### AC 2012-3282: THE GENESIS OF TRANSFORMATION: PREVENTING "FAILURE TO LAUNCH" SYNDROME IN GENERATION IY FIRST-YEAR ENGINEERING STUDENTS

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# THE GENESIS OF TRANSFORMATION: Preventing "Failure to Launch" Syndrome in Generation iY First Year Engineering Students

### Introduction

Students who fail to identify with engineering at the very beginning of their studies will often become retention statistics. The second semester is already too late to introduce students to engineering activities, and the senior year is too late to introduce professionalism in order for students to make the successful transition to workplace engineer. In order to combat high attrition rates and prepare students to be the engineers of 2020, the first course in engineering has been reworked and implemented at LeTourneau University.

This new course, required for all first year engineering students, is intended to increase retention in the engineering program by providing "iY Generation" students with a realistic view of what "real" engineers do and what is expected of engineering students. The course attempts to engage this new type of first semester engineering student with engineering flavored in-class activities and labs (e.g. wind generator design with wind tunnel testing) to provide a balance to the non-engineering core courses (Calculus, Chemistry, English) that fill the first year of the engineering curriculum.

Lesson modules lay the foundations for success in engineering education by providing strong guidance in the area of study discipline, work quality expectations, classroom discipline (both behavioral and note taking techniques), and pride in the profession. Assignments work to jumpstart certain basic engineering science topics that are historically stumbling blocks during the second semester and for second year engineering students (e.g. statics, circuits, vectors, basic mechanics).

This course begins the "Transformation to Professionalism" through introduction of professional topics necessary for success both during and outside the academic realm. Topics covered include codes and standards, professional licensure, colleague and supervisorial relationships, professional societies, litigation and deposition, ethics, meeting behavior, conferences, exposition and professional meetings systems. Simultaneously, the course aims to establish a learning environment that better represents "the real working world" than might be seen in other first-year classes. For some, this is their first introduction to the concept of adjusting oneself to a standard rather than expecting the environment to "part and make way" for the individual. This includes more disciplined, more clearly defined, and perhaps more rigid expectations of assignment due dates and times, while simultaneously providing the motivation and justification for the student to aspire to such standards.

### Need for the course

The revision of the freshman course grew primarily out of a retention initiative at LeTourneau University. The school found itself losing several new students at the end of the first semester and more at the end of the freshman year. Surveys indicated that students were losing motivation to study engineering, in part because they had not yet experienced any engineering work. It seemed that it was easy for new students to get bogged down in calculus and foundational science courses and lose focus on the end goal that had motivated them to enroll in the engineering school in the first place. Students need to see real engineering during their first

semester. They need to see engineering as an exciting career path. After conducting a multi-year study on retention, Neimi reported:

"Loss of interest and motivation is clearly one of the strongest factors across the board. For engineering students, we and others believe that this is preceded by a loss of vision leading to a loss of purpose. When they find themselves academically challenged, many of them for the first time in their lives, and their view of the goal is obscured because their understanding of what it represents is inadequately developed, they lack the purpose necessary to persevere. We believe this ties directly into the poor academic performance which becomes the immediate reason for their withdrawal.<sup>1</sup>"

Thus, a significant part of the retention initiative became to create a new course for the first semester that would primarily address the question, "What do engineers actually do?" The intention being that if students had a solid concept of what lay beyond the first three semesters fresh in their mind, they would be more likely to endure through the foundational courses and succeed in achieving an engineering degree. The content of this new course would be geared toward introducing the practice of Engineering and the delivery method would be designed to mesh well with the learning style and behaviors of the new generation of freshmen. The new first course was adopted into LeTourneau's engineering program as part of a comprehensive five part freshman experience:

Part I - Introduction to Engineering Practice I (this course - first semester, 3 credit hours)
Part II - Engineering Cornerstones (first semester, one hour credit – Introduction to the university mission and values, including study skills, lifelong learning, critical thinking)
Part III - Manufacturing Processes Lab (first semester, one credit – Introduction to hands-on

processes in the Machine Tool lab and in the Welding lab)

