Combining A Freshman Year Seminar With A Design And Build Experience

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Abstract

The University of South Carolina is the home of the National Resource Center for the Freshman Year Experience and Students in Transition. A product of the center is a course called University 101. University 101 (U101) is a nationally recognized freshman year seminar course designed specifically for new students to maximize the student's potential to achieve academic success. This year the College of Engineering at the University of South Carolina required that U101 be taken by all incoming engineering students. The result of this requirement is nine engineering specific sections of the course called University 101 for Engineers (U101-E). The engineering specific content is delivered through a *design and build experience* where freshman engineering students are introduced to the design process through a design project. This paper describes, in a chronological manner, the development of the U101-E course. The course combines the student success content of the U101 freshman year seminar with the engineering content of a design and build experience.

Introduction

In 1972 the University of South Carolina introduced a course called University 101 as an experimental course in response to student riots in 1970 protesting the Vietnam War and other perceived social injustices. The purpose of the course was to establish an open dialogue between students, faculty, staff, and administrators. In the vernacular of the period, the course was a rap session. The course has gone through several transitions, its most recent in the early 1990's when it became a freshman year seminar aimed at maximizing student retention by delivering strategies for academic success. The present course catalog description reads:

> UNIV 101 THE STUDENT IN THE UNIVERSITY (3 credit hours). The purposes of higher education and potential roles of the student within the university. Open to freshmen. Also open to other undergraduate students in their first semester of enrollment.

In 1996, 85% of all incoming freshmen enrolled in U101. The College of Engineering at the University did not ask their students to take this class. Yet, that same year, one-hundred freshman engineering students (43%) enrolled in U101 on their own initiative earning no credit toward their degree. These students recognized that U101 participants have a higher probability of returning for their sophomore year and they wanted to increase their odds of success. The two main reasons the College of Engineering did not give credit for U101 are: 1) the 3 additional credit hours the course would add to a burgeoning 125-132 hour curriculum; and 2) the faculty perception that an unconnected student success course in the engineering curriculum would not have a large impact on student retention.

The University of South Carolina is not unlike most universities with engineering curriculums; retaining students who start in engineering is low. The College of Engineering at the University of South Carolina also has a large minority student body—33.2% of 246 entering freshman engineering students in 1996 were African-American. Retention rates for these students is lower than non-minority students. The existing Introduction to Engineering course (ENGR-101) was not directly addressing student success issues; therefore, the issue of retention was not a planned outcome of the course. The course delivered the typical introduction to engineering content of computer use and did have a design project in 1996 with a design competition.

The ENGR-101 course has had a history of being a contentious course, one that always changed, and one that has never had long time ownership or stewardship. Due to the lack of a stewardship, its content varied from section to section, and the content changed from semester to semester. In the recent past, some professors taught computer tools such as Excel spreadsheets, while others taught mathematical symbolic processors such as Mathcad and Mathematica. A few stuck to teaching Fortran programming up until 1995. There was no uniformity, and again, student success strategies in engineering was not a planned outcome. Professors did not want to teach the course. It became a course described as "the unwilling teaching the uninformed."

In the Spring of 1997, under the auspices of a new dean in the College of Engineering, the issue of student retention was looked at from a new perspective. The Dean persuaded the faculty to add University 101 to the curriculum and drop ENGR-101, Introduction to Engineering. This change addressed the first faculty concern of adding three hours to the engineering curriculum. The second concern, U101 being an unconnected student success course, was assuaged by making U101 college specific. The new course is called University 101 for Engineers, and a U101-E Coordinator for the effort was assigned to take ownership of the course to plan it, organize it, and insure a uniform delivery of student success

issues with an engineering bent. If the goal of the campus version of University 101 (see in Figure 1) is to facilitate success as a university student; the goal of University 101 for engineers is to facilitate success as an engineer student.

