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Project-based Learning in a Forensic Engineering Course

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Project-based Learning in a Forensic Engineering Course

Abstract

Research and design experiences are important components of undergraduate engineering education, each targeting specific skillset serving and different outcomes. While there are several opportunities for learning engineering design process in engineering curricula, mostly notably the capstone senior design series, the primary method to experience research is through faculty-directed research projects. The practice of forensic engineering has many aspects in common with the research process and as such a course based on this topic provides a unique opportunity for students to systematically learn about the strategies and methodologies of scientific research. Faculty at Lawrence Technological University (LTU), in collaboration with a forensic engineer, have co-taught an upper-level undergraduate forensic engineering elective course biennially through the biomedical engineering department. The activities and course structure is specifically designed to develop skills necessary for a forensic engineer, which include the application of the scientific method, deductive and inductive reasoning, organization of facts, forming of opinions and specifying bases for opinions. Effective oral and written communication is also emphasized. The average effectiveness of the course in helping the students develop an understanding of forensic engineering was 4.33 (with 5 as most effective). The students were also engaged and enthusiastic during the semester with the average rating of 4.25 (with 5 as most enthusiastically involved). Some suggestions for changes to the future course offerings included more in-class activities and developing detailed rubrics for major course assignments.

Introduction

Forensic Engineering

The definition of forensic is of or relating to courts of law. Forensic engineering is a multidisciplinary field that focuses on the art and science of engineering in the jurisprudence system.[1] These professionals can be called upon to assist with both criminal and civil litigation matters. The responsibilities include not only an investigation into the physical and technical causes of an accident, but also the gathering of evidence, summarizing opinions in a report/affidavit and providing testimony related to the case. The nature of the profession lends itself to instruction through projects and case studies. A quick survey of forensic engineering courses shows that most are taught at the graduate level in civil engineering departments with an emphasis on failure mode of facilities and transportation infrastructure.[2] However, in general forensic engineering spans many areas of practice and there is a particular focus on evidence-based investigation and the litigation process.

Although people from many different educational backgrounds and experiences, enter the field of forensic engineering, the majority of careers follow a similar framework and responsibilities. Most entry-level positions require a bachelor's degree in an engineering discipline, but it is not uncommon to find specialists with a post baccalaureate degree in a specific area.

The practice of forensic engineering has a strong element of apprenticeship and on-the-job training. Many careers require a probationary period for new hires during which time experienced professionals mentor and guide new professionals. In particular, many states require engineers to have a Professional Engineering (PE) license to provide testimony in a court of law. The licensure requires a four year baccalaureate degree in engineering from an accredited university from the Accreditation Board for Engineering and Technology (ABET), completion of the Fundamentals of Engineering exam (FE), four years of work experience in their field of expertise under supervision from a PE, and also the completion of the Principles and Practice of Engineering exam.

It should be mentioned here that forensic engineering is distinct from forensic science which is popularized and glamorized by television programs like *CSI* (short for Crime Scene Investigation), where the focus is on criminal evidence, forensic biology, chemistry, toxicology, or trace analysis.[3]

Forensic Engineering Course

Only a few universities offer a forensic engineering course and most existing courses are offered in the area of structural failure analysis. Course are structured in a studio format where the investigation techniques are taught, or as part of a forensic practice lecture series where information about case studies is disseminated along with discussions on ethics and jurisprudential issues.[4]

Faculty at LTU, in collaboration with an engineering professional specializing in forensic applications of engineering, have co-taught an upper-level undergraduate forensic engineering elective course biennially through the biomedical engineering department. The course was not focused only on structural failures but surveyed a range of topics such as biomechanics of accidental injury, failure of biomedical implants, human factors/ergonomics, vehicle accident reconstruction, fires and explosions and maritime accidents.

The course was designed to introduce students to forensic engineering and how the investigative procedures contribute to the law, engineering design, safety, and economics. Students learned about the process of investigation of historical structural failures through case studies, which included cause and origin analysis, investigations and proceedings that followed, and the lessons learned from each failure. The involvement from a forensic engineering professional as an adjunct faculty allowed for scheduling of speakers that actively practice in different fields of forensic engineering.

