the Project Advisor, the student must generate a Research Plan, comprising (1) statement of the topic, (2) identification of the major issues that are likely to be confronted in addressing the topic, (3) determination of the appropriate techniques, tools and methods needed to address the challenges. The student must learn effective planning and time management to accomplish the proposed research. This process also involves flexible response to unanticipated issues during the course of the Project.

The student is also required to pass at least one course in Engineering Management, in which organization and management issues are confronted.

*Assessment:*
- formal evaluation by project advisor
- assessments in Management coursework
Learning Outcome 3: working as part of a team

Description:
Students should learn concepts relevant to team-based problem solving. They should demonstrate the ability to strengths and weaknesses within a team dynamic—their own and other’s. They should demonstrate the ability to lead when needed. They should recognize that cooperation and collaboration allow them to work more effectively than they could in isolation.

Assessment:
- student exit surveys/interviews
- project advisors evaluation

Learning Outcome 4: communication

Description:
Students should demonstrate the ability to effectively communicate the results of research in written documents and oral presentations. A formal written project summary must be submitted to the Project Advisor and the M.Eng. Coordinator by the last days of classes before graduation. The project must also be communicated in an oral presentation to the Project Advisor at a mutually agreed upon time.

Assessment:
- evaluation by project advisor

Learning Outcome 5: life-long learning & professional development

Description:
The student should demonstrates the ability to assimilate and make use of new knowledge to solve real-world problems. The student should demonstrate recognition of the importance of life-long learning and continued development of skills and abilities. The student should demonstrate dedication to sharing the benefits of experience particularly with younger professionals.

The student should be able to ascertain the potential moral and ethical implications of their potential actions, and express an understanding of the values and beliefs of multiple diverse cultures. The student should be able to formulate and enact a responsible solution given the moral and ethical values of all parties involved.

Assessment:
- student exit surveys/interviews
- evaluation by project advisor
- alumni feedback & involvement (5yr survey)
List of Core Courses and Common Electives

- MSE5810 Materials Chemistry
- MSE5820 Mechanical Properties of Materials
- MSE5830 Thermodynamics of Condensed Systems
- MSE5840 Kinetics, Diffusion, and Phase Transformations
- MSE5850 Electronic, Magnetic and dielectric Properties of Materials
- MSE6010 Chemistry of Materials
- MSE6020 Elasticity, Plasticity, and Fracture
- MSE6030 Thermodynamics and Statistical Mechanics
- MSE6040 Kinetics of Reactions in Condensed Matter
- MSE6050 Electronic Properties of Materials
- MSE6060 Condensed Matter Structure

M.Eng. Project (required)
- MSE5010, MSE5020 M.Eng. Project (6-12 credits)

Common Electives

- MSE5120 Mechanical Properties of Thin films
- MSE 5210 - Properties of Solid Polymers
- MSE 5230 - Physics of Soft Materials
- MSE 5310 - Introduction to Ceramics
- MSE 5330 - Materials for Energy Production, Storage, and Conversion
- MSE 5410 - Nanofabrication of Semiconductor Devices
- MSE 5420 - Flexible Electronics
- MSE 5430 - Thin-Film Materials Science
- MSE 5450 - Magnetic and Ferroelectric Materials
- MSE 5490 - Nanofabrication: Making It Small
- MSE 5550 - Introduction to Composite Materials
- MSE 5620 - Biomineralization: Formation and Properties of Inorganic Biomaterials
- MSE 5630 - Nanobiotechnology
- MSE 5710 - Analytical Techniques for Material Science
- MSE 5720 - Computational Materials Science
- MSE 5870 - Technology Management
- MSE 5880 - The Science of Nanoparticles
- MSE 5890 - Colloids and Colloid Assemblies for Advanced Materials Applications
- MSE 6100 - Physical Metallurgy and Applications
- MSE 6550 - Advanced Composite Materials
- MSE 6650 - Principles of Tissue Engineering
- MSE 6710 - Principles of Diffraction

Many other electives offered by relevant departments are suitable, depending on the interests and goals of the student, as determined in consultation with the Project Advisor and M.Eng. director.
Table of Learning Outcomes Strongly Targeted by Core Courses and Common Electives

The following table indicates courses that are appropriate for students who do not have an undergraduate degree in Materials Science and Engineering, and who therefore need to assimilate some of the more basic concepts and approaches common to the field. They will not necessarily enroll in all of the core courses, depending on their specific background.