FIGURE 1 – U101 First Year Seminar Content

U101-E Launching Point

Course planning kicked off in early May 1997 when six faculty members attended the NSF sponsored Chautauqua series short course on "Enhancing Student Success Through a Model Introduction to Engineering Course". The same workshop will be offered March 19-21, 1998 in Los Angeles, and May 18-20, 1998 in Pittsburgh[1]. The three-day workshop was attended by the Dean of the College, Associate Dean of Academic Affairs, Chair of the Mechanical Engineering Department, an Associate Professor, and two Assistant Professors. The purpose of the short course was to show how student success issues could be delivered to an audience of engineering students.

The information put forth in the short course was valuable. Equally valuable was the opportunity for the six USC participants to hear what other schools were doing with their introduction to engineering course. The course also gave the six USC participants the opportunity to engage in discussions—without on-campus distractions—about how their U101-E course should be structured. As a result of the workshop and its after hours discussions, the six agreed on a model for U101-E.

The course would be the intersection of three main components (see Figure 2): i) the student success issues seen in the campus U101; ii) the technology content seen in the previously offered introduction to engineering course; and iii) the design process which would be used to deliver the course in an interesting and stimulating manner.

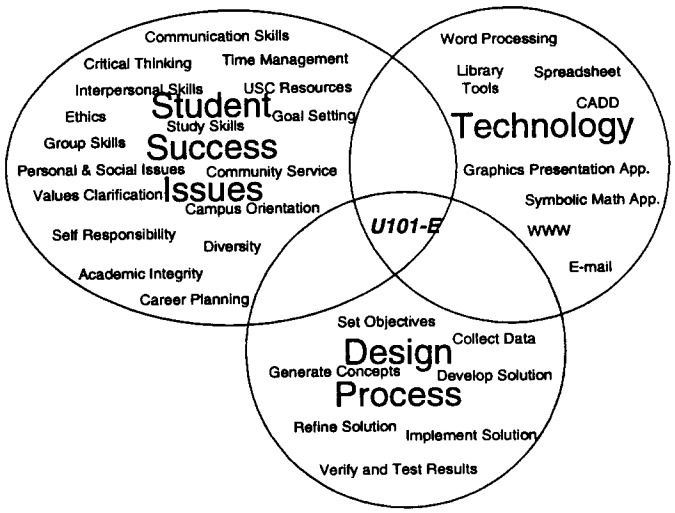

FIGURE 2 – U101-E Course Content

After the May Chautauqua series short course, the U101-E Coordinator attended a four-day workshop in mid-May 1997 offered by the U101 Office for instructors of the campus U101 course. This workshop is offered once a year and non-USC people are welcomed[2]. This was a very valuable workshop because it gave the U101-E Coordinator a perspective on the history, the present content, and the delivery methods of the campus U101 class.

Working with the campus U101 Office, the College of Engineering offered in late-May 1997, an abbreviated two-day version of the four-day workshop for sections of U101 that are engineering, and science and math specific. A requirement was made that to teach U101-E, a faculty member must attend this workshop. All the faculty and staff teaching U101-E attended the course. Faculty from regional campuses and technical colleges in South Carolina also attended, because they will be teaching it at their campuses.

The USC-Columbia campus welcomes a lot of transfer students from the regional campuses and technical colleges. In fact, 43% of students who graduate from USC do not start at USC. Instructors at these institutions were invited to participate in the course development stage since it has a direct impact on how they teach their course from the point of view of satisfying transfer credit requirements.

Because all U101 sections have a strong writing component in them, the U101-E Coordinator attended a workshop on Engineering Writing and Professional Communications Centers in June 1997. This was a NSF Gateway Coalition of Engineering Colleges sponsored workshop and will be offered again. Those in attendance were individuals representing Gateway schools, SUCCEED Coalition colleges, and other institutions involved in engineering or professional education.

[1] Contact Raymond B. Landis for additional information at 213-343-4500 or rlandis@calstatela.edu.

[2] Contact the National Resource Center for the Freshman Year Experience and Students in Transition for further information at 803-777-6029 or fyeconf@ss1.csd.sc.edu.

Referring back to Figure 2, engineering faculty are familiar with the design process and the technology tools used in engineering. What most engineering educators lack is the knowledge of how to facilitate student success issues. Attending the aforementioned workshops gave the U101-E Coordinator and instructors a sense of how these issues could be addressed in an engineering context.