- Part IV FIG groups First-Year Interest Groups Groupings of students by major/concentration with a Peer Advisor and faculty mentor of the same discipline
- Part V Introduction to Engineering practice II (second semester -An introduction to the design process, communication, and further professional skills)

### Approaches to freshmen courses

A number of approaches to "the freshman engineering course" are in place at various institutions. These range from a pure graphics and solids modeling course, to courses that introduce engineering problem solving, to courses that explore the various engineering disciplines and the profession as a whole. Many of the currently available first year engineering texts present some combination of these various components. For the previous 20 years, the first semester course in our engineering curriculum was Engineering Graphics, which evolved from a pure board drafting course to eventually include AutoCad to a primarily SolidWorks based experience. While this provided a good background in spatial manipulation and visualization and CAD, it gave little insight into the work of an engineer.

In looking at several dozen first semester courses in engineering at other institutions, there seem to be six basic approaches that faculty take to these courses. Courses usually focus on one of the following areas or present a course which is a combination of several of these concepts.

- 1. Primarily Engineering Graphics (drafting, spatial manipulation, Inventor, ProEngineer, SolidWorks)
- 2. Study skills and success ideas (Landis<sup>2</sup>)
- 3. Introduction to the profession and various disciplines, including EE, ME, Civil (Engineering Your Future- Oakes et. al.<sup>3</sup>)
- 4. Introduction to the design process, with a one-semester design project
- 5. Introduction to engineering problem solving with an introduction to principles from circuits, statics, and thermodynamics (Eide et.al.<sup>4</sup>)
- 6. Introduction to engineering thinking and engineering skills (Stephan et. al.-Thinking Like an Engineer <sup>5</sup>)

Our goal became to combine the best of each approach while focusing throughout the course on the question, "What do engineers actually do?" Previous studies by Trevelyan and others have served to define what an engineer does in the course of executing their professional duties<sup>6</sup>. A composite list of tasks that engineers tackle became central to the goal of introducing as many "real engineering tasks" as possible into the course. These tasks were divided into six categories and are presented in Table 1.

General Tasks	Theory and Practice	Decision Making	Competencies	Communication	Practical
Solve technical problems	Analyze designs	Deal with cost issues	Apply math and science	Give oral Presentations	Take theory to practice
Plan projects	Lay out systems	Analyze data	Use technical software	Oversee construction	Transform energy
Develop designs	Evaluate needs	Weigh alternatives and select options	Deal with standards	Communicate graphically	Deal with materials
Work in teams	Perform technical experiments	Deal with ethical issues	Define specifications	Communicate data	Develop processes and products
Communicate technical ideas	Estimate solutions	Make decisions, usually under some uncertainty	Perform calculations	Write reports	Investigate failures
Develop new products	Model and Simulate systems		Make technical measurements		Setup manufacturing

Table 1: What Do Engineers Do?

# The New Half Generation of Engineers

One might ask, "Why is the transition to engineer and professional more difficult for the recent classes of young engineers?" Have we not been training engineering students with great success for more than a century in this country? The answer is readily revealed in the research of Tim Elmore and his large scale study of the half generation of Americans born after 1990.

"Generation iY are the younger Millennials born after 1990. Their world has been defined by technology and shaped by the Internet— iPod, iBook, iPhone, iChat, iMovie, iPad, and iTunes—and for many of them, life is pretty much about "I." Generation Y is the largest generation in American history and the second half of this generation is different than the first half, measurably different.<sup>7</sup>"

Elmore argues that professors, mentors, and parents need to change the way that they interact with this generation, "so that they can grow into adulthood and be the leaders they need to be." Five major problems can be cited as the largest source of frustration for these new engineering students and as a reason for failure to successfully launch into engineering studies.

