ASSESSMENT OF A FRESHMAN PROGRAM: INTRODUCTION TO ENGINEERING AT THE OHIO STATE UNIVERSITY
Academic Year 1998-2001

John A. Merrill, Richard J. Freuler, Robert J. Gustafson, Audeen W. Fentiman, and John T. Demel
The Ohio State University

Abstract

In the 1998-1999 academic year, the College of Engineering at The Ohio State University implemented a new freshman program, known as the Introduction to Engineering (IE) Program. This program was designed to incorporate the fundamentals of engineering graphics and basic programming with hands-on labs, opportunities for teamwork, and a stronger emphasis on communication skills. To guide the program's implementation and evaluation, a comprehensive assessment plan was developed to ensure that sufficient tools and methods were in place to properly evaluate the impact of the program. The program is now in its third year, and this plan continues to be instrumental in evaluating the program's effectiveness. This paper presents an overview of the plan, including its tools, methods, and outcomes.

1.0 Introduction

In the Autumn Quarter, 1998, The Ohio State University College of Engineering implemented a pilot program for freshman Engineering students with the express purpose of engaging students in an interdisciplinary curriculum that emphasized hands-on laboratory projects, quantitative analysis, teamwork, and solid communication skills. The pilot curriculum was developed in an interactive lecture / lab format with an emphasis on real-world problems, only after considerable research and the endorsement of the College faculty (Fentiman, et al., 1999). Core and technical competencies identified by the Accreditation Board for Engineering and Technology also provided a framework for setting course objectives. A study table format was used as part of the program to further reinforce study skills, to clarify lab work, and to give teams a chance to meet outside of class. Overall, the College hoped to engender enthusiasm for engineering, to help students feel more connected to the College, to develop skills that would be useful in later courses and on the job, and to have a positive influence on their ultimate career choice. An overarching goal was to improve student retention rates into the sophomore year and beyond.

The purpose of this paper is to describe the assessment plan, as well as the data collection process and the data analysis. The plan itself is structured around a specific measurement focus, supported by tools/methods, supporting actions, and an established timetable. The data that is collected forms the basis for discussions at weekly instructional team meetings, while more detailed analysis of the data enables the team to make decisions regarding program adjustments. Furthermore, the assessment processes and resulting outcomes were instrumental in deciding to continue the program for the 1999-2000 and 2000-2001 academic years.

2.0 Assessment Plan

The purpose of the Assessment Plan is to provide decision-makers with documentation regarding student retention, performance, perceptions about the academic environment, and overall commitment to engineering as a profession. The plan consists of five sections: Measurement Focus, Measurement Tool (or Method), Action, Timetable, and Evaluation Decision. Most of the

Measurement Focus statements are derived from the "Measures of Success" written by the Core Curriculum Implementation Committee in January 1998, and consist of such areas as student performance, quality of instructional materials, attitudes, and competency development. More specific statements such as technical writing skills, oral presentation skills, and teamwork skills are included to capture additional supporting data.

The implementation guidelines which accompany the plan are written to provide an additional The guidelines specify the assessment tool; objective(s) for the assessment activity; which groups are involved; instrument administration; materials preparation; analysis and reporting; and any special notes, such as announcing if the assessment was online. The guidelines underscore the variety of materials and approaches employed to ensure that a balance of qualitative and quantitative data are available to assess the program.

2.1 Web based tools for assessment

A web page developed for the Introduction to Engineering Program states the objectives of the program, gives current and prospective students valuable information about course requirements, and links course outcomes to ABET criteria, with links to other key resources. From the homepage, students can directly access WebCT, an online tool supported by the College of Engineering to provide students with current information about their classes. WebCT allows students to submit assignments, view their grades progressively throughout the quarter, view their daily syllabus, participate in a class calendar, and access information about their instructional team. WebCT also carries a direct link to Course Sorcerer, an online tool used for journal entries and course evaluations. The journal entries are tools for the administration and teaching team to observe student's attitudes towards specific issues throughout the quarter. These submissions are completely anonymous, yet instructors can view completion status. The written results are compiled by graduate teaching assistants and can be shared with the class in order to address their questions and concerns. Course evaluations used at the end of the quarter and are designed to evaluate the overall effectiveness of the program's objectives.

