

AC 2009-319: TEACHING FUTURE MANUFACTURING ENGINEERS LAWS, ACTS, STANDARDS, AND LIABILITIES

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Teaching Future Manufacturing Engineers Laws, Acts, Standards, and Liabilities

Abstract

This study focuses on teaching manufacturing engineering students laws/acts, standards, and liabilities. The teaching environment for this activity is a safety and methods engineering course, which is an elective for this ABET accredited stand alone manufacturing engineering program. Even though there are some relations between the two main elements of the course, methods engineering content is excluded from this study. In addition to the various technical subjects relating to safety, health, and environmental management, the author developed a law content including law categories and associated court structures, law terminology and concepts for engineers, safety and health related law and acts, federal standards and regulations including OSHA standards, environmental legislation and regulations, and ethics and liabilities. To enhance the student learning experience various learning media are utilized. Relevant teaching tool arsenal encompass but not limited to filling in OSHA forms and logs based on case studies, watching a product safety and liability movie and writing a report on it, combining text-book information with short videos, and preparing Workers Compensation presentations to be conducted. The student response for the effort has been positive allowing the author to identify the students having an attitude towards studying law after completing their engineering degrees. The study also better prepares these prospective manufacturing engineers in terms of knowing their own, employers, and customers' rights and responsibilities, and most importantly implications of their actions throughout their career.

Introduction

This paper presents a case study on teaching manufacturing engineering students laws/acts, standards, and liabilities in ENGR 4200 - Safety and Methods Engineering course. Methods Engineering content is excluded from this paper. The course is an elective taken by seniors of this ABET accredited manufacturing engineering program. The author covers a wide variety of *safety, health, and environment related subjects* listed below in the sequence below¹. The curriculum starts with basic safety and methods concepts and their importance in global competition, followed by law content and details of technical hazard subjects. Most of the subjects are covered with concise information due to this busy schedule.

- **Introduction to Safety and Health:** Basic definitions of safety and health concepts constitute the initial subject of this course. Differentiation between sudden and severe (acute) impact of safety concerns versus prolonged and lesser impact of health (chronic) problems is presented. Giving examples such as stress as a safety and health hazard improve student understanding of these two basic concepts.
- **Safety and Health Movement:** The struggles of the safety and health movement since the beginning of the Industrial Age is the second subject covered in the course. This section includes the labor unions' efforts, court fights, public cries after major incidents in history, and their impacts on the state of the safety and health field today.
- **Impact of Safety, Health, and Environmental Issues on Global Competition:** The impact of safety, health, and environmental factors on global competition is another basic

subject covered early in the course. In this section, the relations between safety and health factors and manufacturing enterprise performance metrics such as cost effectiveness, efficiency and productivity are studied.

- **Laws/Acts, Standards, and Liability:** Definition and classification of the U.S. and other countries' laws follow the previous areas covered in the course. The students study differences amongst the statutory, common, and administrative laws, and associated court structures. The students also get familiar with law concepts such as negligence and liability. Act concept is introduced including Occupational Safety and Health (OSH) Act and Clean Air Act. The organizational structure of Occupational Safety and Health Administration (OSHA) and its standard/code generation, inspection, and citation/penalty procedures are all studied through short videos produced by OSHA². Filling in standard OSHA forms and logs pertaining to incident reporting, and their summaries for statistical analysis conclude this section.
- **Workers Compensation:** Overview of Workers Compensation legislation including injuries and disabilities, medical treatment and management of injuries, compensation, cost allocation and control, insurance structure, dispute resolution, spotting fraud and abuse, and the future of Workers Compensation are all covered concisely in this section. The students are asked to prepare and conduct a presentation on Workers Compensation law for a U.S. State chosen by the author.
- **Product Safety and Liability:** Next step is to associate the product design and development process, ethics and legal implications of engineering practice through product safety and liability. The students first learn technical concepts like fail-safe and fool-proof designs, and Failure Mode Effect Analysis (FMEA) through case studies, videos, and computer programs. They are then loaned copies of the movie based on a class action lawsuit, and expected write a report on this product safety and liability case utilizing the law terms they have learned.
- **Stress and Safety:** Definition and sources of workplace stress are the initial components of this section. They are followed by the subjects of measurement of stress, human reactions to stress, shifting work, and reducing stress to improve safety. Stress and safety area is concluded with content on stress in safety managers and stress in Workers Compensation laws.
- **Violence in the Workplace:** Definitions and scale of this problem, legal considerations, risk-reduction strategies, contributing social and cultural factors, conflict resolution, Do's and Don'ts for supervisors, and emergency preparedness are the main subjects of this section in addition to the OSHA's Voluntary Guidelines for this issue.
- **Various Hazard Concentrations such as Mechanical, Electrical, Pressure, Temperature, Fire, Radiation, Automation/Robotic, and Ergonomic:** Each hazard is covered by its definition and outcomes, relevant OSHA standards/regulations, measures for mitigation including taking corrective action after incidents, and personal protective equipment (if available).
- **Industrial Hygiene and Confined Space Hazards:** Overview of industrial hygiene and confined spaces field, industrial hygiene standards, confined spaces and OSHA, definition of toxic agents and carcinogens, air quality, prevention and control, and personal protective equipment are the main components of this section.
- **Hazard and Accident Analysis, and Prevention and Safety Management:** Overview of hazard and accident analysis, preliminary hazard analysis, risk management are