Undergraduate Research

Research experience has been found to increase interest in science, technology, engineering and mathematics (STEM) according to a nationwide assessment of 4,500 students involved in undergraduate research, showing that nearly 70% of the students said that their interest in a STEM career increased due to the research experience.[12] Research experience has become increasingly important in undergraduate education and a primary tool for attracting and retaining students in the various STEM disciplines.[11] One of the purposes of undergraduate research experience is to improve student learning, as it has been shown that active learning is superior to “traditional" teaching methodologies.[8,9] It has also been shown to lead to higher grades. [7,10] Another benefit is student preparation and ability to make connections among seemingly disparate pieces of information, evaluate evidence, and bring the requisite expertise to address complex issues.[6]

Forensic Engineering and the Research Process

The ultimate goal of a forensic engineer is to assist the trier of fact in making informed decisions regarding the causation and/or likely outcome of a specific incident. This requires formulation of opinions within a specific technical discipline. The process follows the scientific method and as such can be considered as a real-world application of the research process. The scientific method is defined as the principles and empirical processes of discovery and demonstration considered characteristic of or necessary for scientific investigation (Fig. 1). The first step is usually the observation and description of the phenomena or phenomenon. Next, formulation of a hypothesis is generated concerning the phenomena. Ideally, the hypothesis is written in terms of a quantitative description that can be used to predict the existence of new observations. Finally, experimentation is carried out to demonstrate the truth or falseness of the hypothesis, and a conclusion that validates or modifies the hypothesis.[5] An essential aspect of research is there is typically no certainty about the outcome -- the hypothesis is either proved or disproved.

Likewise, the forensic engineering process starts with an investigation into the accident causation. A forensic engineer reviews all relevant discovery material and often makes observations at the scene of the accident and reviews evidence related to the case. The observations can lead to a hypothesis about the sequence of events that led to the accident, the root cause, causal factors, and/or relatedness of various claims. It is the responsibility of the forensic engineer to perform scientific analyses based on generally accepted methodologies that lead to a defensible investigation. To do so, the expert often reviews peer-reviewed scientific literature, regulatory documentation and/or patents relevant to the case. He/she also makes calculations, performs mathematical simulations and/or performs scientific experiments to gather data. The information is analyzed to test whether the hypothesis is validated or disproved. In the latter case, the expert develops another hypothesis and repeats the investigative process until a hypothesis is proven true to a reasonable degree of certainty. Ultimately, the expert uses the aforementioned information to form opinions and ultimately testify to these opinions in a deposition, arbitration or trial.

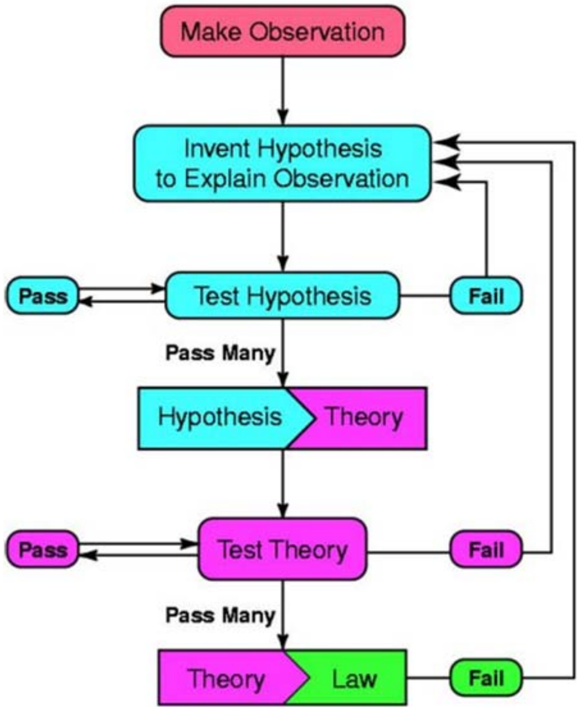


Figure 1: Forensic engineering follows a process similar to scientific method

There are so many aspects in the practice of forensic engineering that a course designed to introduce the students to these principals can be a structured and effective method of training. Thus, introduction to forensic engineering can develop a broader base that includes system engineering, inverse problem-solving and research methodology, which are an essential component a college curriculum at both graduate and undergraduate levels.[4]

Course Structure and Activities

Teaching forensic engineering as a tool to practice the scientific method formed the basis of the course structure. The lectures, assignments and activities were specifically designed to develop skills and knowledge necessary for potential careers beyond forensic engineering, which included the application of the scientific method, deductive and inductive reasoning, organization of facts, forming of opinions and specifying bases for opinions. A key component was to practice oral and written communication skills. Each lecture included a presentation that was followed by a hands-on activity pertaining to the area of discussion.