3.0 Student Involvement

In the 1998-1999 academic year (on the quarter system), one hundred five (105) freshman students enrolled in the IE program and were matched to control groups possessing similar characteristics in terms of gender, ethnicity, ACT scores, and math placement as determined by a math test given at Ohio State. In the 1999-2000 academic year, 275 students enrolled in the IE program. Although the program was no longer considered a pilot, a control group was chosen from students again possessing similar characteristics. For the 2000-2001 academic year, all entering freshman in the College of Engineering either enrolled in the IE Program or the Freshman Engineering Honors program. Thus, five hundred four (504) students enrolled in the IE Program in Autumn 2000, and an additional 216 enrolled in Winter 2001. With the IE and the FEH programs running concurrently, there is no longer a pool of students from within the College of Engineering to serve as a control group.

4.0 Data Collection and Analysis

For each measurement focus, at least one measurement tool was used to collect data. The table below shows the nine measurement areas and some of the tools associated with each focus.

Measurement Focus	Measurement Tool and/or Method
1. Student Performance	Course evaluations, oral presentations, lab reports, written technical reports; standard testing methods; course grades
2. Quality of Instructional Material	Course evaluations, classroom observations, weekly team meetings consisting of faculty and graduate teaching assistants
3. Basic Visualization Skills	Purdue Visualization Test (pre and post)
4. Student Attitudes	Written/Typed comments on course evaluations, Pittsburgh Freshman Attitudes Survey (pre and post), focus group
5. Faculty Attitudes	Weekly team meetings and quarterly written evaluations
6. ABET Competencies	Course evaluations and electronic journals
7. Communication	Feedback on outlines, drafts, lab reports, project reports; observation, feedback, and scoring of oral presentations; support fromTechnical Communications Resource Center
8. Teamwork Skills	Team Building Workshops, exercises, team evaluations, course evaluations
9. Retention	Monitoring enrollment through Registrar's office, the College of Engineering's database, and nightly reports; consultation with advisors; intervention strategies as needed.

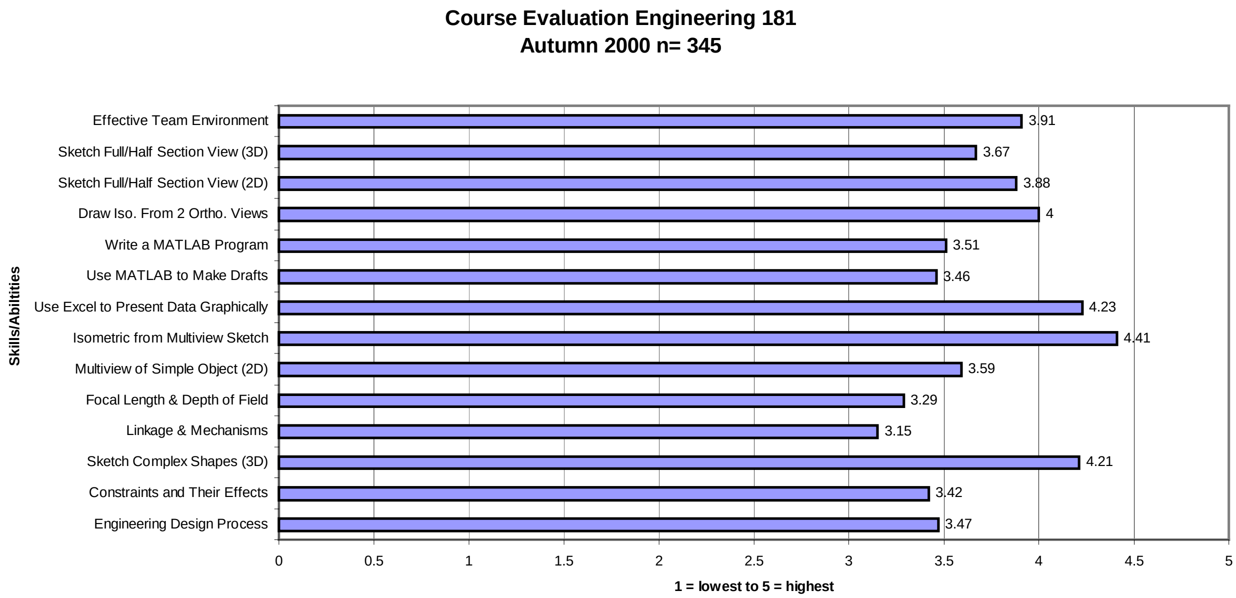
The measurement tool or method chosen for each focus provides a range of options for data collection and analysis. The related action(s) provide additional detail on how the method/tool would be implemented. Where possible, web-based evaluation forms are created for online completion and analysis.