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<th>Core Learning Outcome</th>
<th>MSE 5810</th>
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The following table indicates courses that are appropriate for students who have an undergraduate degree in Materials Science and Engineering, and who wish to study core concepts more deeply as well as gain deep knowledge in specific topics. They will typically enroll in only a few of the core courses, depending on their specific interests.

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Analysis of Assessment Information

The assessment methods listed for each of the learning outcomes will be collected in each of the courses targeting each learning outcome as listed in the table above. This assessment material will be collected on a yearly basis and once collected and organized, the assessment material will be analyzed as part of an annual review. This annual review will include members of the MSE M.Eng. Faculty Committee and the faculty who were directly involved with the assessment collection. Individual courses will be analyzed at least based upon their targeted learning outcomes and the entire curriculum program will be analyzed across all courses that target each learning outcome. The reviewers will identify areas where improvements can be made and will also highlight current successes and best practices.
Feedback/Continuous Improvement

The results of the assessment analysis will be used to revise the curriculum and programs as well as the creation of new ones. For each identified area of improvement, recommendations will be made by both the MSE M.Eng. Faculty Committee and the specific faculty members responsible for the courses associated with learning outcomes. These recommendations will be implemented during the following year.

*document tracking*
10 October 2011: original version, RBvD
13 October 2011: modified, RBvD; voted by field: 19 yea, 0 nay, 23 no vote yet
List of Core Learning Outcomes

1. Mastery and Application of Core Disciplinary Knowledge
2. Problem Formulation & Planning of the Solution Process
3. Collaborative Problem Solving
4. Communication of Knowledge, Reasoning, & Technical Results
5. Learning & Professional Development

Possible General Assessment Tools to Consider

1. Student Course Evaluation / Survey
2. Project Advisor Evaluation
3. Project Student Evaluation
4. Faculty course syllabus and contents. Annual comments on performance and improvements
5. Alumni Feedback & Involvement

Assessment Impact

Analysis of Assessment Information
Feed back into the Program Improvement
Learning Outcome 1: Mastery and Application of Core Disciplinary Knowledge

Description:
Ability to demonstrate a coherent and fluent understanding of some specialization subarea within the field of Mechanical & Aerospace Engineering, and to demonstrate the ability to apply that understanding to solve real problems in an effective way. Ability to connect related concepts, which may span multiple courses, as part of an overall process of problem solving.

Assessment:
- Student Course Evaluation / Surveys
- Faculty Course syllabus and contents. Faculty comments on strengths as well as improvements (as needed) in student performance or course content.

Learning Outcome 2: Problem Formulation & Planning of the Solution Process

Description:
Ability to translate general problem statements into Mechanical Engineering problems of a rigorous and clear form. Capacity to develop a structured approach leading to the decomposition of large problems into smaller sub-problems. Ability to properly document work so that teams can cooperatively solve problems by breaking them into component parts that will be solved separately and independently but then combined. Testing and integration skills.

Assessment:
- Project Evaluation by advisors
- Faculty Course syllabus and contents. Faculty comments on strengths as well as improvements (as needed) in student performance or course content.
- Student Evaluation / Survey

Learning Outcome 3: Collaborative Problem Solving

Description:
Each team member brings unique skills, knowledge and experience, and an effective team must work in a collaborative way that assigns appropriate tasks and responsibilities, then provides mutual support to carry out the needed activities. To this end students should show an ability to recognize their own strengths and weaknesses within a team dynamic as well as the ability to recognize the strengths and weaknesses of others within a team dynamic.

Assessment:
- Team Project and Report Evaluation by advisors
- Student evaluations / surveys

Learning Outcome 4: Communication of Knowledge, Reasoning, & Technical Results

Description:
Ability to effectively describe and discuss the pros and cons of potential techniques or approaches. Ability and experience in putting together an effective report from the points of view of the writing and the technical communication.

Assessment:
- Project Advisor Evaluation
Learning Outcome 5: Learning & Professional Development

Description:
Mechanical and Aerospace Engineering is a large and expanding field with a vast array of existing tools and technologies that often must be “learned” as the person works; no student can possibly learn everything, just as no professional in the field can possibly know everything that may be important within the field. Mechanical & Aerospace Engineering seeks to teach an array of powerful existing tools, and expects its students to graduate both with a set of proven competences with the tools we teach, but also the broader ability to learn new tools as the need may arise.