Upon the completion of the workshops, the U101-E course started to take shape. The purpose of the course is to convey the essence of what engineering is and what an engineer does. Some of the desired outcomes of the course are:

- the course will excite students about the practice of engineering;
- it will maximize the student's potential to succeed;
- students will develop a better understanding of the learning process as it applies to engineering education;
- students will acquire essential academic survival skills;
- students will be exposed to college specific technology resources;
- reading, writing, and presenting will be an integral part of the course;
- the design process will make the course "fun".

Course Development

After going through the workshops, the architects of the course had a good idea of what content they wanted to deliver; they now had to sit down and hammer out the details. The first detail the instructors looked at were the University's U101 requirements.

To qualify as a University 101 class, four programmed events must be included in every U101 syllabus. The events are: i) a sexual responsibility program; ii) a drug and alcohol intervention program; iii) a career planning program; and iv) an introduction to the library program. Instructors are also required to put in their syllabus a class on the responsible use of email and the internet. The last U101 requirement is that students must perform at least ten hours of community service.

The engineering sections set a few more requirements themselves. We require students to join at least one college student organization. The students have the choice of joining ASME, IEEE, AIChE, SAE, NSBE, and SWE. To become more integrated in campus life, we also asked the students to join a campus student organization.

We also require the students to buy a 3-ring loose leaf binder, the cover of which is shown in Figure 3. Directly below the cover image, the student's name appears in bold. The student's name also appears on the spine of the binder. The reason for the binder is so students can easily identify their fellow engineering classmates, regardless of whether the students are in the same section. They can approach each other and address the student by name in non-engineering classes, dorms, libraries, or anywhere on campus. This is to promote esprit de corps, and to promote students to associate with each other as they work on a common goal of obtaining an engineering degree.

The students keep three sections of the binder. One section contains design project information; the second, samples of their student writing; and the third, their completed homework assignments. The binder is referred to as their freshman year experience (FYE) portfolio. A portfolio they can show to prospective co-op employers and to others interested in their freshman year experience at the University of South Carolina.

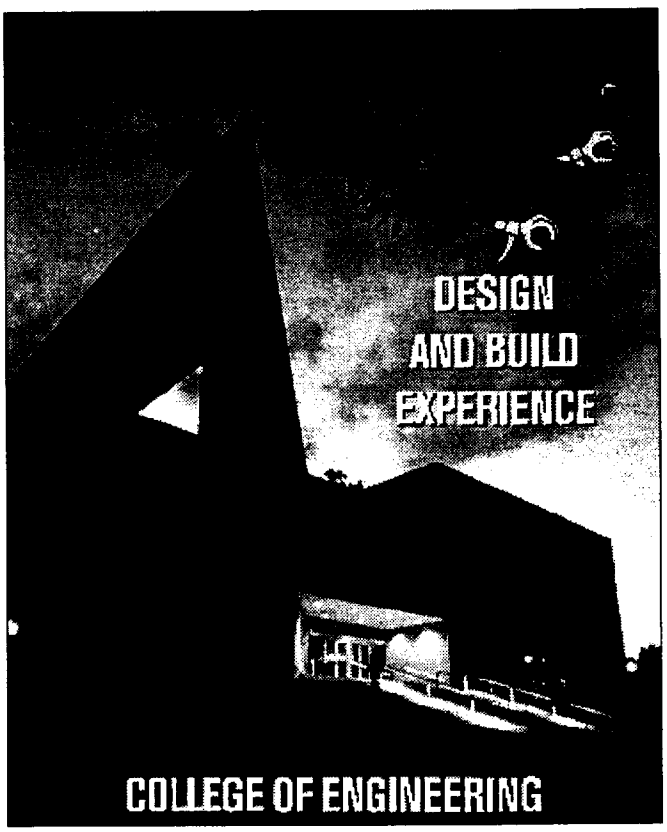

FIGURE 3 – Cover of FYE Portfolio Binder

The structure of the class is to place the responsibility of learning in the students' hands. There are very few lectures. The instructors act as in-class facilitators to direct and orchestrate in-class discussions. The beginning of the course focuses on student success issues using Landis [1]. The first chapters of Landis cover keys to academic success in engineering and the engineering profession. To further support the introduction to the engineering profession and the roles engineers play in society, the students are asked to read selected chapters out of *To Engineer is Human* [2]. This book is supplemented with a 50-minute videotape [3] of the same name.