4.1 Student Performance

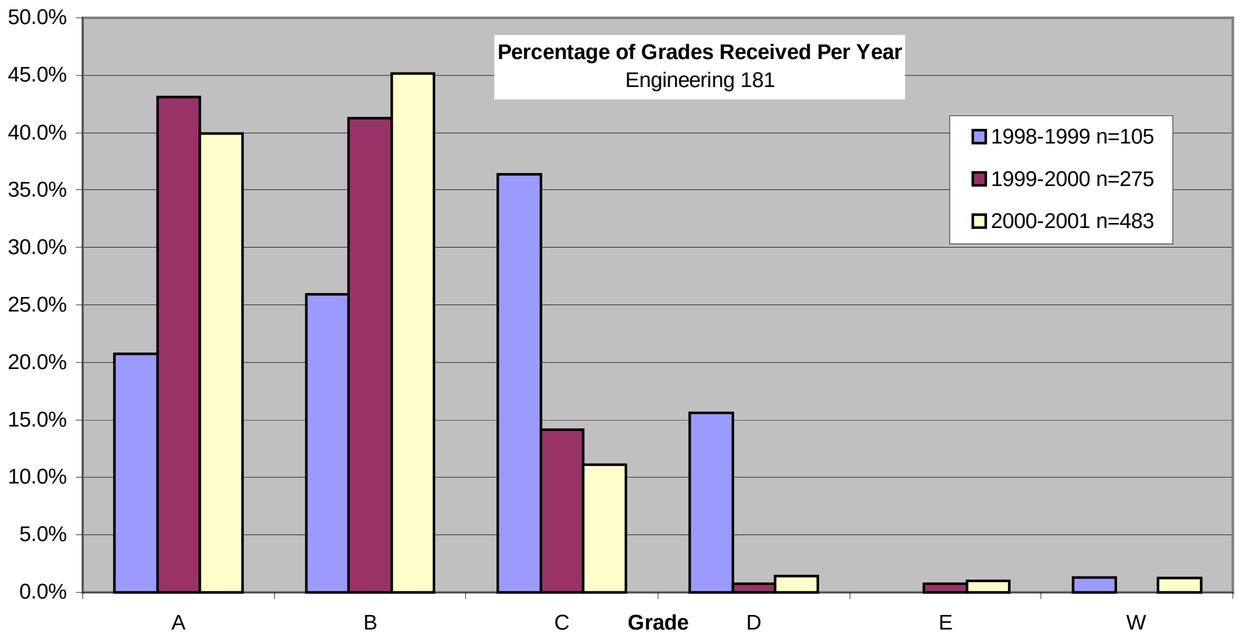
Student performance is measured in each of the course components, based on objectives developed by the faculty. These components consist of Basic Skills (faculty presentation and student practice); Single-Use Camera (hands-on labs); Bicycle Design (hands-on labs), and a long-term assignment that culminates in an oral presentation based on the bike labs. Measurement methods consist of online student course evaluations, daily assignments, scheduled exams, oral presentations, lab reports, and faculty evaluations of student presentations. The lab reports are written as a team effort.