Assessment:
- Course Evaluations / Surveys
- Faculty Course syllabus and contents. Faculty comments on strengths as well as improvements (as needed) in student performance or course content.
- Project Evaluations by advisors

List of Core Courses and Most Common Electives

NOTE: Courses are presently under review (involving a Retreat in December 2011, and further developments) and an accurate MEng list will be available in Fall 2012.

Fall semester
- MAE 5020 Wind Power
- MAE 5200 Dimensional tolerancing
- MAE 5210 Theory of linear systems
- MAE 5430 Combustion processes
- MAE 5550 Intro. Composite materials
- MAE 5680 Soft tissue biomechanics
- MAE 5700 Finite element analysis
- TAM 5700 Intermediate dynamics
- MAE 5780 Feedback control systems
- MAE 5910 Applied systems engineering
- MAE 5930 Design and operation of reliable systems
- MAE 5949 Enterprise engineering colloquium
- MAE 6900 Research project

Spring semester
- MAE 5010 Future energy systems
- MAE 5170 Introduction to Robotics
- MAE 5180 Autonomous mobile robots
- MAE 5230 Intermediate Fluid mechanics
- MAE 5240 Physical micro and Nano fluid mechanics
- MAE 5469 Energy seminar
- MAE 5640 Orthopedic tissue mechanics
- MAE 5690 Clinical biomechanics of musculoskeletal tissues
- MAE 5770 Engineering vibrations
- TAM 5780 Nonlinear dynamics and Chaos
- MAE 5860 Automotive engineering
- MAE 5920 Systems architecture, behavior and optimization
- MAE 5949 Enterprise engineering colloquium
- MAE 6900 Research project
Table of Learning Outcomes Targeted by Core Courses and Most Common Electives

NOTE: Courses are presently under review (involving a Retreat in December 2011, and further developments in Spring 2012) therefore a more accurate MEng list with associated learning outcomes will be available in Fall 2012.

<table>
<thead>
<tr>
<th>Core Learning Outcome</th>
<th>TAM 5780</th>
<th>MAE 5690</th>
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</tbody>
</table>

Analysis of Assessment Information

The assessment methods listed for each of the learning outcomes will be implemented by each of the courses targeting each learning outcome (Target shown as "T") as listed in the table above.

We have selected a set of courses taken by most of our MEng students, depending upon their specialization. Thus, while Mechanical & Aerospace Engineering will not require documentation on a per-student basis for each assessed criteria (our concern is that the costs of a manual tracking process would be prohibitive, and also that such a process would be hard to maintain over time as our offerings evolve), we are confident that the process is one that will ensure that every MEng graduate has achieved the full range of learning objectives. Many will do so redundantly, through multiple courses.

Feedback into Program Improvement

The results of the assessment analysis will be used as an ongoing component to continuously improve the current curriculum and programs. For each identified area of improvement, recommendations will be made as to the lessons, assignments, and activities that should be improved, along with suggestions as to the improvement method.
As part of Cornell University’s continuing accreditation effort, and in accordance with the University’s strategic plan, each graduate field is responsible for identifying Learning Outcomes for each program that it offers, as well as developing Assessment Tools for measuring the extent to which the Learning Outcomes are achieved by its students.

In March 2011, in order to streamline and unify this process for the Master of Engineering (MEng) degree programs offered by engineering graduate fields, the Master of Engineering Committee identified five Learning Outcomes that are common goals of all MEng degree programs, as follows:

MEng Learning Outcomes
LO1. Mastery and Application of Core Disciplinary Knowledge
LO2. Problem Formulation and Organization and Planning of the Solution Process
LO3. Collaborative Problem Solving and Issue Resolution
LO4. Communication of Knowledge, Ideas, and Decision Justification
LO5. Self-Directed Learning and Professional Development

Given this framework, each field has been mandated to describe each Learning Outcome within the context of its particular discipline, as well as to communicate its specific Assessment Tools and plans for administering them.

In this document, we describe the Learning Outcomes and Assessment Plan for the MEng program offered by the School of Operations Research and Information Engineering (ORIE).