During the beginning of the semester the students are introduced to the College's computer resources. Here the students learn how to use email, the internet, word-processing,

and spreadsheets. We are given the luxury of spending very little time on teaching computer applications, because students already know them. In years past, when teaching introduction to engineering, this was not a luxury we were afforded. A class or two is spent orienting them to the computer resources and that is presently all that is required. University and college resources are also introduced through *Scavenger Hunts*. In the scavenger hunts the students are forced to be resourceful, self-reliant, and seek help, to find their way around the college and campus to locate certain resources and laboratories. Feedback from the students about the scavenger hunts have been positive; students say they are an effective way of campus and college orientation. An example of one of the scavenger hunts is given in the Appendix.

Other class activities involve bringing in a panel of upperclassmen that hold court to address students' questions and concerns about studying engineering. The first panel discussion was started by the instructor asking the panel, "What would you do different if you had your freshman year to do all over again?" The students in U101-E responded well to this type of forum.

The students are also given the Keirsey Sorter personality type test. The test proved to be a free alternative to the Myers Briggs Type Indicator test. The students point their browser at http://keirsey.com/ and take the test online. The personality typing results are used to point out strengths and weakness of the students as they apply to being a successful engineering student. The results are also used for career planning purposes along with the Strong Interest Inventory [4] evaluation. Both evaluations are given before academic advisement for the following semester.

Design Project

Design distinguishes the engineer from many professions. Starting with this premise we let the students experience what engineers do by bringing them through the design process. The design process cuts across all engineering disciplines because all engineers create; therefore, all engineers design.

The architects of the course seized on the opportunity of a community service project that is tied to the design project. Several community service projects were evaluated but one stood out among all of them, and it was the designing and building of Habitat for Humanity utility sheds. A design and build project like this had been done before through the NSF sponsored SUCEED coalition [5]. It was decided to use the coalition's experience to launch the U101-E design project and expand it to a larger scale of 240 students.

The timing of the project could not have worked out better for the Central South Carolina Habitat for Humanity (HFH) local chapter and the U101-E students who would serve as the contractors for constructing the utility sheds. In September, 1997 the Central S.C. HFH chapter kicked off its September Blitz where they constructed seven Habitat homes in eight days. The College of Engineering agreed to construct all seven utility sheds for each of the Habitat homes. Participation in the project satisfied some, if not all, of the 10 hours of community service work required by the University 101 office. The material for the construction of the sheds was the left over scrap wood from the seven homes built during the September Blitz. Figure 4 shows the students collecting the scrap after the September Blitz. Using scrap allowed us to fold in sustainable design and development into the course. The sustainable design course content was further supported by readings from a short text that discussed man's impact on society through the tracking of the product life of everyday things [6]. Be warned, the students found this text interesting but a bit depressing at times.