For example, in Autumn Quarter, 2000, students completed an online assessment form in class to evaluate their own performance within the class as well as general aspects of the program. The form consisted of 25 questions in which the students had to rank their competency in specific areas. Questions on the evaluation form were written in an effort to assess the objectives of the program. The form also included general questions about the positive and negative aspects of the program. These questions allowed the students to respond with a short written narrative. Where possible, students were provided class time to complete the survey; therefore response rates were close to 100 percent, barring absences. Students who were absent had the opportunity to take evaluation from any computer containing an Internet connection. Students were then given credit for completion of the evaluation. Results are anonymous, but instructors could view a completion list to grant credit. Instructors could also view the narrative responses.

The following table of students' perceived skills and abilities is an example of the data that can be calculated from the online evaluations. This data indicates student proficiency relative to the course objectives. The narrative responses (not shown here) measure students' attitude towards quality of instructional material and delivery methods, and provides qualitative data from which further insights can be gained for program improvement.



The following chart depicts the grade distribution by percentage for Engineering 181 in Autumn Quarter of the 2000-2001 school year, showing marked improvement over the past three years in grades for the first course of the Introduction to Engineering sequence. Possible reasons for the increase in higher grades could be due to the growing number of students in the program, the higher abilities of those students (based on increasing ACT average), better informed faculty and teaching assistants, and/or improved curriculum materials.



4.2 Quality of Instructional Material

The instructional materials and delivery methods were designed for use by a variety of faculty members. Key to this process was consistency to ensure that students were receiving a uniform educational experience, regardless of the variance of instructor and graduate teaching assistants. The combined Honors and Introduction to Engineering (IE) programs have grown to over 900 hundred students. It is important that all students receive the same basic material. While instructors were free to introduce material into their lectures based on practical experience and knowledge, the core material in the presentation was identical across all sections. Despite minor problems with this approach, the importance of teaching a uniform curriculum to incoming students remains an important objective to the faculty. Members of the faculty have expressed willingness to help the administrative staff fill gaps in presentation material and to develop revisions as needed to keep consistency between sections.

4.3 Basic Visualization Skills

The Purdue Visualization Test (Purdue Research Foundation, © 1976) is administered on a pretest basis early in the quarter and again as a posttest at the end of the quarter. The principal value in using this test has been to provide faculty and TAs with scores immediately after each pretest, so that they can identify students who may need additional assistance with graphics early in the quarter. Although posttest scores provide a general indication of individual student progress, the scores are not correlated with other course components for analysis at the present time.

4.4 Student Attitudes

Measuring student's attitudes regarding the engineering discipline and their first-year experiences was an essential factor in determining the success of the pilot and the future of the program. The narrative data captured on course evaluations revealed a broad range of positive comments, legitimate concerns, and success stories, as well as perceived failures. However, students tend to be harsher on themselves in their written comments regarding their abilities than the quantitative data would suggest. No effort has been made to extensively analyze the narrative information through coding frequency of comments, but in a formative sense the instructional team finds that these narratives helped them to gauge the climate for learning.

In an effort to rely also on attitudinal data that can be more readily quantified and validated, the IE students will take the Pittsburgh Freshman Engineering Attitudes Survey (administered under Engineering Education Information Grant 98-4) in the current academic year. The instrument measures personal as well as financial reasons related to the pursuit of an Engineering career. An example category with related statements is shown below.

Student Attitude and Self-Assessment Measures and Their Definition

Student Attitude and Self-Assessment Measures With Rating Value	**Definition** ***(Statements in italics are reversed scored)***
General Impressions of Engineering 1 – does not strongly like engineering 5 – strongly likes engineering	How much a student likes engineering 1. I expect that engineering will be a rewarding career. 2. I expect that studying engineering will be rewarding. 3. The advantages of studying engineering outweigh the disadvantages. 4. *I don't care for this career.* 5. The future benefits of studying engineering are worth the effort. 6. I can think of several o*ther majors that would be more rewarding than engineering.* 7. I have no desire to change to another major. 8. *The rewards of getting an engineering degree are not worth the effort.* 9. *From what I know, engineering is boring.*

Ohio State is one of nineteen universities participating in the study. The data will be used for program improvement and for benchmarking relative to student attitudes among students in the other participating institutions.