ORIE MEng Learning Outcomes

LO1. Mastery and Application of Core Disciplinary Knowledge
   
   For ORIE, core disciplinary knowledge entails fundamental theoretical concepts, modeling methods, solution techniques, and computational skills in the areas of optimization, probability, statistics, and simulation. Application entails engaging in team-based project work with real organizations to address real problems.

LO2. Problem Formulation and Organization and Planning of the Solution Process
   
   For ORIE, this entails: (1) assessing a complex organizational or management need for which ORIE techniques are relevant and applicable, (2) synthesizing an accurate, coherent problem description, including (where applicable) mathematical representations of key elements, and (3) developing a logical solution approach to address the problem.
LO3. Collaborative Problem Solving and Issue Resolution

For ORIE, this means: (1) contributing to team-based problem solving efforts, (2) promoting good team dynamics, and (3) resolving conflict by exercising strength-based communication to build consensus.

LO4. Communication of Knowledge, Ideas, and Decision Justification

For ORIE, this means developing the skills to speak, write, and present in a manner that is clear, concise, convincing, visually effective, and at an appropriate level for the target audience.

LO5. Self-Directed Learning and Professional Development

For ORIE, this means demonstrating the initiative to cultivate the knowledge and skills needed to accomplish goals, both in the classroom and in the professional arena. This includes: (1) recognizing personal strengths and weaknesses, (2) embracing opportunities for improvement, (3) building a contact network, and (4) developing “soft skills” to effectively engage and sell ideas to others.

ORIE Assessment Plan

The ORIE MEng program at Cornell entails three primary components:

- Core and Elective Coursework
- Capstone MEng Project
- Professional Development Activities (workshops, seminars, networking events, etc.)

Each of these components contributes in substantive ways to our students’ achievement of the stated Learning Outcomes. The table below relates the components to the Learning Outcomes with which they are most closely aligned, as well as to Assessment Tools that ORIE currently uses. The Assessment Tools themselves and the processes surrounding how and when they are administered are described in greater detail on pages 2-7. On page 8, we provide a summary mapping of the Assessment Tools to the Learning Outcomes that they are used to measure.

<table>
<thead>
<tr>
<th>ORIE MEng Program Component</th>
<th>Learning Outcomes</th>
<th>ORIE Assessment Tools</th>
</tr>
</thead>
</table>
| Core and Elective Coursework      | LO1, LO2, LO3, LO4, LO5 | • Milestone Deliverables  
• Peer Evaluations                      |
| Capstone MEng Project             | LO1, LO2, LO3, LO4, LO5 | • Final Project Deliverables  
• Project Sponsor Evaluations  
• Project Peer Evaluations  
• Project Advisor Evaluations     |
| Professional Development Activities | LO1, LO3, LO4, LO5 | • MEng Connect Presentations and Program Evaluations  
• Student Exit Surveys/Interviews  
• Job Placement Statistics  
• Recruiter and Alumni Feedback   |

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**Milestone Deliverables and Peer Evaluations from Selected Courses**

Milestone deliverables (e.g., project reports, presentations, coding/software projects) and peer evaluations are common requirements in many of the core and elective courses taken by ORIE MEng students. Typically these deliverables are collected by the course instructor, and depending on their specific nature, they may be used to assess students’ mastery of applying ORIE fundamentals, level of self-directed learning, oral and written communication, presentation and persuasion skills, ability to work in teams, and/or overall professionalism.

Selected ORIE MEng core courses and popular electives that have milestone deliverables and/or peer evaluations are listed in the table below, along with a mapping that indicates which of the MEng Learning Outcomes the course deliverables can be used to meaningfully assess.

### Summary Mapping of Selected ORIE Courses to MEng Learning Outcomes

<table>
<thead>
<tr>
<th>Courses</th>
<th>Outcomes</th>
</tr>
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<tbody>
<tr>
<td>ORIE 4300: Optimization Modeling</td>
<td>LO1: Mastery and Application of Core Disciplinary Knowledge</td>
</tr>
<tr>
<td>ORIE 4310: Discrete Models</td>
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<tr>
<td>ORIE 4270: Statistical Data Mining</td>
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<td>ORIE 4610: Simulation-Based Modeling and Data Analysis</td>
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<td>ORIE 5900: Design of Manufacturing Systems</td>
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<td>ORIE 5110: Case Studies</td>
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<td>ORIE 5126: Supply Chain Management</td>
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<td>ORIE 5130: Service System Modeling and Design</td>
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<td>ORIE 5140: Heuristic Methods for Optimization</td>
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<td>ORIE 5580: Simulation Modeling</td>
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<td>ORIE 5630: Computational Methods in Finance</td>
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<td>ORIE 5660: Bond Mathematics and Mortgage-Backed Securities</td>
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<tr>
<td>ORIE 9100, ORIE 9101, and ORIE 9160 (Colloquia)</td>
<td></td>
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</table>