- 1. College is largely a cultural change, a cross-cultural adaptation, from high school [or home school] culture to professional culture.
- 2. Students are not used to the rigors of college courses (2-3 hours of outside work per hour of class time). Most that are bright enough to pursue engineering studies state that they "never" or "very rarely" did any homework during high school.
- 3. While science and mathematics are somewhat familiar, all of engineering design processes, open-ended problem solving, client-based needs analysis, and professional technical communication is totally new territory.
- 4. Most entering students are part of the "iY Generation," and don't think or learn like previous generations of students. These students have spent their entire life giving their opinions (blogs, Facebook, twitter, etc.) and thus largely define their sense of self worth by what they "upload" and not by what they "download."
- 5. Many entering students have been heavily influenced by a postmodern culture. "These kids really do desire to change the world; they just don't have what it takes to accomplish their lofty dreams. When the work becomes difficult, they change their minds and move on to something else. The new term for them is 'slactivists' – they are both slackers and activists.<sup>7</sup>"

As the list of "what engineers do" defined the content of the course, these five considerations helped to shape the delivery method, so as to be somewhat palatable while simultaneously transforming for the first year engineering students.

# Initiating the transition to Professionalism

Unlike law and medicine, engineering prepares professionals from an undergraduate curriculum. This means that upon receiving a four-year degree, young engineers are expected to hold and present themselves at the same level that other professionals do after several additional years of in-situ residencies and practicum. In order to lead students through a transition to professionalism, the aspects that define the profession and professionalism itself must first be understood. The basic aspects that define a professional are the following:

- 1. Understanding the purpose and basic knowledge of the profession
- 2. Developing a sense of identity with the profession ("I am preparing to be an engineer.")
- 3. Developing expertise to act with competence
- 4. Having a sense of responsibility in carrying out one's work
- 5. Understanding and endorsing the ethical standards of the profession
- 6. Having a sense of serving the public through the profession
- 7. Developing a professional manner in presenting oneself through speaking and writing

The primary challenge in instilling a desire to achieve a transformation from high school student to highly marketable professional is in linking the new behaviors with something that the engineering student already values. As Kirk summarized from his analysis of the process of seeding professionalism in students,

"Various studies have suggested that several steps are involved in teaching professionalism: setting expectations, performing assessments, remediating inappropriate behaviors, preventing inappropriate behaviors, and implementing a cultural change. The first step is defining the characteristics of expected behavior for the institution. Policy statements can be developed that detail unacceptable behaviors.<sup>8</sup>"

Professionalism concepts were introduced beginning with the first class period. Students are encouraged to see the goal of their education as being to become engineers and professionals, as opposed to just graduating from college. They will soon be worth much more (by salary) than a high school graduate. This will be based on what they know and what they can do – the Engineering competencies. Their paradigm of work must also change; no one will pay them simply to look up equations or to find information on the Internet. Instead, they will be valuable because of what they know, what they can apply, and the problems they are able to solve. Copying and pasting from web sites is not research, rather, Internet resources should be used to point them towards primary sources of information. Preparing students for professionalism from the first day of class includes simple rules that can become positive habits as they are consistently practiced. The launching mantra of professionalism is given in class, "As you will do in the business meeting, so practice in the classroom." This included basic expectations such as the following:

- 1. No cell phones during class (including texting)
- 2. No laptop use during lecture
- 3. Appropriate attire. (No hats on in class, no pajamas, no bare feet)

- 4. Communicate with faculty by business quality email, not text vernacular in email format
- 5. Turn in clean, complete, and on time homework assignments
- 6. Operate as a team, with a team leader, during the in class activities and in the lab from the first day

After receiving initial homework sets with loose pages, no problem numbers, and only first names, the stack became cleaner and more professional with each subsequent homework set. Details that might seem like standard fare for a junior high English class turn out to be major hurdles for many students: Neatly lettered or printed text, Full name, date, problem set #, Stapled in the corner, Pages or problems numbered. By having clear guidance for homework, with a specific format and defined penalty system, students began to find personal pride in turning in "professional" looking documents.