Weekly Lectures and Guest Speakers

The course met once a week for 2.5 hours. The first few lectures were devoted to educating students on the legal process and how an engineer plays a role. Emphasis was placed on civil litigation procedures. Students learned about the discovery process and were shown examples of discovery material. This was utilized to illustrate where a forensic engineer gathers knowledge regarding the alleged sequence of events pertaining to an incident. Examples of discovery depositions were presented showing the difference between fact and expert testimony. The students were shown how the formation of a hypothesis stems from careful review of these materials.

Once the forensic engineer formulates a hypothesis they attempt to prove or disprove it using sound scientific principles that are generally accepted within the scientific community. One of the first steps in this process is an inspection of an incident scene, vehicle, product, etc. Students were lectured on the procedures and equipment needed to document evidence to be used in an engineering analysis. They learned skills and techniques required for proper documentation. This lecture focused on photographic documentation skills.

The next lecture pertained to the analysis phase, which is designed to assist the investigator in proving or disproving the hypothesis. Students learned that an analysis can have many aspects, namely literature review, scientific testing, mathematical calculations, computer simulations, etc. Any of these can assist in establishing proper scientific basis for potential opinions. The primary focus of this lecture was the use of peer reviewed scientific literature. Students learned the importance of relying on data from authoritative sources. Students were taught skills required for a thorough literature review and how to properly interpret published data.

These initial lectures provided the students with the core knowledge and skills that every forensic engineer uses. As previously stated, there are many different analysis procedures that can be utilized to assist in proving or disproving a hypothesis. Using any one particular analysis method stems from the ability to design a problem to solve. This is a skill that comes with experience and breadth of knowledge. Therefore, each proceeding lecture was provided by a different forensic engineer/scientist with expertise in various areas such as biomechanics, marine engineering, material science, vehicle accident reconstruction, fires and explosions, and medical device failures. Each lecture focused on case studies that required different methods of analysis to properly investigate a specific hypothesis.

Weekly Assignments

Students were assigned homework projects that followed each lecture. Assignments were designed to give students practice performing a specific task. The initial lectures stressed communication skills. Therefore, each student was required to give a 5-minute presentation on any topic of his or her choice. Grades were based on clarity of message, ability to convince, and appearance of visual aids. The next assignment required students to document a specific monument located on campus (Fig. 2). They were instructed to use cameras, measuring devices, and other equipment to determine measurements of all details in all three planes. Students were unaware of the specific dimension required to receive all available points. This exercise gave students practice utilizing proper photographic documentation techniques. They were required to use measuring devices in their photographs to illustrate the location and dimensions of the subject matter. The forensic engineer is rarely giving the opportunity to document a scene or piece of evidence twice. Therefore, diligence and accuracy is required at any inspection.

Figure 2: In the photographic documentation assignment students were asked to take pictures of a campus monument with proper size and scale information. The photographs had to be able to show an unknown mystery object (height of plant).

The remaining assignments were designed to give students practice performing various analysis techniques and methods. The first of these required students to locate a peer reviewed scientific article of his or her choice and provide a detailed critique. This illustrated the students' ability to use the tools available to perform a literature search and review. It also forced the students to understand the type of study (experimental, review, cohort, longitudinal, etc.) and the specific methods used in order to understand the potential limitations of the data presented.

Photogrammetry was introduced during the marine engineering lecture. The forensic engineer was able to use photographs taken moments before a specific incident to draw conclusions regarding the location, posture, and conduct of various passengers on a boat. One specific photograph was used to determine the likely throttle position. However, this information was obtained from a reflection off a pair of sunglasses (Fig. 3). Students were required to obtain a photograph from any source that contained a hidden image revealing an interesting fact about the photograph.

Figure 3: Photograph presented during the marine engineering lecture illustrating a hidden image reflected off a pair of sunglasses. The image on the right show a prop that was used in maritime accident reconstruction.