| LO2: Problem Formulation and Organization and Planning of the Solution Process |
| X | X | X | X | X | X | X | X | X |

| LO3: Collaborative Problem Solving and Issue Resolution |
| X | X | X | X | X | X | X | X | X |

| LO4: Communication of Knowledge, Ideas, and Decision Justification |
| X | X | X | X | X | X | X | X | X |

| LO5: Self-Directed Learning and Professional Development |
| X | X | X |

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**MEng Project Deliverables**

The MEng project in ORIE – a 5-credit-hour course that spans 2 semesters – is an intensive practical experience in which teams of students tackle real problems for real companies.

ORIE MEng projects typically involve designing, evaluating, and/or improving a system that has both technical and economic attributes. The roles of such systems may include (but are not limited to): resource allocation, forecasting, production scheduling, facilities location, strategic and tactical planning, decision analysis and support, product pricing, quality control, or improvement of manufacturing, distribution, marketing, information, and/or customer support processes.

At the conclusion of the projects – December for Financial Engineering (FE) projects, May for all others – student teams deliver to the sponsor a formal written report, an oral presentation, and any supporting materials, including prototype software that has been developed as part of the project.

The faculty advisor(s) for the project, in consultation with the MEng Directors and (potentially) the project sponsor, evaluates the deliverables and provides feedback to the student team. The deliverables themselves, taken together with the project sponsor evaluation and the project peer evaluations (see below), are used to assess students’ mastery of applying ORIE fundamentals, level of self-directed learning, oral and written communication, improvement in presentation and persuasion skills, ability to work in teams, and overall professionalism.

**MEng Project Sponsor Evaluations**

At the conclusion of ORIE MEng projects – December for FE projects, May for all others – project sponsors are asked to complete a survey in which they rate (on a 1-5 scale) and provide feedback to the team on the following aspects of the project:

• Satisfaction of Project Expectations
• Business Value of Project Output
• Implementation or Usage of Results
• Quality of Written Deliverables
• Quality of Final Presentation
• Productivity of Team Meetings with Organization’s Staff
• Team’s Professionalism, Organization, and Initiative
• Participation of Cornell Faculty
• Willingness to Engage in Future Projects
• Suggestions for Improvement

The MEng Directors administer and collect these surveys, share them with the student teams, and, in conjunction with the project advisors, use them to assess students’ mastery of applying ORIE fundamentals, level of self-directed learning, oral and written communication, improvement in presentation and persuasion skills, ability to work in teams, and overall professionalism. These surveys are also used to identify and inform future project work with the sponsors and to improve the project administration process.
MEng Project Peer Evaluations

At the conclusion of ORIE MEng projects – December for FE projects, May for all others – each student is asked to complete a survey in which they rate (on a 1-5 scale) and provide feedback on each member of their project team, including themselves. Categories of assessment are:

- **Leadership:** To what extent did this individual initiate discussion, generate enthusiasm, work for consensus, and/or coordinate your efforts?
- **Effort:** To what extent did this individual carry a fair share of the workload?
- **Analysis and Problem Solving:** To what extent was this individual a valuable contributor in analyzing and solving problems related to the project?
- **Deliverable Preparation:** To what extent was this individual a valuable contributor in preparing your final report and project presentation?
- **Team Dynamics:** To what extent did this individual arrive to meetings on time, participate in discussions, cooperate with team strategies, and coordinate his or her activities with the group? Was it pleasant to work with this individual?
- **Overall Contribution:** To what extent did this individual contribute to your team’s success?

Students are also required to describe their specific contributions to the project, the contributions of their teammates, and the most valuable and most problematic aspects of the project.

The MEng Directors administer and collect these surveys and, in conjunction with the MEng project advisors, use them to assess the students’ ability to work in teams, level of self-directed learning, and overall professionalism. They are also used to identify opportunities for improving project administration.