# Goals of the course

One major outcome of the retention study was a clear set of goals for the new first semester course. The five goals of the course, as delineated by the School of Engineering were:

- 1. Aid retention by introducing engineering activities in the first semester
- 2. Introduce students to what engineering actually is
- 3. Begin to ingrain engineering professionalism
- 4. Create a common foundation for all engineering and engineering technology students
- 5. Develop enjoyable and engaging engineering activities

The list of secondary goals grew rapidly as the Engineering faculty was consulted for what they felt were essential items to include in the first engineering course. Many felt it necessary to create excitement about the engineering profession by getting students involved in a project, using basic engineering tools. Others felt that professional mentoring and involving students with practicing professionals was needed. All engineering faculty agreed that the introduction of fundamental engineering principles, including motion, force, conservation of energy and matter, basic electrical circuits, and computer logic was best done in a first engineering course. Additionally any early introduction to problem-solving, design, innovation, time and cost, and professionalism would be appreciated by upper-division instructors. Teaching systematic approaches to problems and problem solving (not hacking or shotgun approaches) was to bed considered a bonus, though not expected at the introduction level by most faculty.

One of the most oft cited desires of faculty from a student needs perspective was to get rid of bad habits learned in and carried forward from high school. These complaints consisted primarily of:

- Blind dependence on calculators using the calculator without understanding the equation
- Designing solutions before understanding the problem
- Building without first establishing a plan
- Lack of estimation ability, checking whether results are reasonable
- Common algebra mistakes

- Lack of reading for meaning
- Jumping to building solutions before understanding problems and requirements

From the first day of their semester, it was clear that this course needed to help students think like engineers. Planning, systematic problem solving, and choosing solutions based on costs and benefits have to replace Google searches, Facebook votes, and checking responses to Tweeted photos for this generation of students as primary techniques for solving problems. IY students need to consider the answers to these kinds of questions:

How do you solve a problem (stepwise)? What's the difference between an open-ended problem and a single-answer problem? What constrains an open-ended problem? How do you generate multiple solutions? How do you choose a good solution? What makes a good product? How do you estimate an answer? How do you plan any activity? What do parts cost? What saves money? How do you get organized? Where can you find information (besides Google)? How do you present your ideas effectively? How do you present material graphically? How do you break a system into components?

# Structure and content of the course

The current structure of the new Introduction to Engineering course consists of meeting for two one-hour lecture periods per week with an in-class activity included during about 80% of the classes. Selected lecture topics and their associated in class activities are listed in Table 2. Seven lectures are dedicated to Engineering Graphics and Solids Modeling using SolidWorks with associated Graphics labs topics as shown in Table 3. Each student also completes seven highly hands-on engineering lab activities, in a two or four person team, depending on the activity. These lab topics are also given in Table 3. Homework assignments were given on a weekly basis and typically consist of five sections that review the previous class, preview the next class, and offer supplemental engineering topics. A sample homework assignment in this format is attached in Appendix 3. Typical homework sections are as follows:

- 1. Review A review of the current class period's material
- 2. Creativity A creativity-generating question. Think about it and answer the best you can.
- 3. Engineering Science An introduction to engineering science circuits, statics, thermodynamics concepts. Most will require you to read some background material on your own and then attempt some basic problems. (You do not need advanced courses to do these.)
- 4. How Things Work An introduction to the principles behind useful things. Use any resource available. Briefly outline and sketch.