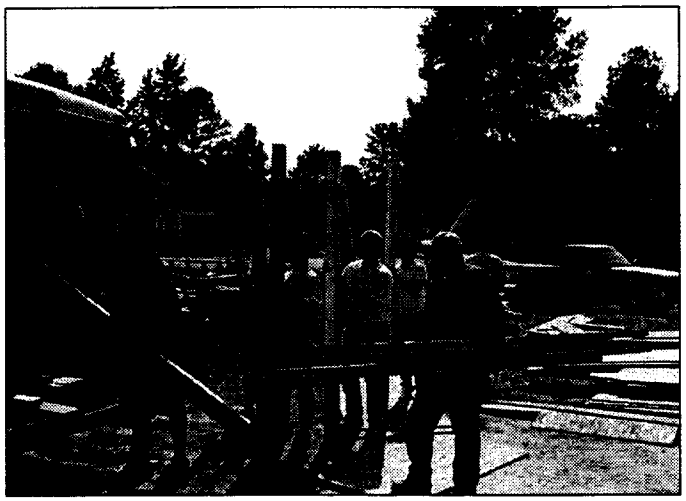

FIGURE 4 – Scrap Pickup from September Blitz Site

The students were presented with the fundamentals of the design process in sequential steps. The first step was to establish teams. A student questionnaire was completed by each student (see Appendix). Based on the results of the questionnaire, each instructor formed teams of four that complemented each other. For example; every team had at least one team member with a car on-campus, and every team had at least one person who had carpentry or woodworking skills. To promote an equal voice and contribution, women in the class were placed in pairs on the teams. A single team member was elected as team leader and collected $20 from every team member to cover any project material cost not covered by Habitat or the College. The money was also used to cover transportation costs for the individuals with cars.

Once the teams were established the next step was for them to evaluate four existing utility sheds through the benchmarking process [7]. Included as one of the four benchmark sheds was an existing HFH shed they were to improve upon. A fifth benchmark shed, the proposed team benchmark, was added to the list.

The students established over 40 design evaluation criteria using *quality function deployment*, QFD [7]. QFD requires the designers to identify the customers and then, "listen to the voice of the customers," in order to identify the

needs, wants, and desires of the customers. The identified customers were: the HFH building supervisors, the HFH homeowner, the professors teaching the class, and the students themselves. The students identified themselves as the customers because they were the ones that were going to be building the sheds, and they wanted to keep it simply.

The five benchmarked sheds were evaluated in an evaluation matrix [8, 9] using the 40+ design criteria. Based on this evaluation the teams submitted a preliminary design study that contained sketches and accompanying documentation to support their design. The students then went to work on building a prototype 1/6th scale balsa wood model of their utility shed. After completing the model the teams put together a detailed design study which included detail drawings, assembly plans, and a bill of materials.

Two design competitions were then held. The first competition was an in-class competition. Each class section had no more than twenty-eight students, so no more than seven teams were in each section. Judges of the in-class competition were instructors and teaching assistants from the other nine sections of U101-E. The team winner of the in-class competition then received input from their fellow classmates to enhance their design before submitting it to the intra-college competition. The intra-college competition was judged by HFH construction personnel, who chose the winner based on their needs. The winning team's design was enhanced once again by the entire U101-E class body and the final design was used as a template to build all seven utility sheds. Selecting a single winning design by HFH personnel insured that Habitat was getting a uniform product and a product that they indeed wanted.

The final step was the actual construction of the sheds. One of the major design constraints that pushed the students the most was the contrived requirement that the U101-E instructors came up with, which was that the shed must be erected in an hour. This forced the students to put a lot of planning into their design and also forced them to build the sheds in a modular fashion. Some interesting designs were the result of this single design constraint. Figure 5 shows the students preparing the modular sections for transportation out to the build site.

On November 22, 1997 a crew of six students per shed (42 students total) set out to construct the seven utility sheds. Though the design constraint of erecting the shed in one hour was met, the completion of the shed (painting, hanging the door, applying roofing material, transportation, cleanup, etc...) took a total of seven hours.

The Central South Carolina chapter for Habitat for Humanity are very pleased with the sheds the students constructed (Figure 6). At the completion of project, the students handed over to Habitat the completed design details of the shed—this included detailed drawings, assembly instructions, and bill of materials. Upon receiving the completed design, Habitat commented that they plan on using the same design on their utility sheds for many years to come.