Student focus groups have been held at least once a year. In the past, students have expressed concerns that were similar to those captured on the web-based evaluations. For example, they felt that the labs did not always relate very well to the lectures; they expected to be exposed more to different types of engineering; and they thought better use could be made of the study table with more attention given to specific homework problems. Other concerns were the result of different expectations over the goals of the Introduction to Engineering program. Conversely, high marks were given to the hands-on approach, exposure to reverse engineering concepts, and contact with many of the same faculty over a two-quarter period, to name a few.

4.5 Faculty Attitudes

Comments from the program faculty are collected using an online instrument. Most of the faculty have worked with upper division students only, and it has been clear from their comments that they enjoy working with the freshman, but have had to adjust their teaching styles as well as their expectations. Despite the emphasis on using a hands-on approach and lots of teamwork, they found that the students needed more coaching than was expected, needed concrete examples and specific instructions, and perhaps did not show as much initiative as was desired. The following are sample comments:

Faculty: Unique problems, many related to the high school to college transition, were evident. Teaching freshmen was definitely a new experience for me, but not shockingly so. I was surprised at the wide range of interest and ability, and the generally weak grasp of basic math. These presented challenges that were perhaps not too well met. The growth of the students over the two quarters was truly remarkable. I suspect the students don't fully appreciate how much they've learned.

Faculty: I had my doubts along the way, but I think the second quarter experience really helped build a positive environment for the students. In large part this was because of the student's interactions with each other – my class really seemed to grow and develop a personality of its own.

4.6 Communication Skills (Technical writing and Oral presentation skills)

In the first course of the Introduction to Engineering sequence, communication skills are evaluated through weekly lab reports assigned in both the Camera and Bicycle labs as well as a written report and oral presentation made by each team at the end of the quarter. The written report is based on a summation of assignments throughout the Bicycle labs that students have to organize into a technical presentation aimed at engineers and product buyers. The emphasis is placed more heavily on the technical aspects, but the faculty feel that economic concerns must also be considered. Students are given an outline on which to base their final technical report, a lecture on PowerPoint for their presentations, and are also provided with the grading requirements and a sample evaluation form. Based upon the online course evaluations, students enjoy working with others to complete the presentation, but still struggle with the technical writing. Given the demand for technical writing skills in upper level courses and in industry, comprehensive lab reports will remain a central ingredient of the IE program.

The second course in the two-course Introduction to Engineering sequence focuses on design and communications. In the laboratory portion of the course, students design and build a conveyor/sorter system that must sort three types of recyclable objects into bins. The Basics presentations focus on technical aspects of design-build projects, Cadkey, as well as communication skills, project management, and teamwork.

Each team is required to write a technical report about their project. Students are required to keep a project notebook, consisting of meeting notes (including key decisions), sketches, brainstorming, weekly lab reports, and their project schedule. The notebooks are checked each week to ensure that teams are on task. Students are also provided with a detailed outline of what is expected in their final written report and required to turn in two drafts of their paper. Feedback from faculty and graduate teaching assistants is given on the drafts and notebooks in an effort to guide students to a polished final report. The College's Technical Communications Resource Center also provides assistance to the students in their writing. The Center is conveniently located in the same building and the classrooms and labs and provides staff members to critique student's writing samples. Graphical communications are an important part of the technical report, and students are given instruction in and expected to use Cadkey in their final reports. They are also given instructions about proper placement and documentation of graphical representations within their technical report. In the spring of 2000, students gave themselves an average rating of 3.85 on a scale of five (five being the highest) when asked to rank their ability to, "Write a thorough project report that is well organized, flows logically, and is grammatically correct."

The team's final task in the second course is to present their technical report to the class. Students use PowerPoint for their presentations, having already received instruction in how to use the software application in the first course of the sequence. Students are again presented with the evaluation criteria to be used by faculty. The oral presentations at the end of the second course often show marked improvement from those made in the Bicycle lab portion of the first course. Again, the spring evaluation showed an average student ranking of 3.85 when asked if they could, "Present a technical oral report that is clear, concise, factual, and a reflection of team effort."