MEng Project Advisor Evaluations (to be implemented starting in 2011-2012)

At the conclusion of ORIE MEng projects – December for FE projects, May for all others – project advisors will be asked to complete a survey in which they rate (on a 1-5 scale) and provide feedback to the team on the following aspects of the project:

- Satisfaction of Project Expectations
- Quality of Written Deliverables
- Quality of Final Presentation
- Productivity of Team Meetings
- Team’s Professionalism, Organization, and Initiative
- Participation of Project Sponsor
- Willingness to Advise Future Projects with Sponsor
- Suggestions for Improvement

Currently this information is collected by the MEng Directors on an ad-hoc basis from project advisors. In 2011-2012, this process will be formalized (as it is for project sponsor evaluations and student peer evaluations), and the results will be shared with the project team as appropriate. The MEng Directors will use them to assess students’ mastery of ORIE fundamentals, level of self-directed learning, improvement in presentation and persuasion skills, ability to work in teams, and overall professionalism. The surveys will also be used to inform the suitability of future advisor/sponsor collaboration.
**MEng Connect Presentations and Program Evaluations**

MEng Connect is a 5-day Professional Development program for incoming ORIE MEng students focused on essential skills for success. The program is highly interactive, with numerous opportunities for active learning and participation. MEng Connect is held in August, the week before fall classes begin, and is an integral part of the ORIE MEng experience. Topics include:

- American Business Culture
- Communication Essentials
- Working in Teams
- Selling Ideas and Selling Yourself
- Workplace Communications
- Professional Ethics

A central component of MEng Connect is the team presentation competition. On the first day of the program, students are grouped into teams and are given guidelines for formulating an idea and developing a sales pitch according to a particular theme. On the last day of the program, the teams present their ideas to the group in a two-phase competition where everyone casts votes for the winners. These provide a benchmark for us to gauge students’ presentation and persuasion skills early on, as well as their ability to work in teams.

At the conclusion of MEng Connect, every participant completes a detailed evaluation survey that covers all aspects of the program. The MEng Directors use the ratings and feedback to identify areas where students’ needs for professional growth are greatest, as well as to improve MEng Connect content and the overall experience for future participants.

**Student Exit Surveys/Interviews**

At the end of each semester, each MEng student finishing his or her degree is required to complete an exit survey and is given the opportunity to meet with the MEng Directors for a brief exit interview. The exit survey covers numerous aspects of the student’s MEng program experience and future plans, including:

- Preparedness and expectations
- Courses and Instructors
- MEng Project
- Administrative and Advising Support
- Career Services
- Job Search Channels and Outcomes
- Post-graduation Professional Plans
- Program Strengths and Weaknesses
- Ideas for Improvement
- Advice for Incoming Students

The MEng Directors administer and collect these surveys and use them to assess the impact of the MEng program on each student’s overall growth, ability to work in teams, level of self-directed learning, and preparedness for the professional arena, as well as to address general gaps in the program curriculum and/or activities.
Job Placement Statistics

Our students’ ability to secure employment (or admission to other graduate programs) prior to graduation from Cornell is one of the most telling measures of success for any MEng program. As part of the ORIE MEng Exit Survey (see above), students answer questions regarding career resources and channels they have used, as well as job placement information (offers, employer, position, salary).

The MEng Directors use this information to assess each student’s level of initiative and preparedness for the professional arena, as well as to address general gaps in the program curriculum and/or activities.

Recruiter and Alumni Feedback

Currently, feedback is collected from recruiters and alumni regarding our students’ ability to communicate, their mastery of specific ORIE concepts, and their preparedness for the professional arena. This is done both on an ad-hoc basis, as well as in conjunction with planned professional events, including:

- **FE Orientation at CFEM**: During MEng Connect, new FE students spend a day in NYC participating in resume and interviewing workshops, meeting with program alumni for career advice, and visiting a financial company (usually a large investment bank).
- **Meet & Greet Wall Street**: This annual event, held in NYC in October, brings our FE students (based in Ithaca and at CFEM) together with recruiters, alumni, and other practitioners for an evening of networking and informal job- and career-related discussions.
- **Cornell GARP (Global Association of Risk Professionals) Chapter events**: Throughout the year CFEM hosts several events with keynote speakers and networking receptions.
- **CFEM Mock Interviews**: Alumni who are Wall Street professionals conduct hypothetical interviews for CFEM students to help them improve their communication and interviewing skills.
- **CFEM Advisory Council Meetings**: During these annual meetings, our students’ preparedness and feedback on current or new practitioner-taught courses are discussed in great detail.
- **MEng Seminar Courses**: The Enterprise Engineering Colloquium (ORIE 9100/9101) and the Financial Engineering Seminar (ORIE 9160) are professionally-oriented seminar series that showcase the wide variety of roles, responsibilities, and opportunities that Cornell alumni have embraced over the course of their careers. The talks, the Q&A sessions, and the post-seminar gatherings that follow provide our students with a forum for learning firsthand about many interesting and diverse issues faced in today’s global business environment.

