The Olin Competencies

Listed in this section are the nine competencies the committee recommends Olin use as a **starting point** in this process. Definition of these competencies is a challenging undertaking, and is best done with examples of student work in hand.

Overview

The committee recommends Olin adopt the following nine competencies.

Qualitative Analysis: *Olin graduates will be able to analyze and to solve engineering problems qualitatively.*

Quantitative Analysis: *Olin graduates will be able to analyze and to solve engineering problems quantitatively.*

Teamwork: *Olin graduates will be able to contribute effectively in a variety of roles on teams, including multi-disciplinary teams.*

Communication: *Olin graduates will be able to convey information and ideas effectively, to a variety of audiences, using written, oral, and visual and graphical communication.*

Life-long Learning: *Olin graduates will be able to identify and to address their own educational needs in a changing world.*

Context: *Olin graduates will demonstrate knowledge of the ethical, professional, business, social, and cultural contexts of engineering, and the ability to articulate their own professional and ethical responsibilities.*

Design: *Olin graduates will be able to develop creative, effective designs that solve real problems.*

Diagnosis: *Olin graduates will be able to identify and resolve problems within complex systems.*

Opportunity: *Olin graduates will be able to identify opportunities, to predict challenges and costs associated with the pursuit of opportunities, and to muster resources in response to opportunities.*

Qualitative Analysis: *Olin graduates will be able to analyze and to solve engineering problems qualitatively.*

- Estimation
  - Student is able to use bounds, orders of magnitude, units, and triangulation to estimate relevant quantities.
  - Example evidence: Student makes reasonable estimates of the power requirements of common devices (cell phone, automobile, etc.)
- Analysis With Uncertainty
  - Student is able to proceed with analysis despite incomplete data
  - Example evidence: Student selects or interpolates for unknown values and is capable of completing analysis, resulting in a value with a known margin of error.
    (e.g. estimating the maximum load sustainable by an object when the mechanical properties of the constituent material are not fully known)
- Qualitative Prediction and Visual Thinking
  - Student is able to make qualitative predictions about the behavior of engineering systems.
  - Example evidence: Student is able to look at a design and discuss where it would fail, and why.

Quantitative Analysis: *Olin graduates will be able to analyze and to solve engineering problems quantitatively.*

- Use of Tools
  - Student can select and use modern engineering tools appropriate to the task.
  - Example evidence: Student selects and uses psplice to analyze a non-trivial circuit.
- Quantitative Modeling
  - Student can formulate appropriate analytical and/or numerical models for the behavior of a physical system and can use the models to predict behavior of the system.
  - Example evidence: Student develops and implements a numerical model for a thermal system, and uses the model to make predictions about possible design decisions.
- Numerical Problem Solving
  - Given an engineering problem with known parameters, the student can apply analytical techniques to determine unknown values.
  - Example evidence: Student determines voltage across an electrical component when various other parameters are known.
- Experimentation
  - Student can use appropriate experimental techniques to acquire relevant physical data.
  - Example evidence: Student uses a hemocytometer to determine cell density, and therefore how much medium to use in a particular experiment.

Teamwork: *Olin graduates will be able to contribute effectively in a variety of roles on teams, including multi-disciplinary teams.*

- Teaming theory
  - Student can describe and analyze group dynamics, working styles, and the role of teams
  - Example evidence: Student observes a team in action and writes analytical report on dynamics.
- Personal attributes
  - Student is aware of his or her personal attributes relevant to effective teamwork(e.g., flexibility, time management).
  - Example evidence: Student is able to discuss past successes and failures on teams, and relate these experiences to his or her personal attributes.
- Team membership
  - Student contributes effectively as a team member.
  - Example evidence. Peer evaluations of participation in team project.
- Team leadership
  - Student can lead a group effectively.
  - Example evidence: Observation of leading a group in a specific situation—brainstorming, decision-making, project planning meeting etc.
- Project management
  - Student is familiar with project management techniques.
  - Example evidence: Student is able to discuss past successes and failures on projects, and relate these experiences to concepts and techniques in project management.

Communication: *Olin graduates will be able to convey information and ideas effectively, to a variety of audiences, using written, oral, and visual and graphical communication.*

- Strategy, structure, and format
  - Student is able to articulate who his/her audience is, what his/her goals are, and can justify his/her use of structure and format based on his/her goals and audience.
  - Example evidence: Student defends existing piece of work on the above grounds.
- Technical Writing
  - Student is able to effectively convey technical concepts in writing.
  - Example evidence: Laboratory reports or software documentation.
- Non-technical Writing
  - Student is able to effectively convey non-technical information in writing.
  - Example evidence: Literary criticism, historical research, political analysis
- Oral Communication
  - Student is able to effectively use speaking style, visual aids, and content organization to convey technical and non-technical information.
  - Example evidence: Student gives an oral presentation.
- Visual Communication
  - Student is able to display quantitative information and qualitative information effectively.
  - Example evidence: Student graphically presents experimental data.
- Graphical communication
  - Student is able to present information in a graphically compelling way.
  - Example evidence: Student produces a clear and effective poster.