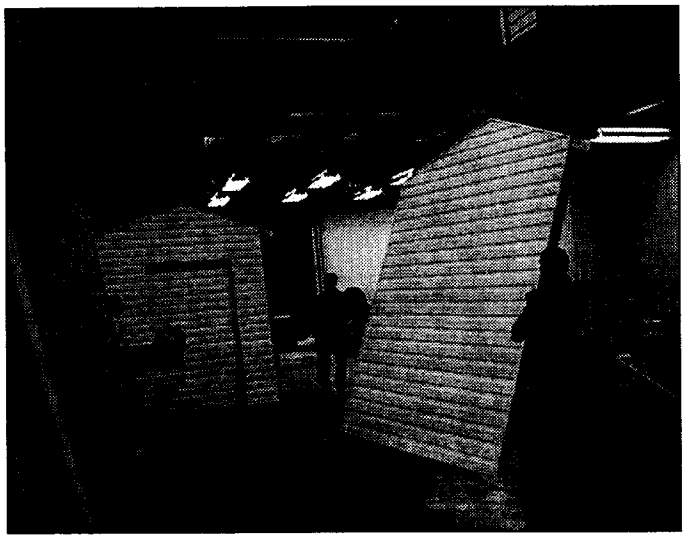

FIGURE 5 – Students Moving Modular Sections

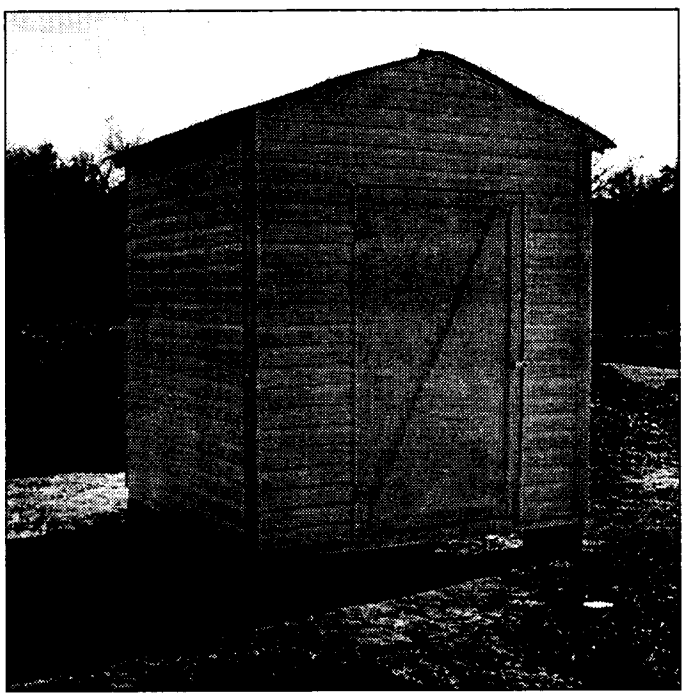

FIGURE 6 – One of the Seven Completed Utility Sheds

Freshman Design and Build Shop

A Freshman Design and Build Shop was established in the college to allow the students to build their 1/6th scale balsa wood prototypes of their utility sheds, and to allow the students to build their full-scale sheds on-campus in a modular fashion. The shop consists of workbenches, hand tools, glue guns, and small power tools (drills and sanders) for the students. The shop is open thirty-five hours a week, mainly in the weekday afternoons and evenings, Saturday morning, and

Sunday afternoon. Shop hours are covered by seven ¼-time (10 hours/week) senior engineering teaching assistants who are directed by one ½-time graduate teaching assistant. The teaching assistants checkout tools, and are trained to run a radial arm saw for cutting wood for the students. Work orders requested by the students are turned around in 24-hours by the teaching assistants.

At the beginning of the semester the teaching assistants were not required in the shop and they covered 35-hours as roaming tutors in the computer labs. Students who were having computer difficulty were directed to show up in the computer lab during the posted teaching assistant hours.

Freshman Writing Program

Many engineers lack confidence in their writing ability. Many engineers actual say that they decided to be an engineer because they cannot write. In the U101-E class we stress that writing is a process that can be taught just like any other process. We make writing a major component of the U101-E for this very reason—to teach writing as a process. To facilitate this effort, a Freshman Writing Program was established. All the instructors and teaching assistants involved in the U101-E course attended a workshop on how to respond to freshman writing. This is a very new and foreign experience for most engineering faculty and the workshop was very helpful in guiding and directing faculty how to use writing in their class. The Freshman Writing Program has a Writing Center that students who are identified as having writing difficulties can use it to sharpen their writing technique. The Writing Center is open 27-hours a week and consultants from the Writing Center come into the classroom for two in-class visits during the semester. The Writing Center helps students with planning their papers, organizing a report, making sentences clearer, proofreading their own work, and becoming more confident writers.

High School Outreach

The last component of the new freshman U101-E course is the High School Outreach program. Three times a week for the full school year the Introduction to Engineering course is taught at a local high school. A select group of high school seniors, who have stated their interest in pursuing an engineering degree, participate in the program. They participated in the HFH design project and took part in the design competitions and the construction process. The purpose of the program is to teach the students the difference between engineering and science. As Theodore von Kármán (Hungarian-born American research engineer best known for his pioneering work in the use of mathematics and the basic sciences in aeronautics and astronautics. His laboratory at the California Institute of Technology later became the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory) said, "Scientist explore what is. Engineers create what has not been." This is promoted in the high school. Another benefit of the program is that it is hoped the outreach program will be an effective recruiting tool to attract some of the State of South Carolina's best and brightest to study engineering at USC.

Conclusion

The goal of the U101-E course is to integrate engineering content into the U101 course that has been traditionally taught as a non-major-specific student success course. The students learn orientation to campus and college resources. They are promoted to discover these resources in a self-reliant manner which is a key to life-long learning. The students are introduced to the engineering profession through the product realization process. They learn teaming skills, sharpen their computer skills, and learn how to express themselves better in writing.

Much work has been done in developing this course in a short time period. Much work needs to be done to grow this course into a well established and well liked course; one that engineering faculty will be enthusiastic to teach. Assessment tools need to be developed and tested. Metrics need to be established. There is only one metric now—as articulated by the Dean of the College who was in the trenches teaching a section of U101-E himself—that is; at the end of the sophomore year we want our students when asked about the best class to date to say, U101-E was that class.

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Appendix

Sample Scavenger Hunt

1. Math lab.
   a) Where is the Math Lab it located?
   b) What are its hours?
   c) What services are offered to you?
   d) Get a signature of a person working there.
2. Computer Labs for the college of engineering.
   a) What rooms are open for engineering students in the college and how many computers are in each?
   b) Where is the computer help desk?
   c) What is your computer account login name?
   d) What is your global e-mail address?
   e) What is your instructor's e-mail address?
   f) Send an e-mail to your instructor.
   g) Get a signature of a person at the help desk.
3. Physical Education (PE) Center.
   a) Where is the PE center?
   b) How many Courts are available for general use? (Pick one Racquetball, Tennis, or Basketball)
   c) What are 3 pieces of equipment you can check out?
   d) What is required to get a locker in the PE center?
   e) What are their normal hours?
   f) Get a signature of a person at the equipment desk.

Student Questionnaire

1. Name (as you would like to be called):
2. Male or Female: Age:
3. Do you have a car here on campus?
4. Mechanical Drafting or Computer-Aided Drawing and Drafting Experience; if so, what CADD package?
5. What computer software application skills do you have and assess your knowledge level on a scale of 1 to 10?
6. Have you ever used:
   a) Hammer b) Handsaw c)Glue Gun
   d) Miter saw e) Power Drill f) Other...
7. Do you live on or off campus? Where?
8. Describe some marketable skills for yourself; e.g., computer knowledge, auto-mechanic, carpentry, woodworking, electronics, etc...
9. What is your course schedule?

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David Rocheleau received all three of his degrees in Mechanical Engineering. He received his Bachelors of Science from the University of Vermont in 1981; his Masters of Science from the University of Illinois, Urbana-Champaign in 1986; and his Doctorate from the University of Florida in 1992. He has worked as a Field Engineer for Schlumberger Well Services in Midland, TX.; a Software Engineer for Computervision, Inc. in Bedford, MA., and is currently an Assistant Professor in the Department of Mechanical Engineering at the University of South Carolina in Columbia, SC. Dr. Rocheleau has served as the University 101 for Engineers Freshman Year Coordinator since April, 1997. When Dr. Rocheleau is not busy coordinating the Freshman Year Experience for the College of Engineering, he enjoys pursuing his research interest in applied mechanisms, robotics, and computer-aided engineering.