To the extent possible, the MEng Directors use alumni and recruiter feedback to help specific students identify areas for improvement, as well as to address general gaps in the program curriculum and/or activities.
## Summary Mapping of ORIE Assessment Tools to MEng Learning Outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Tools→</th>
<th>Milestone Deliverables and Peer Evaluations – Selected Courses</th>
<th>MEng Project Deliverables</th>
<th>MEng Project Sponsor Evaluations</th>
<th>MEng Project Peer Evaluations</th>
<th>MEng Project Advisor Evaluations</th>
<th>MEng Connect Presentations and Program Evaluations</th>
<th>Student Exit Surveys/Interviews</th>
<th>Job Placement Statistics</th>
<th>Recruiter and Alumni Feedback</th>
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<tbody>
<tr>
<td>LO1: Mastery and Application of Core Disciplinary Knowledge</td>
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<td>LO3: Collaborative Problem Solving and Issue Resolution</td>
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<td>LO4: Communication of Knowledge, Ideas, and Decision Justification</td>
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<td>LO5: Self-Directed Learning and Professional Development</td>
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Systems Engineering Learning Outcomes
and Associated Assessment Methods

List of Core Learning Outcomes
1. Mastery & Application of Core Disciplinary Knowledge
2. Problem Formulation & Organization and Planning of the Solution Process
3. Collaborative Problem Solving and Issue Resolution
4. Communication of Knowledge, Ideas, & Decision Reasoning
5. Self-Directed Learning & Professional Development

Potential General Assessment Tools
1. Student Exit Surveys/Interviews
2. Project Advisors Evaluation
3. Project Sponsor’s Evaluation
4. Job Placement Statistics
5. Recruiter Feedback
6. Alumni Feedback & Involvement (5yr Survey)
7. Student Peer Evaluation
8. Major Course Deliverable Evaluation

Assessment Impact
Analysis of Assessment Information
Feedback into the Program Improvement

Learning Outcome: Expand/Learn/Master & Apply Core Disciplinary Knowledge

Description:
Ability to demonstrate a coherent and fluent understanding of the study of the System Engineering field.
Ability to connect field related concepts between courses with regards to their overall relationship within the Systems Engineering process.

Assessment techniques that can be used:
• Student Exit Surveys/Interviews
• Job Placement Statistics
• Recruiter Feedback
• Alumni Feedback & Involvement (5yr Survey)
• Student Peer Evaluation
• Major Course Deliverable Evaluation
Learning Outcome: Problem Formulation & Organization and Planning of the Solution Process

Description:
Recognition within or the reformulation of engineering challenges/projects as Systems Engineering challenges. Determination of appropriate Systems Engineering techniques, tools and methods as a solution to these challenges. Effective planning and application of those tools toward these challenges. Analyze and efficiently respond to the results of these methods application.

Ability to apply Systems Engineering to a variety of disciplines’ challenges. Ability to objectively compare the requirements, benefits, costs, and risks across the multiple discipline aspects of the same project to the overall goals of that project. Ability to aid experts within various disciplines to determine the requirements, benefits, costs, and risks of the aspects within the experts’ disciplines.

Assessment techniques that can be used:
- Project Advisors Evaluation
- Recruiter Feedback
- Major Course Deliverable Evaluation

Learning Outcome: Collaborative Problem Solving and Issue Resolution

Description:
Ability to recognize their own strengths and weaknesses within a team dynamic. Ability to recognize the strengths and weaknesses of others within a team dynamic. Ability to lead a project, when needed, to aid the team in evaluating options and coming to a decision. Ability to perform all of the above in order to help produce a more effective solution than possible by any one team member alone.

Assessment techniques that can be used:
- Student Exit Surveys/Interviews
- Project Advisors Evaluation
- Student Peer Evaluation
- Major Course Deliverable Evaluation

Learning Outcome: Communication of Knowledge, Ideas, & Decision Reasoning

Description:
Ability to effectively describe and discuss the pros and cons of potential Systems Engineering solutions or approaches. Ability to evaluate and discuss the pros and cons of other’s solutions or approaches. Ability to help others recognize the trade-offs and risks inherent to a potential solution or approach.

Assessment techniques that can be used:
- Project Advisors Evaluation
Learning Outcome: Self-Directed Learning & Professional Development

Description:
Demonstrates ability to pull information from multiple sources to formulate improved solutions to traditional problems. Demonstrates ability to seek new knowledge and develop new applications of taught knowledge to solve untraditional and real-world problems.

Recognition of the importance of and commitment to life-long learning. Continued development of skills and abilities. Dedication to sharing experience and aiding colleagues and particularly younger professionals in related fields. Ability to understand and express an understanding of the values and beliefs of multiple diverse cultures as they relate to the challenges and choices being examined.

Assessment techniques that can be used:
- Student Exit Surveys/Interviews
- Project Advisors Evaluation
- Job Placement Statistics
- Alumni Feedback & Involvement (Syr Survey)
- Major Course Deliverable Evaluation
List of Core Courses and Most Common Electives

- SYSEN 5100 : Applied Systems Engineering
- SYSEN 5200 : Systems Architecture Behavior and Optimization
- SYSEN 5300 : Systems Engineering and 6-Sigma for the Design and Operation of Reliable Systems
- CEE 6910 : Project Leadership
- CEE 5970 : Risk Analysis and Management
- ECE 4450 : Computer Networks and Telecommunications
- NBA 5070 : Entrepreneurship for Scientists & Engineers
- ORIE 5100 : Design of Manufacturing Systems
- ORIE 5126 : Supply Chain Management
- SYSEN 5920 : Systems Engineering Management for Virtual Teams
- SYSEN 5940 : Creativity and Innovation within Systems Engineering
- SYSEN 5900/5960 : M-Eng Project in Systems Engineering

Table of Learning Outcomes Strongly Targeted by Core Courses and Most Common Electives

<table>
<thead>
<tr>
<th></th>
<th>SYSEN 5100</th>
<th>SYSEN 5200</th>
<th>SYSEN 5300</th>
<th>CEE 6910</th>
<th>ECE 4450</th>
<th>CEE 5970</th>
<th>ORIE 5100</th>
<th>NBA 5070</th>
<th>ORIE 5126</th>
<th>SYSEN 5920</th>
<th>SYSEN 5940</th>
<th>SYSEN 5900/S960</th>
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<td>Problem Formulation &amp; Organization and Planning of the Solution Process</td>
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<td>Collaborative Problem Solving and Issue Resolution</td>
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<td>Communication of Knowledge, Ideas, &amp; Decision Justification</td>
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<td>Self-Directed Learning &amp; Professional Development</td>
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Additional Assessment

- Survey of Companies focusing on Potential Distance Learning Partners
Collection and Analysis of Assessment Information

Each year the Systems program will focus their efforts on assessing and improving upon a single learning outcome. To begin this evaluation and improvement process the assessment methods listed for that learning outcome will be collected in each of the courses targeting each learning outcome as listed in the table above. Once collected and organized, the assessment material will be analyzed as part of an annual review. This annual review will include members of the Systems’ executive committee and the faculty who were directly involved with the assessment collection. Individual courses will be analyzed at least based upon their targeted learning outcomes and the entire curriculum program will be analyzed across all courses that target each learning outcome. The result of this analysis will not only be identification of opportunity areas to improve upon, but also highlight current successes and best practices in an effort to not only strengthen the overall program but take full advantage of our current strengths.

Feedback into Program Improvement

The results of the assessment analysis will be used to not only redesign both current curriculum and programs but also aid in the creation of new ones. For each identified area of improvement, recommendations will be made by both the executive committee and the faculty of the learning outcome targeted courses as to the lessons, assignments, and activities that should be improved, along with suggestions as to the improvement method. These recommendations will be implemented in specific curriculum and programs during the next year and before the next assessment cycle. Special attention will be given to those areas that were recommended for improvement in the assessment analysis of the next assessment cycle.