The opinions presented during the lectures illustrated that conclusions drawn from analyses are to a reasonable degree of certainty. The standard requires the expert's opinions to be more probable than not. When evaluating a specific hypothesis the forensic engineer must consider all potential scenarios. This involves use of maximum and minimum parameters. Consequently, students learned the importance of ranges in data. The assignment given to practice this concept required students to develop mathematical calculations to determine the speed, distance and timing of the vehicle and a pedestrian involved in an accident. Each student was provided several peer reviewed articles that contained ranges of data such as pedestrian running speeds and coefficient of friction values for different roadways and roadway conditions. They were required to determine if the driver of the vehicle could have avoided the collision given the potential ranges in human and vehicle performance.

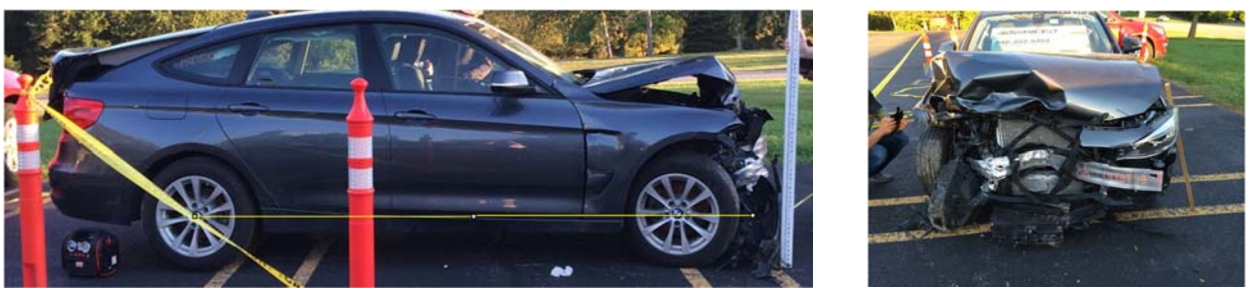
It is noteworthy that students were not assigned homework every week. This was to provide students with time to finalize the three large projects that were due at specific intervals of the semester. Students had three main projects that included the investigation of a crashed car and the claimed injury, summarizing the evidence of an actual forensic case and a final project that required the complete investigation and litigation process of a mock accident situation. These projects were designed to give students practice with putting all the steps of an investigation together. The last project served as the final exam.

Summary of Facts Assignment

Students were separated in to groups of two and provided with an actual litigation case. They were all provided with discovery documentation that was initially supplied to the forensic engineer. Although each group was provided with a different case, each involved a plaintiff claiming injuries sustained in a minor rear-end vehicle collision. Students were required to read all the material provided and extract the pertinent information needed for an engineering analysis. Each group was required to write a report, which served as a summary of the facts provided. Additionally, each group was required to develop a hypothesis that they were to analyze.

Accident Reconstruction Project

This project required students to analyze evidence from an automobile collision and to develop opinions based on a set of provided facts. Specifically, a vehicle that was involved in an actual collision was burrowed from a local salvage facility and parked on campus (Fig. 4). Students were instructed that they were being hired by an insurance company that was interested in determining if the claimant's statement regarding the facts of the collision were supported by the physical evidence on the vehicle. Students were paired into groups given access to the vehicle. The vehicle remained on campus for two days. Similar to a real world investigation, students were required to gather all the data needed for their analysis during one inspection. The presence of the vehicle provided the ability to educate the students on the technology in vehicles known as the Event Data Recorder.



Pre-Crash Data -5 to 0 sec (Record 1, Most Recent)

Time (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal, % Full (%)	Engine RPM	Steering Input (deg)	Service Brake, On/Off	ABS Activity (Engaged, Non-engaged)	Stability Control (On Engaged, Non-engaged)
-5.0	48 [78]	16	1200	0	Off	No ABS Activity	Non-engaged
-4.5	48 [78]	16	1200	0	Off	No ABS Activity	Non-engaged
-4.0	48 [78]	17	1200	0	Off	No ABS Activity	Non-engaged
-3.5	48 [78]	17	1200	0	Off	No ABS Activity	Non-engaged
-3.0	48 [78]	9	1200	0	Off	No ABS Activity	Non-engaged
-2.5	48 [78]	6	1200	0	Off	No ABS Activity	Non-engaged
-2.0	48 [77]	4	1200	0	Off	No ABS Activity	Non-engaged
-1.5	48 [77]	15	1200	0	Off	No ABS Activity	Non-engaged
-1.0	48 [77]	19	1200	0	Off	No ABS Activity	Non-engaged
-0.5	47 [76]	0	1200	0	On	No ABS Activity	Non-engaged
0.0	38 [61]	0	1300	0	On	ABS Activity	Non-engaged

Figure 4: Photograph of the vehicle borrowed from a local salvage facility that was used in the accident reconstruction project. The table at the bottom shows the data from the onboard data recorder up to five seconds before the crash.