covered initially. These subjects are followed by hazard prevention and deterrence, safety management concerns, and best practices in safety management.

- **Promoting Safety and Health, and Training:** Employee and management participation in safety and health programs and committees, suggestion programs, visual awareness, incentives and competition, company sponsored wellness programs, teamwork Approach, and persuasion are covered concisely within this section.
- **Environmental Safety and ISO 14000:** Environmental legislature and regulations, role of safety and health professionals, hazardous waste management, environmental management systems, and ISO (International Organization for Standardization) 14000 standard are the main subjects of this section.
- **Ethics:** Definition of ethics, safety and health professionals' and company's role in ethics, handling ethical dilemmas, questions to ask when making decisions, and whistle blowing are all covered in this section.

Reasoning for and Benefits of Teaching Law

Safety engineering is an important part of industrial engineering curriculum and some manufacturing engineering programs if they are housed within the industrial engineering departments. These safety elements can be taught at undergraduate^{3,4} and graduate⁵ levels and may include reliability of systems, and product safety and liability courses in addition to a basic safety course. They can also be bundled with ergonomics and human factors elements to form specialties and options⁵.

As an undergraduate mechanical engineering student at oversees the author took a mandatory labor law course. At the time, the course was not too much of an interest to him as a Technical University student. The most of the curriculum at his school was composed of technically based courses and the students were not fond of non-technical courses due to their strong interest in engineering. Immediately after graduation, the author realized that the subject was crucial to any practicing engineers. *The practicing engineers need to know own and their employers' legal rights and responsibilities in terms of the safety, health, and environment fields. The laws pertaining to safety, health and environment grow continuously due to many cases occurring non-stop¹. Key personnel in each company's safety and health division, an engineer working in the work environment or supervising it, designers and developers of products or systems to be utilized by others need to understand the legal implications of their work or consequences of their decisions.* Thus, the ENGR 4200 – Safety and Methods Engineering course encompasses the following law content to better prepare the manufacturing engineering students who are enrolled in the course¹ (this list is extracted from the main content list above) :

- Historical antilabor laws such as Fellow Servant Rule, Contributory Negligence, and Assumption of Risk
- Various law categories including Common, Statutory, and Administrative
- Various law terms and concepts such as Civil and Class Action Lawsuits, Negligence, Liability, Care, Ability to Pay, Damages, Proximate Cause, Willful and Reckless Conduct, Tort, and Foreseeability
- Federal Act Structure including OSH Act, Mine Safety and Health, Consumer Product Safety Act, and Clean Air Act.

- Comparison and contrasting various states Workers Compensations Laws, fraud and abuse cases⁶
- The OSHA's standard and regulation generation, inspection, and citation/penalty procedures. Several OSHA forms and logs as a part of study of OSHA recordkeeping and reporting guidelines
- Product liability laws including development of product literature including Material Safety Data Sheets (MSDS)⁷
- Environmental legislation and regulations tied to Environmental Safety Management (ESM) concept and ISO 14000 Standards
- Ethics and Liabilities

Sample Course Activities

Three major components pertaining to the law content are presented in this section of the paper. These are the study of OSHA related elements, Workers Compensation laws, and the movie review for product safety, liability, and ethics:


- The students study the official OSHA recordkeeping practice based on OSHA resources² and other Industrial Safety textbook information⁷. They are given several hand-outs and links to the OSHA web resources. They study the requirements for qualifying incidences as recordable, distinguishing between the non-recordable first-aid and the recordable medical treatment. They are then given multiple cases to process as shown in Figure 1. They make a decision based on given information for each case. After that, the information for each recordable case transferred to the OSHA 301 Form - Injury and Illness Report as shown in Figure 2 and each recordable case becomes an entry for the OSHA 300 Form - Log of Work-Related Injuries and Illnesses, Figure 3. Summary information from page totals are calculated and inserted to the OSHA Form 300 A - Summary of Work-Related Injuries and Illnesses Form, Figure 4. Once OSHA Form 300 A is completed, the students can calculate the Incidence Rates. They also study the reporting and posting requirements and other details pertaining to all of the forms.

Case Study 2.1

- File 1 – January 31: Press-blanking operator lacerates hand on strip stock scrap from punch press; first aid received; no medical treatment; worker remains on the job.
- File 2 – February 19: Maintenance worker, not wearing eye protection, operating grinding machine in tool room, injures eye from flying chip, medical treatment required; injury occurs on Tuesday, employee returns to regular job at regular time on Thursday.

Figure 1. Case study exercises⁷

OSHA's Form 300A
Summary of Work-Related Injuries and Illnesses

Year 20 
U.S. Department of Labor
Occupational Safety and Health Administration
Form approved OSHA no. 3218-0720

All establishments covered by Part 1904 must complete this Summary page, even if no work-related injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete and accurate before completing this summary.
Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the Log. If you had no cases, write "0."
Employees, former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR Part 1904.25, in OSHA's recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases			
Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
(a)	(b)	(c)	(d)

Number of Days	
Total number of days of job transfer or restriction	Total number of days away from work
(e)	(f)

Injury and Illness Types			
Total number of... (g)			
(1) Injuries	_____	(4) Poisonings	_____
(2) Skin disorders	_____	(5) All other illnesses	_____
(3) Respiratory conditions	_____		

Establishment information

Your establishment name _____
Street _____
City _____ State _____ ZIP _____

Industry description (e.g., *Manufacture of motor truck trailers*) _____
Standard Industrial Classification (SIC), if known (e.g., SIC 3711) _____

Employment information (If you don't have these figures, or the historical on the back of this page to estimate.)
Annual average number of employees _____
Total hours worked by all employees last year _____

Sign here
Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Company executive _____ Yes _____
How _____ / / _____
_____ / / _____ No _____

Post this Summary page from February 1 to April 30 of the year following the year covered by the form.
Public reporting burden for this collection of information is estimated to average 50 minutes per response, including time to review the instructions, search and gather the data needed, and complete and review the collection of information. Persons are not required to provide information unless it displays a currently valid OMB control number. If you have any comments about this estimate or any other aspect of this data collection, contact: U.S. Department of Labor, OSHA, Office of Statistics, Room N-3644, 200 Constitution Avenue, N.W., Washington, DC 20210. Do not send the completed form to this office.

Figure 4. OSHA Form 300 A - Summary of Work-Related Injuries and Illnesses²

- The students are asked to prepare and conduct a PowerPoint presentation on Workers Compensation laws of a state chosen by the author. This is a compare and contrast activity where students see major differences amongst the states in concern. With this activity, students learn about their rights and benefits in terms of the Workers Compensation system. The class also reviews a case that a worker is hired by a company in one state and sent to another one with a temporary assignment. The question of which states' laws apply to the worker in case he or she gets hurt during that temporary assignment is answered.
- After watching a movie entitled, *Class Action*⁸, the students prepare a short report on the movie. They are required to write on the main plot of the movie utilizing law terms they have learned during class and the movie. Two different reports submitted are included below. One gives a brief statement about the main plot with the critical law terms marked and this is followed by the descriptions of each law term mentioned in the plot, while the other gives a better picture of the plot without the descriptions of the critical law terms. Both received less than perfect grades.
 - **Class Action Movie Report #1**

“Class Action” is a movie concerning a class action lawsuit dealing with injuries that have been caused by a problematic automobile. There are several individuals (the plaintiffs) who are suing the car manufacturer (the defendant). Their claim is that faulty circuitry caused the cars to catch fire upon impact during a crash. These victims have been seriously injured. The car manufacturer uses “bean counters” to perform risk management analysis. The “bean counter” estimated how much it would cost to fix the circuitry in all of the vehicles. He also estimated how much the car company would pay out in lawsuits if they didn't fix anything. The car company chose to not fix

the problem since the estimated cost of lawsuits was less than the estimated cost of fixing the problem. In the end, the case was awarded to the plaintiffs.

Bean counters – one that is injured, destroyed, or sacrificed under any of various conditions

Claim – to make a demand for money, for property, or for enforcement

Class Action Lawsuit – a lawsuit filed by one or more people on behalf of themselves and a larger group of people "who are similarly situated

Defendant – the party sued in a civil lawsuit or the party charged

Deposition – the taking and recording of testimony of a witness under oath before a court reporter in a place away from the courtroom before trial

Plaintiff – the party who initiates a lawsuit by filing a complaint

Victim – one that is injured or killed under any of various conditions

- **Class Action Movie Report #2**

Class action was a movie based around a car company, Argo Motors, and the “class action lawsuit” they faced. They were allegedly producing cars, particularly the 1985 Meridian station wagon that would explode on impact and severely injure the car’s occupants. The movie was written around two lawyers, father and daughter, who happened to be on opposing sides of the lawsuit. The movie did an excellent job showing how personal relationships can interfere in court proceedings. The lawsuit was set up as a contingency case where the “plaintiff”s may not receive money for many years after the verdict.

The movie went through the many steps it may take to get an actual case to trial including the pre-trial and the collecting of witnesses and evidence. Procedures were explained in the movie about sharing of evidence, although both sides made it as hard as possible for the other to have access to this information. After an interview with the president of Argo Motors, we reveal that at 30 mph, the rear end of this vehicle crumbles in the crash test. Every model produced is sent through 78 total tests and the Meridian performance charts exceeded all standard and passed the company’s independent test. We are also introduced to the company’s researcher who realized the circuit used in the car was faulty when the car was struck from the rear with the left turn signal on. The lawyer tells the company to not worry about this and wants the evidence destroyed.

We also get a good look at how witnesses can be discredited. After the movie introduces a few witnesses, including a man who was paralyzed and lost his wife and child in the car accident, it shows the lengths a lawyer will go through to discredit the witnesses. We see in an interview that the lawyers press the witness with the issue that he has a phobia of driving and has been cited numerous times for driving too slow and that may have been the cause of the accident. I was most interested in the description of the “bean counters”. They played an important role in the movie as they were the ones that told the company to go ahead with the production of the vehicle. Comparing the cost to recall the cars and fix the circuit with the amount of lawsuits they would have to face, it was a simple actuarial analysis that said it was cheaper to take their chances and go with facing lawsuits. The movie ends with the trial and the car company ultimately losing 100 million dollars, which was 50 million more than it would have cost to recall the cars and fix the circuit.

Ethical dilemma is the center of discussion since the automaker knew about the flaw within the product and chose not to correct it based on the cost savings reported by the actuarial consultants. In the Product Safety and Liability and Hazard Analysis sections of ENGR 4200, the class studies the importance of thorough Risk Assessment and Hazard Analysis with the assistance provided by previous experiences and theoretical knowledge related to the area. Other risks associated but unknown are also discussed with the

employment of a four-layered safety approach incorporating various factors including observation and surveys.

Assessment

The author uses multiple ways to gauge students' interest and learning. These include:

- Verbal questioning of students on recently studied concepts during class
- Discussions during class
- Student performance in graded works
- Student feedback from course evaluations

Verbal questioning of the students yield that learning law terms still seem to be a challenge since these students are very technically oriented making achievement of a high level of sophistication a little bit harder. However, acceptable responses are commonly given by the students.

Discussions are favored by the students, and interesting and accurate points are made by them during these discussions. Student performances are above the ABET threshold set (B- or 80%). This can be attributed to small class sizes of 5-7 students over the 4 years. Student course evaluations indicate some interest towards the law content. However, they yield high scores on almost every component supporting the importance of the course content and its consequences.

Conclusions and Future Work

Establishing law content in ENGR 4200 – Safety and Methods Engineering course allows students to learn own and their future employer's rights and responsibilities in safety, health, and environmental management related issues. It also teaches understanding of the implications their actions and decisions at the work-place, and during the design and development assignments.

Textbook¹ utilized in the course has more than adequate law content and gives some case studies as examples. However, it is hard for engineering students to get familiar with the law portion due to not having enough exposure to law terms. Thus, watching movies like Class Action⁸ teaches them relevant laws, court structures, and penalties while giving them an ethics lesson. This is in addition to the short videos the students watch in learning acts, standards, and regulations. All of these visual-aids bundled with filling legal forms such as MSDS and studying written documents enhances the students' learning experience. Students also develop necessary skills for the workplace as well as better understanding of hazards and accidents. While judging on an incident case for OSHA recordkeeping exercises, students actually learn more about the facts about the case.

During the class, the author promotes a variety of safety, health, and environmental related roles for his students including working as consultants, expert witnesses⁹, and safety, health, and environmental officers. Future plans to further enhance the law content encompass extending an invitation to a renowned Pennsylvania injury lawyer for a presentation on liability cases, and adding a second movie on Environmental issues to the existing curriculum.

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