# 5. Prepare for next lecture – Reading or video and questions

Lecture Topic	In Class Activity		
Introduction to the engineering profession	Get to know your team		
Problem Solving	Problem solving method		
Engineering Ethics	New Orleans ethics exercise		
Prototyping and Rapid Prototyping			
Gathering Design Input and Feedback	Decision Matrix Exercise		
Teamwork	Teamwork exercise		
Communications	Written communications and directions		
Communications	exercise		
Design	Schematics and Blueprints		
Engineering Estimation	How many iPods Fermi exercise		
Global Economy Concepts			
Creativity	Creativity and Ideation Methods		
Product Development	Product Evaluation		
Units	Units conversion and dimensions exercise		
Design from Nature	Biomimetic design		
Leadership	Team members issues activity		
Graphing and Spreadsheet Graphing	Data Collection and graphing data from a		
	simple experiment		
Systems Design and Analysis	Systems thinking and bidding exercise		
Programming			
Remote and Third World Engineering			
(Humanitarian Engineering)			
Introduction to the Faculty and their Areas of			
Expertise			

Table 2. Lecture Topics and Associated In Class Activities

Table 3. Engineering and Graphics Labs

Engineering Labs	Graphics Labs			
Lightweight Bridge Design and testing	Sketching			
Digital Logic	Orthographic Projection			
Wind Turbine Design with wind tunnel testing and Data Collection	Spatial Visualization			
Basic Circuits	Assemblies and SolidWorks			
Reverse engineering and Product Dissection	Constructive Solid Geometry			
Lighter than Air R/C vehicle	Geometric Relations			
Timer Circuit Lab	Rapid Prototyping			

Two textbooks have been used for the course thus far, each having its own strengths and weaknesses, and both meshing with the course content in approximately equal, yet different ways. The first year's text was *Thinking Like and Engineer* by Stephan et. al.<sup>5</sup> and the second year's text was *Engineering-Fundamentals and Problem Solving* by Eide et. al.<sup>4</sup>

### **Student responses**

After five sections of the Introduction to Engineering (IEP) course were completed (Fall 2010- 2 sections, Spring 2011 - 1 section, Fall 2011 - 2 sections), student responses were decidedly positive. Students were asked to complete a survey regarding their experiences during the course and their intentions at this point concerning future endeavors in engineering education. Amongst other items relating to perceived challenges and courses enjoyed, students categorized themselves according to the following questions:

I intend to stay at LeTourneau University for the rest of my Bachelor's degree. I intend to stay in Engineering at Letourneau University. I intend to change my major to:

Table 5 shows the combined results from all students in all sections of the new course.

Table 5. Student Survey Outcomes(374 Respondents, representing 98% of students who have taken the course)

Staying in Engineering,				
Staying at the	Staying in	Staying in		Leaving
University, Staying in	Engineering, Staying	Engineering,	Leaving Engineering,	Engineering,
their declared	at the University,	Leaving	Staying at the	Leaving
Discipline	<b>Changing Discipline</b>	University	University	University
79.6%	12.4%	3.5%	1.8%	2.7%

This survey was not given to engineering students before the new course was implemented, but fall to spring retention was tracked as early as AY2009. The most recent data indicates that the fall to spring retention for first time in any college (FTIAC) engineering students was 94.4% compared to 85.7% in 2009. Though it is difficult to ascertain what portion of the retention increase is directly related to this course, it suggests that the overall approach is helping. Statistics for the last three academic years are tabulated in Table 6.

Table 6. Fall to Spring Retention AY 2009 - 2011

Academic Year	SEET FTIACs	Fall SEET Returning Spring	SEET FTIAC Fall to Spring Retention
2009-2010	119	102	85.7
2010-2011	115	102	88.7
2011-2012	124	117	94.4

### **Concluding thoughts**

The iY engineering student can certainly make it through the rigors of the engineering curriculum. Many find themselves starting at an increased deficit of foundational knowledge and study habit than their predecessors of even recent previous generations. With only minor course format changes on the part of the instructor and some increased special attention by the program, these students should be able to make the transition as effectively as previous students.

Though it will take several more years to measure and identify long term effects on retention, ability to complete the engineering course of study, and effectiveness of transition to the professional world, instructors in follow-on courses have already reported higher student motivation, higher work quality, and an increased sense of "professionalism" in students who have had the new Introduction to Engineering Practice course over first year students from previous years.