Student's narrative comments are indicative of the importance of the skill and knowledge taken from the introductory courses. As one student stated, "I feel that I have a much greater grasp of engineering design and what goes into the engineering process. I have better learned how to plan, implement, evaluate, and re-engineer." Comments such as the following are encouraging to the faculty in the general goal of peaking interest in engineering, "I was not looking forward to doing the conveyor belt lab, but throughout the quarter, I considered it to be more fun than class should be."

4.7 **Teamwork Skills**

Both courses in the introductory sequence place a large emphasis on working in teams. In the first course, students are placed in one team for the camera labs and then change teams for the bike labs. In the second course, each team works together the entire quarter to construct the conveyor system. To further promote healthy teamwork skills in the second course, students spend one, two-hour class session in a Team Building Workshop. This workshop combines presentations with exercises designed to promote awareness of team roles and to encourage positive team behaviors. Most of the exercises and evaluations are taken from <u>Teamwork and Project Management</u>, by Karl Smith, which the students purchase. Later in the quarter, a one-hour Team Building Workshop is held for reflection and analysis of the team experiences throughout the quarter.

Teamwork and participation are evaluated on the course evaluation in both the first and second course. Questions include topics such as following a schedule, holding productive meetings, participation, and cooperation as a team. Students also have a chance to respond in a narrative format about their attitudes towards teamwork.

4.8 Retention

Retention of students from freshman to sophomore year, and beyond, has been a concern among colleges of Engineering for some time. As was mentioned earlier, one of the key "measures of success" for the IE program was the degree to which the experience had a positive effect on student retention.

To measure retention rates, the College of Engineering has a longitudinal tracking system. The database tracks information about students ranging from math placement scores, grades, academic standing, retention within the program, and the number of quarters required to graduate The following table shows the retention rates for students in the first two years of the Introduction to Engineering (IE) Program The data shows a positive trend towards persistence in the sophomore year for all groups. By the junior year, however, the first group of pilot students is persisting at a rate 20% greater than the control group. The students in the pilot and control groups for the 1998-1999 school year and the 1999-2000 school year will continue to be tracked as they progress through to graduation.

Groups	Started the IE Program	Returned to COE (Sophomore year)	Retention Rate	Returned to COE (Junior Year)	Retention Rate
1998-1999 Pilot	105	94	89.5%	72	68.6%
1998-1999 Control	85	77	90.5%	37	48%
1999-2000 Pilot	275	250	91%		
1999-2000 Control	121	109	90%		

5.0 Summary

The assessment plan, guidelines, and supporting evaluation materials were designed to provide data that the Instructional Team, the College Committee on Academic Affairs, and the faculty's Core Curriculum Committee could use to determine the future structure and content of the Introduction to Engineering Program. In October 1999, at the outset of the program's second year, the faculty of the College of Engineering voted to accept the Introduction to Engineering as a formal part of the freshman curriculum. The program is now in its third academic year, with 720 students enrolled for the current year.

The groundwork has been laid for tracking these students as they progress throughout their college years and for making judgments about the long-term benefits of a "hands-on" approach to learning. The IE Program Assessment Plan has been maintained into its third year to ensure ongoing evaluation of the program's goals and to help guide continuous improvement of the curriculum.

Bibliographies

Dr. Merrill received his Ph.D. in Instructional Design and Technology from The Ohio State University in 1985. He has an extensive background in public education, corporate training, and contract research He is currently Program Manager for the Introduction to Engineering (IE) Program at The Ohio State University. His responsibilities include management and assessment for the IE Program, including the use of web-based instruments. He also collaborates with the Associate Dean for Academic Affairs/Student Services, and with key faculty, in the establishment of outcome-based assessment processes. These activities were instrumental in helping the College of Engineering prepare for its accreditation visit under new criteria issued by the national Accreditation Board for Engineering and Technology (ABET). He is a co-recipient of the Boyer Award for Excellence in Teaching Innovation, The Ohio State University, May 1999.