The instructor extracted the information for the students and each group was allowed to use this as part of their analysis to validate or refute the possibility of a biomechanical injury due to the accident. All groups were responsible for writing a report and for giving a presentation.

Final Project

The final project required students to perform all the steps of an actual investigation. Again, groups of two were developed and each was supplied the same case. This involved a criminal case involving injuries to a child allegedly stemming from abuse. The students were only provided discovery material. Groups were responsible for synthesizing the material to understand the facts at hand. They had to develop a hypothesis and prove or disprove the hypothesis through scientific analysis. The case involved head injuries sustained by an infant that allegedly fell from its papasan chair that was placed on a kitchen counter (Figures 5—7). They were provided photographs taken of the subject scene. These contained dimensions of the incident scene. All groups were provided access to the Experimental Biomechanics Laboratory. Groups were encouraged to perform scientific testing utilizing the instrumentation available to properly support their opinions. Each group was required to write a report, give a presentation, and give a mock deposition.

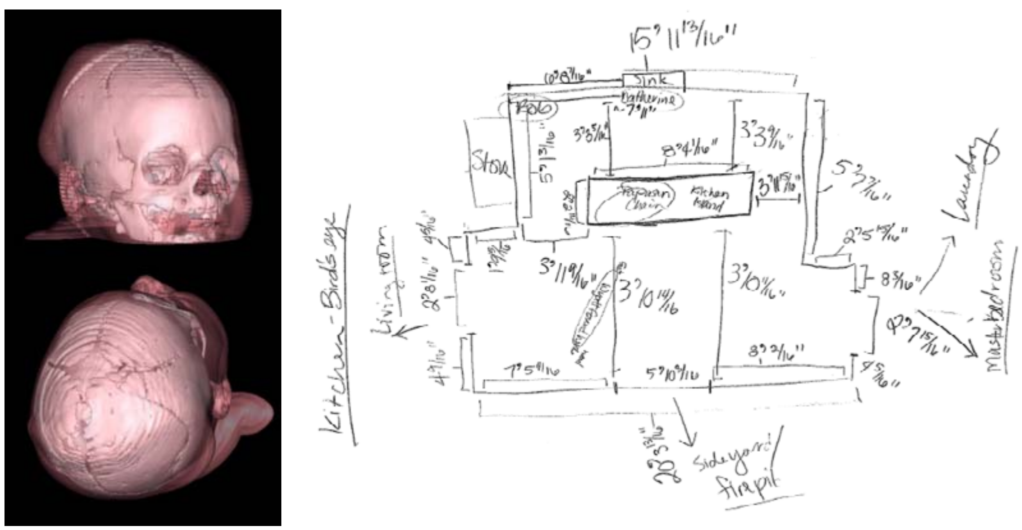


Figure 5: Images show the reconstructed skull of the infant as well as the sketch of the kitchen where the incident occurred. This information was provided to the students.

An interesting aspect of the implementation was that the groups presented only to the faculty for 10 minutes followed by 10 minutes of Questions and Answers (Q&A). This was instituted to prevent from later groups learning from the questioning of the previous ones. Simple rubrics were used for grading, which were broken down as 40%, 40% & 20% for facts, Q&A and conduct respectively. Performance was incentivized by 10 extra points for the best deposition.

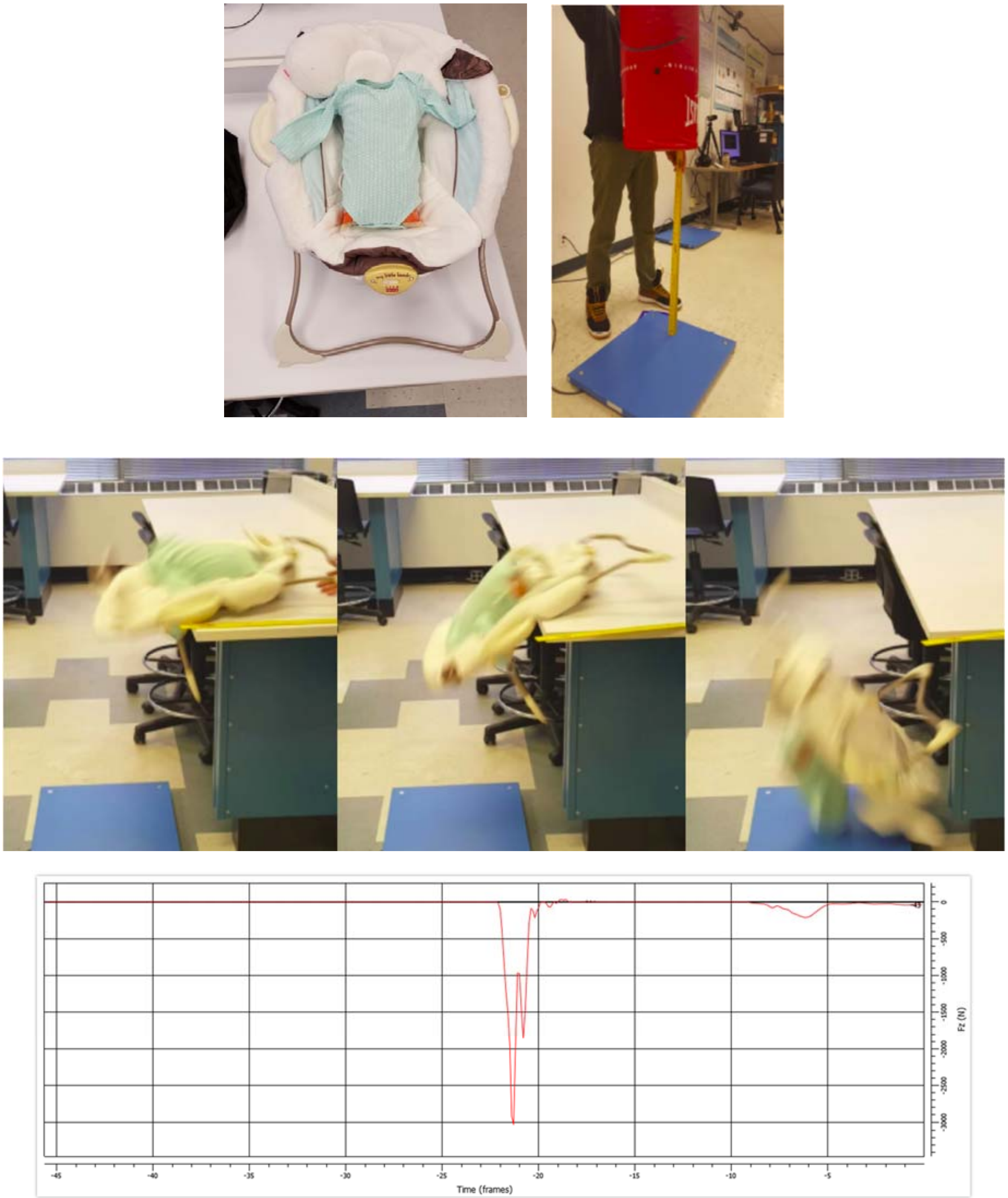


Figure 6: Students used various surrogates and instruments to conduct the infant fall experiments. Some students just matched the weight of the infant, while others tried to match both weight and size. The bottom graph shows the z-axis force measured by the force plates.

Figure 7: An image of the final project fall scenario that was created by the instructor. This was used after the mock deposition for demonstration purposes

Implemented Course Modifications

The forensic engineering course has been offered twice, once in Fall 2013 and then again in Fall of 2015. Each time the students' feedback about the course was extremely positive. However, the instructors made slight modification to emphasize the project based learning and hands-on component of the course. The lectures were also modified to focus on the BME related topics while some of the other lecture topics were removed. Accordingly, course topics and assignments can be tailored to reflect the background and majors of the students.

In 2013, the students had two main projects. The open-ended biomechanics project was a fictitious case related to child skull injury (See Appendix). Working in groups of two or three, the students had to review the documents provided to them (deposition, scene photographs, computerized tomography (CT) scans and medical and police reports) and form an opinion on the sequence of events that led to the accident. In order to prove their opinion, they had to provide evidence of analysis. Different groups chose different strategies for analysis from finite element model (FEM) simulations and theoretical hand calculations to use of motion capture system for inertial measurement to determination of ground reaction force using force plates and motion capture. The use of different techniques by student groups was indicative of a successfully executed open-ended program based leaning (PBL) activity. The final project for the semester was similar to the summary of fact assignments described earlier which included a mock deposition and a case report. Also, the instructors arranged for a crashed car to be brought to campus but it was only used for demonstration purposes during the lecture.

After the completion of the course, the instructor assessed student outcomes and it was decided that the PBL was more appropriate as the final project. Therefore in 2015, when the course was offered for the second time, the focus was shifted to more hands-on activities. The first three lectures focused on forensic engineering, scene investigation and effective communication. The associated activities were pitch presentations and scene photography assignments described earlier. Students practiced these skills again in the accident reconstruction project. For the second project, each student group summarized the fact of a simple biomechanical injury case in class presentation. This was similar to the final project in 2013 albeit the presentations were not like mock depositions. The instructors provided the information and resources from a real infant injury case to the students for the final project. The objective of the assignment was to combine the background literature search, similar to the summary of facts project, with experimental data gathering and analysis from the accident reconstruction project. The semester schedule for the both offerings is shown in the appendix.

Student Evaluations and Assessment

Student were surveyed for their understanding of the field of forensic engineering before and after having taken the course. The surveys also asked about the effectiveness of class lectures, homework and projects. Overall, the students felt that the course did an excellent job of introducing them to forensic engineering and the skills and experience important to this field. The survey results showed that 75% of the students rated their understanding at '2' on a Likert scale from (1: Least – 5: Most). After the course, 67% rated their understanding at '4' and 33% at '5'. The two time points were compared with an unpaired t-test and a value of $p>0.01$ was used to determine the results were significant.

Table 1: The results of the student survey questionnaire are summarized on the Likert Scale. This survey is from the course offered in Fall of 2015. (Sample size = 14).

	Least (1)	2	3	4	Most (5)
Understanding of Forensic Eng. (Before Course)	8%	75%	8%	8%	0%
Understanding of Forensic Eng. (After Course)	0%	0%	0%	67%	33%
Course effectiveness in generating interest in FE	0%	0%	8%	42%	50%
Effectiveness – Lectures	0%	0%	8%	50%	42%
Effectiveness – Projects	0%	0%	0%	50%	42%
Effectiveness – Homework	0%	0%	17%	42%	33%

The survey also showed that the students found the course to effective and 75% of them were *Involved* (level 4) and 25% were *Enthusiastically Involved* (level 5). The student engagement was also apparent from the effort that they put into various assignments and projects. The students found the lectures from various forensic engineers to be the major strength of the course as highlighted with comments such as "*Interesting content from each lecture*" and *"Hearing from multiple speakers".* All students responded that they would recommend the course to other students.

When asked about the most interesting assignment, 50% of the student chose the Accident Reconstruction project while the others mentioned the *Fire and Explosion* and *Human Factors* topics. Due to the involvement of a forensic engineer professional, the course was only offered once a week during evenings and several students found the 2.5 hour class period to be too long. Along the same lines, the students also wanted to see more interaction between the instructor and students during class lectures through use of hands-on activities.

The feedback from a few students indicated that the directions and expectations for the projects could be improved. This was also observed by the instructors which found that while the students performed very well on the *Accident Reconstruction* and *Summary of Fact* projects, not enough emphasis was paid on developing tests and gathering data needed to analyze the scenario in the final project. This corresponds to the 'Test Theory' step of the scientific method (Fig. 1) which most undergraduate students do not usually engage in their curriculum. Determination of test setup and then using the scientific data to support or invalidate a hypothesis are the hallmark of graduate research. In this sense, it is expected that the undergraduate student would struggle with these skills. Thus the open-ended forensic engineering PBL addressed one of the key learning objectives of the course by giving undergraduate students to practice the scientific method.

Finally, many of the students were somewhat flustered by the argumentative nature of the questioning during mock depositions but in the end appreciated the opportunity to have experienced it. In future, the instructors are considering recapping the learning objectives and the mapping to scientific methods during the final class period of the semester. Depending on the availability of the adjunct faculty, the course may be broken into two class periods per week where the second period is used for hands-on activity related to the topic under discussion. Additionally, the instructors would like to utilize more advanced technology such as 3D scanning and printing in future classes to better educate students on the available tools that can be used in the documentation, investigation and demonstration process of forensic engineering.

Conclusion

Faculty at Lawrence Technological University, in collaboration with a forensic engineer, have co-taught an upper-level undergraduate forensic engineering elective course biennially through the biomedical engineering department. The course structure was specifically designed to develop skills necessary for a forensic engineer, which included the application of the scientific method, deductive and inductive reasoning, organization of facts, forming of opinions and specifying bases for opinions. PBLs and hands-on activities were used to make the course more interactive and students had several opportunities to practice oral and written communication of their opinions about case.   The course topics can be easily modified to reflect the focus of other engineering disciplines. Based on student performance and feedback, the course was effective in providing experiences with the *Making Observations* and *Inventing a Hypothesis* steps of the research process. However, some modifications to the description of final project as well as the setting of expectations will be made during future offering of the course to allow the student to better experience the *Testing of Hypothesis* step.

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Appendix

Skull Fracture Biomechanics (2013)

This assignment has a number of learning objectives. It is intended to introduce students to the concepts of structure, material properties and function in human tissues as they relate to the field of impact biomechanics. Second, for students to demonstrate the ability for self-directed learning by planning, research and design of a scientific experiment to answer a hypothesis based on a “real-world” injury case. The four week activity was introduced in Week 5 of the semester. The following learning objectives were emphasized with the module:

- Relationship between structure/properties in tissues
- Self-directed learning
- Application of the scientific method
- Organization of facts
- Forming of opinions and specifying bases for opinions
- Written and oral communication

In the case presented for this assignment, an 18 month old infant is presented at the emergency room with a linear parietal bone fracture by her nanny. The nanny has described a scenario that involved the infant playing and falling off a small plastic gym structure that was located on the wooden deck attached to the back of the house. When the parents arrived at the hospital, the infant is stable, but the doctor doubts the likelihood that this injury occurred as the nanny described. Child abuse was not suspected. During the lawsuit that follows, the family's lawyer contacts an expert in biomechanics to investigate the plausibility of the nanny's accident scenario.

Students were given details and documents from this "real world" case, including; site visit photographs and drawings, the patient's medical report, the police report, and the nanny's deposition. Based on this evidence, they were instructed to organize the facts of the case, complete literature reviews, research the tissue properties of an infant's skull bone and find mechanisms of infant skull fracture, as well as existing experimental methods to make measurements during similar accident scenarios. They had to use this evidence to form their own hypothesis about how the injury occurred and then validate their claims based on data collected.

Course Syllabus 2013

Wk. #	Topic	Assignment
1	Course introduction. Forensic engineering basics	
2	Injury biomechanics	Quiz #1
3	Electrical engineering	Quiz #2
4	Scene and evidence documentation	Quiz #3
5	Human Factors	Quiz #4
6	Structures / Civil engineering	Quiz #5 / Structures Lab
7	Biomechanics lab – shaken baby investigation	Biomechanical testing experiment
8	Biomedical engineering – bioinstrumentation	Summary of facts report due
9	Vehicle Accident Reconstruction	Pedestrian accident project
10	Fires and Explosions	Fire demonstration lab
11	Metallurgy	Quiz #6
12	Medical device failures	Quiz #7
13	Forensic sciences	Quiz #8
15	Final Project Presentation	

Course Syllabus 2015

Wk. #	Topic	Assignment
1	Introduction and overview of forensic engineering and the litigation process	
2	Evidence documentation and giving testimony as an expert.	Short presentations Evidence documentation report
3	Biomechanics and injury information	Short presentations Literature review report
4	Vehicle accident reconstruction	Short presentations
5	Vehicle lab	Midterm project
6	Marine engineering	Hidden image
7	Midterm Project Presentations	
8	Human factors / ergonomics	Perception reaction project
9	Civil engineering / Structure failures	
10	Metallurgy	Dielectric couple experiment
11	Industry Perspective (GMP/DFMEA)	
12	Thermal / Fires / Explosions	Spontaneous combustion experiment, Fact Report due
13	Forensics Science	Finger printing experiment
15	Medical Device Failures	
16	Final Project Presentation	