#### References

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# Appendix 1. In Class Activity sample

# **Engineering Ethics**

As a team, discuss and respond to the following ethics issues for the case of Hurricane Katrina and the subsequent damages to the city of New Orleans, Louisiana.

6. How should society balance the need to preserve natural wetlands with the need to control flooding?

7. Should a double-wall levee be built so that a second wall backs up a breach in the first wall? Is the additional expense warranted?

8. While on vacation in July of 2005, you noticed that the levee had severely eroded in several places. What are your moral obligations as far as reporting your observations?

What if you were a registered engineer at the time?

9. How should engineers design for unexpected events, such as the grain barge that was suspected of hitting the levee?

10. Should there be penalties pursued against those groups who stopped the levee reinforcement with litigation?

Against the judge who ordered the reinforcements stopped?

# **Appendix 2. Homework Directions Sample**

As future leaders in the Engineering Profession, you will be required to follow corporate, industry, federal, and other guidelines in the preparation of almost all work that you submit. Homework is the training tool used at the university level to sharpen your skills at paying attention to detail and transform you from high-school students with great potential into professionals with outstanding communication skills.

- Homework should be typed or, if handwritten, it should be on Engineering Paper (Stadler or Ampad. Ask the instructor if you wish to use another brand). Homework should never be torn out of a spiral notebook.
- Clear communication is the primary goal. If multiple problems can be answered on one page without crowding, then this is acceptable. If a problem is continued across pages, be sure to make annotations to this effect.
- Collate problem answers. This means that if there is a whole page attachment for Problem #1, it should follow directly behind the page containing problem #1. (If it will fit reasonably, it should be included inline.)
- Staple your work before arriving at class. Your homework should be ready for delivery upon entering the room.
- Engineering Science Problems (ES) should be done on Engineering paper using the format given on the course blackboard site.
- Do not print and hand in items that were handed out in class or posted to blackboard. (e.g. Homework assignment sheets, ES lessons, Engineering background handouts, book chapters.) It is useful to state the problem with each problem solution (as shown in the following pages. It is not useful to hand in 5 pages that contain no original work.
- Grade Penalties will be assessed as follows:

Error	Cost in Points	
Not Stapled	- 0.5	
Not Typed or	1	
Handwritten on Non-Engineering Paper	-1	
ES Problem not in given ES Format	-1	
No Name	- Value of Homework	
Late (same day)	- 10%	
Late (after due date)	- 50%	
Extraneous Printed Internet Material Included	-1/2 point per page	

ENGR 1513 IEP 1

HW#3

**Paul Leiffer** 

14 September 2011

#### Problem 1

Problem Statement:

Part A: Given a Stainless Steel pipe of 1/4" nominal pipe size with dimensions and characteristics as shown. Determine the wall thickness at which the ASTM standard for maximum residual hoop stress is within 5% of the 'correct' shell calculation using midplane measurements of diameter.

Part B: Determine the wall thickness at which the ASTM standard for maximum residual hoop stress is within 5% of the 'correct' shell calculation using midplane measurements of diameter. Conduct this calculation for Nominal Pipe Sizes of 1 inch, 2 inch, and 4 inch.

Part C: Compare the results of Part B with the standard Nominal Pipe sizes for Austenitic SS Pipe. Which of the results are close to the known Nominal sizes?