Life-long Learning: *Student is able to identify and to address his/her own educational needs in a changing world.*

- Personal attributes
  - Student is aware of his or her personal attributes relevant to life-long learning (learning style, curiosity, perseverance).
- Tools
  - Student selects and uses appropriate tools to meet specific learning needs
  - Example evidence: Plan for independent study with reflection that shows student understands variety of options available and makes informed choice.
- Information fluency
  - Student can locate relevant information and assess quality of information sources
  - Example evidence: Literature search for major technical project (capstone, independent learning, passionate pursuit) with reflection.
- Career planning
  - Student demonstrates awareness of need to plan for his/her career.
  - Example evidence: Student determines the necessary background and skills for a particular career direction and develops a plan to obtain those skills.
- Self-directed learning
  - Student demonstrates capacity for self-directed learning independent of coursework.
  - Example evidence: Student is involved in Passionate Pursuits, student completes independent study of a topic.

Context: *Olin graduates will demonstrate knowledge of the ethical, professional, business, social, and cultural contexts of engineering, and the ability to articulate their own professional and ethical responsibilities.*

- Professional Ethics
  - Student is able to articulate the professional ethics within their discipline, and can connect these concepts to their own work.
  - Example evidence: Student can discuss design decisions in the context of a professional code of ethics.
- Disciplinary Practice
  - Student is able to apply the standards of scholarship, inquiry, evidence, and argument of their discipline, and appreciates that other disciplines use other standards.
  - Example evidence: Student chooses appropriate evidence and modes of argument in writing a technical paper.
- Perspective
  - Student is able to articulate the views of others in an accurate manner, and to articulate and defend one's own views. Student is able to make analogies and connections between different contextual frameworks
  - Example evidence: Student understands and can articulate differing viewpoints on stem cell research.
- Influence and Impact
  - Student can identify the major contextual factors that influence a product or decision or action, and can identify the impacts of one's actions, decisions, and work.

Example evidence: Student can describe the possible social ramifications of a line of stem cell research.

Design: *Olin graduates will be able to develop creative, effective designs that solve real problems.*

- Concept Creation
  - Student can develop concepts that respond to non-technical aspects of a design problem.
  - Example evidence: Student develops product concept as a result of a user-centered design process, and can justify decisions based on knowledge of users.
- Problem Formulation
  - Student can turn a non-technical concept into a technical design problem.
  - Example evidence: Student creates technical specifications based on a product concept. and acceptance tests based on a product concept and interactions with customers.
- Personal attributes
  - Student is aware of his or her personal attributes relevant to effective design (e.g., creativity, time management).
  - Example evidence: Student is able to discuss past successes and failures with designs, and relate these experiences to his or her personal attributes.
- Application of Other Competencies
  - Student is able to bring other competencies to bear in design process (analysis, context, communication, diagnosis)
  - Example evidence: Student demonstrates effective communication in interaction with users as part of the design process.
- Tradeoffs
  - Student is able to balance tradeoffs and make defensible choices among design alternatives.
  - Example evidence: Student balances the cost, power consumption, and power output of a transistor together with its effect of the rest of the circuit to determine the correct part to use.
- Craftsmanship and Realization
  - Student is able to execute design in an aesthetically-pleasing fashion (where aesthetics are discipline-specific)
  - Example evidence: Student produces computer code that elegantly solves the specified problem.

Diagnosis: *Olin graduates will be able to identify and resolve problems within complex systems.*

- Problem Identification
  - Student is able to identify and formally pose problems within complicated systems.
  - Example evidence: Student recognizes and summarizes unexpected or implausible stress distributions calculated by finite element analysis.
- Hypothesis Formation
  - Student is able to suggest hypotheses in response to identified problems.
  - Example evidence: Student makes a reasonable guess as to why there is aberrant output (ie a problem with a particular piece of code)
- Hypothesis Testing / Experimental Inquiry
  - Student is able to design appropriate experiments to test a hypothesis.
  - Example evidence: Student designs test data or a test program to specifically focus on the code in question.
- Recommending Solutions
  - Student is able to develop solutions in response to experimental results.
  - Example evidence: Student is able to fix the code in response to the results of hypothesis testing.

Opportunity: *Olin graduates will be able to identify opportunities, to predict challenges and costs associated with the pursuit of opportunities, and to muster resources in response to opportunities.*

- Opportunity Recognition
  - Student is able to distinguish between an idea and an opportunity, based on costs, needs, and other contextual factors.
  - Example evidence: Student develops a business plan for a non-profit organization.
- Team Recognition
  - Student is able to identify an appropriate team to respond to an opportunity.
  - Example evidence: Student discusses context-dependent weaknesses of a management team in a case study on a new venture.
- Resources
  - Student is able to develop reasonable estimates of the resources required to pursue an opportunity.
  - Example Evidence: As part of a design project, student develops cost estimates and financing plans to develop new product.
- Personal Attributes
  - Student is aware of his or her personal attributes that are relevant to recognizing and pursuing opportunities (creativity, perseverance, risk-taking).
  - Example evidence: Student reflects on the experience of starting a new club at Olin, and can discuss personal attributes that assisted or hindered the process.

Office of Innovation and Research

Quick Tips #5
Developing Course Objectives/Measurable Outcomes

For Olin purposes, we use the term **course objectives** for the things students should be able to do at the end of a course. The term **measurable outcomes** is used to describe a more specific level of tasks that demonstrate that students have achieved the course objectives.

1. Developing Course Objectives and Outcomes

When developing course objectives and outcomes remember to focus on what the student can **do** as a result of the teaching and what is observable or **measurable**. Think about what your students can do now, and what you want them to be able to do at the end of the course. Be specific—saying that your students will "understand" thermodynamics is not a useful objective.

Finally, specify **when** you expect the students to achieve the objectives and **to what standard**. For example, "by the midterm exam" or "by the end of the course", and "accurate to three decimal points", "within 15 minutes", etc.

2. Examples of Course Objectives

"By the end of the course, I want my students to use historical data to develop the elements of an argument."

"I want my students to use the scientific method to conduct original scientific research and to communicate their research orally and in writing to the scientific community."

"By the end of the course, the students should be able to: Identify a product opportunity. Generate, evaluate, and select product concepts. Develop a working prototype."

3. Examples of Measurable Outcomes

"When this chapter has been completed, the student should be able to *define* the variables in the ideal gas equations of state in terms a high school senior could understand, *calculate* the value of any one of the variables from given values of the other three, *estimate* the error in the calculated value, and *outline* the derivation of the ideal gas equation from the kinetic theory of gases."

Write a business (marketing) plan."

4. **Defining Outcomes and Objectives.**

Define objectives using active verbs. There are a number of suggested terms in the literature. The following list, keyed to Bloom's Taxonomy of Educational Objectives may be useful:

Verbs that you might use to specify different sorts of outcomes[1]

For Knowledge: arrange, order, define, recognize, duplicate, label, recall, list, repeat, memorize, name, state, relate, reproduce

For Comprehension: classify, locate, describe, recognize, discuss, report, explain, restate, express, review, identify, select, indicate, translate

For Application: apply, operate, choose, practice, demonstrate, schedule, dramatize, sketch, employ, solve, illustrate, use, interpret, write

For Analysis: analyze, differentiate, appraise, discriminate, calculate, distinguish, categorize, examine, compare, experiment, contrast, question, criticize, test

For Synthesis: arrange, formulate, assemble, manage, collect, organize, compose, plan, construct, prepare, create, propose, design, write

For Evaluation: appraise, judge, argue, predict, assess, rate, attach, score, choose, select, compare, support, estimate, evaluate.

[1] NCGIA Learning Outcomes
http://www.ncgia.ucsb.edu/education/curricula/giscc/units/format/outcomes.html

OIR Quick Tips #6
Classroom Assessment

Classroom assessment is a powerful tool for improving teaching and learning. Here are some key points to remember along with some suggested techniques. Many other techniques are described in the sources listed at the end.

1. ***Principles***
    - Classroom assessment should focus on the learner
    - Classroom assessment is formative, focused on making changes and improvements, not on judging or evaluating. At Olin, classroom assessments are between the faculty member and the class only.
    - Classroom assessment should be ongoing or periodic.
    - Classroom assessment should foster a dialogue between faculty and students

2. ***Classroom assessment can measure learning.***
    - Conventional quizzes or assessments.
    - "Minute Papers" Ask your students to take a minute at the end of class to answer the following questions: "What was the most important thing you learned in class?" "What important question remains unanswered?"
    - "Muddiest Point" Ask your students to fill in the blank. "What was the muddiest point in…"

3. ***Classroom assessment can measure student opinion about the class.***
    - Minute paper again. "What worked well in this class?" "What could be improved" "What could the faculty member do to improve the class?" "What could you do as a student?"
    - Open-ended discussion on the same topics.
    - Discussion with outside moderator (OIR or others)
    - Allow for some anonymous feedback and some non-anonymous.

4. ***Classroom assessment should foster dialogue***
    - Take a few minutes to discuss the results.
    - Responding doesn't mean agreeing with or implementing every student suggestion—just responding.

5. ***Additional Resources (Books available in OIR)***
    - Angelo, Thomas and K. Patricia Cross, Classroom Assessment Techniques; a Handbook for College Teachers. 2nd ed. San Francisco, Jossey-Bass, 1993.
    - Palomba, Catherine and Trudy W. Banta, Assessment Essentials; Planning, Implementing, and Improving Assessment in Higher Education. San Francisco, Jossey-Bass, 1999. See chapter 6.
    - Olin Classroom Assessment Chart on the Assessment Organization on BlackBoard