#### **Solution**

Answers answers answers answers answers answers. [Ref 1]

# **Appendix 3. Homework Sample**

### **ENGR 1513 Introduction to Engineering Practice I – Fall 2011** HOMEWORK SET #6 – Due Tuesday, October 4, 2011

- 1. **REVIEW** Estimate the square footage of Glaske Hall. Clearly state your assumptions. Describe your method. Include a relevant sketch (or sketches) with appropriate dimensions. Show all work.
- 2. **REVIEW** Estimate the height of the new light poles on the soccer field using two different methods. (neither method may include climbing the towers or cutting them down) Describe each method. Clearly state your assumptions and provide an appropriate sketch.
- 3. **REVIEW** Choose <u>ONE</u> of the following Fermi Questions and conduct the estimation using the Fermi Method:
  - a) Estimate the number of gallons in the LETU swimming pool.
  - b) Estimate the cost of all the food that you will consume this semester.
  - c) Estimate the weight of one of the LeTourneau machines sitting on the LETU front lawn. (specify which one)
  - d) Estimate the number of raccoons in Texas.
  - e) Estimate the number of pages of homework you will turn in while earning your BS Degree.
  - f) Estimate the number of texts that you will send in your lifetime.
- 4. **CREATIVITY** A current nationwide concern is the possible danger of natural gas pipeline explosions. Suggest a way to monitor subsurface gas lines and gas line connections for leaks without completely digging them up. Discuss who should pay for this new service (individuals, companies, states, federal government).
- 5. **ENGINEERING SCIENCE** Voltage Division (ES#5) Background reading material: Eide text, pg 394-397
- 6. **How Things Work** Research and summarize the principles behind a jet engine. Include a sketch. (Research this briefly and answer in a few sentences. Properly cite your sources.)

# 7. Prepare for Next Lecture

Read Eide text Chapter 4 - Engineering Solutions Solve problem 4.7 using the method described in section 4.4.

Read Introduction to Engineering Background #5. (Expect quiz questions in the future on the highlights of these handouts.)

### **Appendix 4. Laboratory Activity Sample**

ENGR1513 Fall 2011 Engineering Lab #3

# **Dissection, Reverse Engineering, and Redesign**

### Background

Dissection and Reverse Engineering are common components of the design process for working engineers. In order to improve existing products or benchmark the state of the art, engineers often use dissection and reverse engineering.

Dissection is the process of orderly disassembly of an object to its subcomponents. Implied in this process is that the engineer does not know exactly how the assembly was constructed in the first place. Extreme care is required in disassembly, as often the product was not designed to be taken apart easily and in some cases items are intentionally made to be difficult to take apart.

Reverse Engineering is the process of discerning how subcomponents were fabricated or how assemblies were brought together. Through reverse engineering, an engineer can learn what materials were used, how they were processed, and what time saving manufacturing techniques were employed.

### **Required Materials**

Dissection Specimen (Toy or small, multi-piece device) Recording materials (pen, pencil and notebook) Disassembly Tools (Standard Tools provided, specialty tools – if required, must be supplied by the Team) Drawing paper (Engineering graph paper)

### Execution

DURING LAB:

- 2) Disassemble your specimen (carefully) to its lowest required components
  - a. Use your powers of observation to note how the assembly goes together
  - b. In case of a breakage, keep broken pieces together and record how they fit in the assembly
- 3) Count, Name and Number all components

Part #	Nomenclature	Description	Location
1	Top Case	Rubberized plastic cover	Topmost part, held in place with part 2, and 2 snap tabs
2	Attachment Screw	Phillips head, Coarse threaded screw x 0.25 in	Inserted into part 1 through part 3 from bottom
3	Lever Spring	1" x ¼" metal spring	Inserted in part 6, held in place with part 5
etc.	etc.	etc.	etc.

- 4) Divide up components between team members.
- 5) Produce a proper 2 or 3 view sketch of each component, appropriately scaled to fit 1 per page. (components might not all be scaled the same)
- 6) Produce a proper assembly sketch that includes all components in pictorial (isometric) form. Each part to be labeled or have keynote.
- 7) Produce an isometric sketch of the specimen.
- 8) Produce a Materials List (Bill Of Materials) that contains all components along with standard parts (screws, washers, bolts etc). List should include a part number, part name, and quantity required. This list can be on the same sheet as the assembly or separate sheet if space does not permit.

AFTER LAB:

- 9) Finish all drawings, compile into a report with cover page.
- 10) Recommend three design or manufacturing changes to improve the product.

### Deliverables

(Due to your section instructor ONE WEEK from lab date)

Submit a typed laboratory report, containing the following (in this order):

- Cover page
- Description and discussion of manufacturing changes
- Isometric <u>sketch</u> of the assembled specimen
- Assembly <u>sketch</u> that includes a breakdown of all parts
- 1 page, dimensioned, 2 or 3 view <u>sketch</u> for <u>EACH</u> non-standard part
- Bill of Materials that contains all components (including standard parts)

The report must be signed by all members of the group and the report grade will be assigned to all members of the group.

# **Appendix 5. Supplemental Reading Sample**

#### Engineering Background Reading #1 -

What characteristics do employers want in the graduates they hire?

- 1. Strong technical skills
- 2. Honesty and hard work
- 3. Good communication skills
- 4. Ability to work well with others

#### **<u>PHYSICAL PRINCIPLE</u>** - Conservation of mass

Simply stated, mass is neither created nor destroyed. Total mass in a closed (isolated) system will remain constant over time. In chemistry, mass of the products =mass of the reactants.

#### **ENGINEERING CONCEPT** - Input/output

Engineers often think with boxes, an arrow coming in (inputs) and an arrow on the other side going out (outputs). Physical systems relate outputs to inputs. Input might be light or sound or force (or similar). Output might be voltage or velocity or displacement (or similar). Thinking in terms of action boxes or "transfer functions" is the first step in designing systems.



#### **<u>USEFUL COMPONENT</u>** - Battery

A battery is a simple DC voltage source that converts chemical energy to electrical energy. Small batteries supply 1.5 volts, with different total output (milliamp-hours.)



### THINKING SKILLS - Analysis/ Analytical thinking

Solving problems by breaking them down into smaller parts. Solving given problems for basic values of force, displacement, current, voltage,... Identify the problem, the knowns, the unknowns, the approach. Based on the given information, what answer do you find? Five questions engineers regularly ask--

- What is required?
- How can we do this?
- How long will it take?
- What will it cost?
- How will we verify that we have met the goals?

#### **<u>PEOPLE SKILLS</u>** - Approachable (not prickly, like a cactus)

Every so often I hear about a brilliant engineer whose interpersonal skills are so bad that the company basically keeps him locked in a room in the back where he doesn't interact with clients and customers. Like a porcupine, he is said to be "prickly": if you get too close you'll feel the hurt of his sharp words or complaints. Modern engineering is a team-based activity, and graduates need to develop good relational skills, reaching out to others rather than driving them away.

#### **LEADERSHIP CONCEPT** - Competence

Successful leaders must have competence in the area in the area in which they are leading as well as competence in leadership. Those who are following want to have confidence that their leaders know what they're doing. Like creativity, skills in leadership can be developed.

Note: John Maxwell books on leadership

#### **CORE COURSE PREVIEW** - Chemistry

General Chemistry introduces students to the atomic structure of all materials and calculations relating to the combining of atoms.

# Appendix 6. End of First Semester Survey Sample

# **End of Course Survey**

Declared Major: Semester at LETU:

Semester of College:

Please Evaluate the Engineering Labs from this semester.

Lab Name	Awesome	Keep in Course	Just Okay	Remove from Course	Rank Order (1-7) (1 is best)
A Bridge too Far					
Basic Circuits					
Toy Dissection					
Boolean Circuits					
R/C Vehicle					
555 Screamer					
A Mighty Wind					

Toughest Course this Semester (and Instructor):

Easiest Course this Semester (and Instructor):

I liked best about this Semester at LETU:

I disliked about this Semester at LETU:

My thoughts about engineering at this point:

I intend to stay at LETU for the rest of my bachelor's degree:

I intend to stay in engineering at LETU:

I intend to switch (or declare) my engineering concentration to: