A Discussion of Tort Liability in Engineering Technology Laboratories

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Abstract - Industry and the military will often provide mandatory training on safety procedures for their employees in order to ensure the safest working environment. Academia often does not have the funding or other assets to provide similar training for professors and students. Engineering technology professors must provide laboratory experiences for their students, which may be unsafe if proper procedures and guidelines are not followed. A manufacturing engineering technology program, for instance, will often include courses which require welding, drilling, grinding, milling, and other potentially dangerous activities in a machine shop setting. Are professors legally liable if a student is injured during a laboratory exercise? The current paper summarizes several law cases where students were injured during an educational experience and discusses the development and use of a risk assessment model for engineering technology laboratories. Hopefully, this discussion will help professors who teach laboratory courses avoid legal liability in the pursuit of their trade.

Keywords: liability, injury, tort, negligence, risk assessment

INTRODUCTION

Common tort cases involving higher education institutions are instructor negligence claims in laboratory settings. Administrators at higher education institutions have a responsibility to protect students from harm in laboratory learning environments as well as to protect their organizations from lawsuits. Case law pertaining to negligence resulting in injury of adult students in public higher educational environments is somewhat limited. However, the courts have established precedence in areas that should be of concern for instructors and administrators. This established precedence may offer insight for administrators and professors to follow in developing laboratory safety guidelines and procedures. Professors and administrators should strive to avoid lawsuits altogether for the sake of time, resources, and most important, student safety. The discussion which follows examines several cases involving students in educational settings and provides suggestions for professors and administrators to reduce potential liability. Additionally, a concerted effort to establish an extensive safety program in laboratories within the Department of Engineering and Technology at Western Carolina University (WCU) is underway. A risk assessment model was implemented so as to provide a baseline for future development of the program. The risk model will be presented and discussed.

DISCUSSION

There are several cases in the literature which exemplify important concepts for a college professor to consider. The discussion which follows includes several law cases including: standard of care, negligence, duty to protect, supervision, safety, assumption of risk, duty to rescue, duty to warn, reasonable care and maintenance of equipment. The list does not include every legal area of concern, but is only meant to provide an introduction to case law for faculty members seeking awareness of the legal risks involved in their everyday work. Legal assistance should be sought to answer any questions raised by the current paper. All laboratory safety programs and policies should be reviewed and cleared by legal counsel.

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Standard of Care

A 19-year-old student at Forsyth Technical Institute in North Carolina severed his fingertips while operating a sheet metal break in shop class. The plaintiff brought suit against his teacher claiming negligence due to lack of instruction on using the machine [7]. The Court found in favor of the defendant on the grounds that sufficient evidence had been presented showing that instruction was indeed provided to the student. The instructor presented general operating information along with demonstrations and illustrations for using a separate stick or other device to push the metal to be cut from the feeder area under the guardrail toward the cutting surface to insure good safety practices. The student neglected to use the feeding stick and used his hands instead. In the moments prior to cutting the metal, the student looked down at his feet so that he could apply force to the cutting lever. Never looking back up to determine the placement of his fingers in relationship to the blade, he activated the machine, thus severing his fingertips. Case Headnotes stated, “A teacher in a vocational training class has a duty to warn students of known hazards in the operation of machinery used in the class.” The opinion of the Court stated, “A teacher must abide by that standard of care "which a person of ordinary prudence, charged with his duties, would exercise under the same circumstances."

Negligence and Contributory Negligence

Important points from the North Carolina Supreme Court on negligence and contributory negligence appeared in the headnotes of this case [2]. The case involved a 21-year-old engineering major who inadvertently stuck his arm into a piece of agricultural equipment while working on a farm resulting in his arm being cut to pieces; even though the machinery had been turned off the flywheel was still turning. The court ruled contributory negligence.

Important notes:

- Every person having the capacity to exercise ordinary care for his own safety is required to do so, and if his failure to do so concurs and co-operates as a proximate cause of the injury complained of he is guilty of contributory negligence.
- Ordinary care is such care, as an ordinarily prudent person would exercise under the same or similar circumstances to avoid injury.
- A person cannot be held contributory negligent in failing to avoid injury from dangerous machinery unless he acts or fails to act with knowledge and appreciation, either actual or constructive, of the danger.
- It is the duty of the employer to warn the employee of dangers known to the employer and not known to the employee or not discoverable in the exercise of due care, or dangers which the employee, by reason of youth, inexperience or incompetency, could not appreciate.
- The employer is not an insurer of the safety of his employee.

Duty to Offer Protection

Furek, while pledging to a fraternity on the University of Delaware’s campus, was subjected to a series of events, which constituted hazing during a “hell night.” During his “initiation,” a lye-based chemical was poured on him resulting in severe chemical burns. Even though these activities violated an established university policy on hazing and similar activities, Furek brought suit against the institution and the fraternity [5]. The court sided with Furek against the university and stated, “we acknowledge the apparent weight of decisional authority that there is no duty on the part of a college or university to control its students based merely on the university-student relationship, where there is direct university involvement in, and knowledge of, certain dangerous practices of its students, the university cannot abandon its residual duty of control.” Because the university, through policy, had established the knowledge of the act of hazing at fraternities within the institution, it had in fact established an assumed duty to offer protection services.

Lack of Supervision

An 18-year-old college student enrolled in an introductory chemistry II course inadvertently mixed potassium chlorate with other chemicals resulting in an explosion, which injured the student. The student sued the university and professor claiming negligence even though the previous experiment warned against such use of potassium chlorate [1]. The professor was not in the room at the time, but had left shortly with instructions to set the lab up and to not proceed until he had checked the setup. The students proceeded anyway causing an explosion. The Court ruled in favor of the plaintiff citing the instructor's lack of supervision.

Failure to Provide Safety Information

A college sophomore was burned when she placed a flask of ether too close to a Bunsen burner. The student brought suit against the university and professor claiming negligence because the instructor's lectures, nor the laboratory manual, mentioned the dangers of the keeping ether away from flames [9]. The jury found for the plaintiff and the appellate court upheld the award.

Assumption of Risk

A graduate-level college student was burned severely when he inadvertently created an explosion by synthesizing glucose and acetone to produce mono-acetone glucose. The graduate student, by choice and convenience, used a laboratory that was alleged to be deficient in necessary safety and laboratory equipment verses other appropriate laboratories available within the institution. The laboratory was unsupervised by the major professor. The student sued the professor and university claiming negligence for, "not supplying the particular laboratory in which the plaintiff was working with "any ordinary or reasonable safety measures or precautions or devices necessary and proper for the purpose of quenching, controlling and extinguishing chemical explosions and fires," and that the plaintiff's injuries were proximately caused by this negligence [4]. The court found in favor of the defendants stating, "The appellant, who, far from being newly initiated in laboratory work, was quite experienced therein, having worked in such laboratories both at the undergraduate and postgraduate levels, knew what devices were necessary adequately to protect himself from the effects of a laboratory explosion and fire, if any should occur," and the, "Plaintiff, therefore, preferred convenience to safety and knowingly took the chance." Therefore, the court cited "assumption of risk" in finding for the defendants.

Duty to Warn Students with Advanced Degrees

A doctoral student at Georgia Tech, Julian Niles, mixed a series of chemicals in a metal canister, which reacted violently causing an explosion that resulted in metal fragments entering Nile's legs and lower abdomen. Niles sued the university and professor for negligence claiming that they did not provide necessary safety training and should have warned him about mixing these types of chemicals in a metal canister [10]. The Court found in favor of the defendants citing, Cir. 1979). "Although a university student is an invitee to whom the university owes a duty of reasonable care, see Rawlings v. Angelo State Univ., 648 S.W.2d 430, 432 (Tex. App. 1983), college administrators do not stand in loco parentis to adult college students. Bradshaw v. Rawlings, 612 F.2d 135. Additionally, the Courts made equivalent the knowledge and experience possessed by graduate students. They stated, "Dr. Erbil had the right to assume that a physics doctoral student, who had graduated with highest honors in chemistry, would either know the dangers of mixing these chemicals or would perform the research necessary to determine those dangers and take the necessary precautions. "Ordinarily, there is no duty to give warning to the members of a profession against generally known risks. There need be no warning to one in a particular trade or profession against a danger generally known to that trade or profession." (Citations and punctuation omitted.) Brown v. Apollo Indus., 199 Ga. App. 260, 263 (2) (b) (404 S.E.2d 447) (1991); Eyster v. Borg-Warner Corp., 131 Ga. App. 702, 705 (2) (206 S.E.2d 668) (1974). Under these circumstances, neither Dr. Erbil nor Georgia Tech had any duty to warn a student with a degree in chemistry of the dangers of mixing these common chemicals."

Reasonable Care

An anonymous plaintiff, John Doe, who is in fact female, was serving her residency at Yale-Hospital when she was ordered to change arterial line in an AIDS patient. During the process, she inadvertently stuck herself with the needle, which in turn infected her with the AIDS virus. Dr. Doe sued the university for negligence claiming lack of instruction, supervision, and guidelines for such a procedure [3]. Yale argued that Doe was claiming educational malpractice. The courts found in favor of the defendant citing, "If the duty alleged to have been breached is the common-law duty not to cause physical injury by negligent conduct, such a claim is, of course, cognizable. That common-law duty does not disappear when the negligent conduct occurs in an educational setting. This principle underlies this court's decision in *Kirchner*. The duty of an educator or supervisor to use reasonable care so as not to cause physical injury to a trainee during the course of instruction or supervision is not novel."

Legal Duty to Rescue

Kleinknecht, a college student, died of cardiac arrest while playing in a lacrosse game. His parents claimed wrongful death and sued the college [8]. The college official rendered care, but it was questionable as to the time period that had elapsed between incident and action to recover (12 min until an official began CPR and 22 minutes until arrival of ambulance). In general the Court stated, “Any person who renders emergency care, first aid or rescue at the scene of an emergency . . . shall not be liable to such person for any civil damages as a result of any acts or omissions in rendering the emergency care, first aid or rescue . . . except any acts or omissions intentionally designed to harm or any grossly negligent acts or omissions which result in harm to the person receiving the emergency care, first aid, or rescue . . . .” However, under the precedence, “teachers/professors have a "special relationship" with their pupils/students, such that teachers/professors have a legal duty to rescue and to render first aid” the college was held liable.

Maintenance of Equipment

Jay, a junior chemistry student, heard an explosion in an adjacent laboratory where two students were working on an experiment. Jay proceeded to put the fire out with a fire extinguisher he found in the hallway. Upon using the extinguisher, he discovered it was empty. The extinguisher exploded causing permanent loss of sight in one of his eyes. Jay sued the college claiming negligence in providing adequate emergency and safety equipment [6]. In fact, the only working extinguisher had been previously emptied due to the fighting of two previous fires in the laboratory. Additionally, the fire extinguishers had not been certified or maintained to common standards. The college argued that Jay had consented to the risk of injury when he volunteered to fight the fire stating, “When a person voluntarily assents to a known danger, he must abide the consequences, even if another party is negligent, but a party is excused from the force of this rule if an emergency is found to exist, or if the life or property of another is in peril.” The court found in favor of Jay stating, “In such an action, the facts established a *prima facie* case of negligence in failing to provide adequate firefighting equipment…”

This review of several cases in the literature exemplifies a few important concepts for a college professor to consider. The discussion included ten cases with subjects such as: standard of care, negligence, duty to protect, supervision, safety, assumption of risk, duty to rescue, duty to warn, reasonable care and maintenance of equipment. The list did not include every legal area of concern, but was only meant to provide an introduction to faculty members of the legal risks involved in their everyday work. Legal assistance should be sought to answer any questions raised by this paper, as the Department of Engineering Technology at WCU only used the law cases in developing a framework for a safety program in the laboratories.

ONE MODEL FOR LABORATORY RISK ASSESSMENT

The preliminary work in developing a safety program at WCU included the review of case law and identifying and using a risk assessment model for documenting and gaining insight into the process. A robust risk assessment model was found in the Department of the Army’s Training Circular No. 9-524, Fundamentals of Machine Tools [11]. The risk assessment model was applied to several laboratories within the department. Typically, our array of modern Haas CNC and manual machine tools are used to generate prototype and custom pieces. Both students and faculty frequently use the equipment in completing coursework, engineering projects, and senior capstone projects.

Specialized Machine Tools

Machine tools are power-driven equipment designed to drill, bore, grind, or cut metal or other material. In view of the different design and operating features incorporated in specialized machine tools by various manufacturers, no attempt was made to include information pertinent to them in this model. For complete information on these tools see pertinent technical manuals published by the manufactures covering their specific machines. The machining facilities available for students to learn Computer Numerical Control (CNC) problem solving as well as manual machining techniques primarily consist of state-of-the-art Haas machines. A summary of machining capability included:

- Haas VF-3 with TR-160 Trunnion Table: The Haas VF-3 vertical machining center has 1016 x 508 x 635 mm of x-y-z travel and is built utilizing cast-iron components. The VF-3 produces 75 ft-lb of torque at a low 1400 rpm, and will run up to 7500 rpm in 1.2 seconds for finishing aluminum. This machine is equipped with a dual-spindle trunnion table for machining helical parts, giving the machine 5-axes of motion.
- Haas TM-1 Toolroom Mill - The Haas Toolroom Mill combines the ease and simplicity of a manual machine with the power and flexibility of full CNC. The instrument has x-y-z travels of 762 x 305 x 406

mm. It is easily moved with a pallet jack and takes up very little floor space. The instrument is considered an open machine. It may be run in the CNC or manual mode and is intended to handle small parts.

- Haas Mini Mill – The Haas Mini Mill is a compact machine which features a 40-taper spindle, speeds to 6000 rpm, 600-ipm rapids and a 10-pocket automatic tool changer. The Mini Mill handles small-parts manufacturing – it is ideal for finishing work and cutting aluminum, yet also provides enough low-end torque to cut steel.
- Haas TL-1 Toolroom Lathe - The TL-1 operates in four modes, ranging from fully-manual to fully-automatic. In all modes, the Haas control provides extremely accurate digital read-out of position, displayed to 0.0005" when using the manual hand wheels or to 0.0001" when using the electronic jog handle.
- Haas SL-10 CNC Lathe - The SL-10 takes up only 6.5' x 4.5' of floor space, yet provides an 11" turning diameter, 14" turning length and a 16.25" swing over the front apron. This compact machine is well-suited as a “second-op” machine. It is also ideal for start-up shops, or as a first step into CNC turning. Tailstock provides rigid support between centers.
- Haas SL-20 CHC Lathe - Haas SL Series offers a wide range of capacities, and the SL-20 increases capacity further while retaining the original footprint. The SL-20, with a max turning capacity of 10.3" x 20" and an 8.3" chuck, has a bar capacity of up to 2.0".
- Haas VF-1 with HRT-210 rotary table: The Haas VF-1 machining center has 508 x 406 x 508 mm x-y-z travel and is built utilizing cast-iron components. This machine employs a 20-position tool changer and has 4th-axis capability provided by an HRT-210 rotary table.

Image 1: Rapid Tooling and Prototyping Laboratory

Manual Machine Tools and Equipment

Not as high-tech but equally important are various machine-tools that are not controlled using CNC. They are able to be operated manually without a lot of training or skill to perform certain operations related to materials processing. They included:

- Horizontal Band Saw: Used to cut bulk materials into appropriate sizes for further processing. This machine is equipped with coolant that can be applied to lubricate, cool, and manage chip accumulation.
- Vertical Band Saw: There are two of these machines available, one for processing bulk metal materials and the other for processing plastics and wood. Neither of these machines have coolant capability.

- Index Turret Drill Press: Vertical drill press with a turret that can support a series of drills, reams, or tap in one setup.
- Pedestal Grinder: Used for manual grinding of FERROUS MATERIALS ONLY!. Can be setup with two grinding wheels or with one grinding wheel and one wire wheel.
- Heat-treating Oven: For heating metal materials in order to change the characteristics of the material to suit a specific product requirement.
- Tensile Testing Machine: For conducting destructive testing on materials to determine the materials stress-strain relationship and other factors of tensile strength.
- Metal Inert Gas (MIG) Welder: For fabrication of products or prototypes that require the joining of steel components into one structure.
- Oxygen Acetylene Gas: For fabrication of products or prototypes that require the joining of steel components through gas welding into one structure or for the separation of components or bulk materials through a gas cutting process.
- Plasma Cutter: For the separation of metal components or bulk materials using a plasma arc process.

Image 2: Fabrication Laboratories

Applying the Risk Assessment Model

The assessment model assumed that all tools are potentially dangerous if used improperly or carelessly. Working safely is the first thing the user or operator should learn because the safe way is the correct way. A person learning to operate machine tools must first learn the safety regulations and precautions for each tool or machine. Most accidents are caused by not following prescribed procedures.

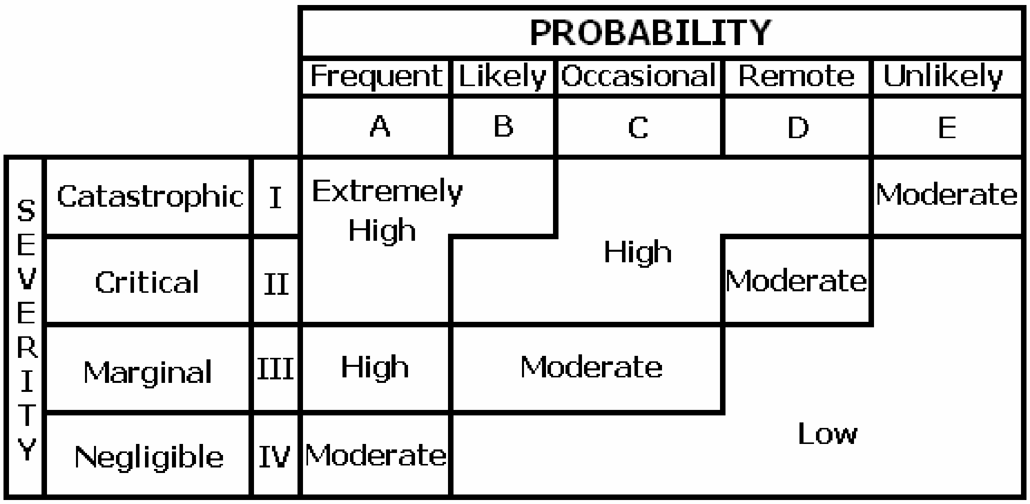
Risk Assessment for the Department of Engineering and Technology's Machine and Fabrication Shop is described below and is matched to the diagram that follows:

1. The <u>Probability</u> of an accident occurring is assessed among five categories: Frequent-occurs often, Likely-occurs several times a career, Occasional-occurs sometimes, Remote-possible to occur, and Unlikely-can assume will not occur. Since all students participating in the Engineering and Technology Curriculum are exposed to the hazards involved with operating the equipment listed above during their tenure at WCU, this exposure to the materials and processes involved in the Rapid Tooling, Machining, Fabricating, and Senior Capstone courses put students into the <u>Remote</u> category of being involved with an accident.

2. After determining the probability of an accident occurring, the <u>Severity</u> of an accident is accessed along the following levels: worse case, an accident could be Catastrophic-resulting in death or permanent total disability, Critical-resulting in permanent partial disability or temporary total disability in excess of three months, Marginal-resulting in a minor injury with lost school days, or Negligible-requiring first aid or

minor medical treatment. An accident involving any one of the Haas machining centers or manually operated equipment could fall into any one of the Critical to Negligible categories.

3. Risk is determined along four levels. Extremely High Risk signifies a student could lose his ability to complete school, High Risk signifies he could be significantly degraded in his ability to complete school, Moderate Risk signifies a student could be hindered in school, and Low Risk means there could be little to no impact on the student. Since the probability of an accident is Remote but the severity of a accident could be anywhere from Critical, Marginal, to Negligible, the Risk Level accessed for the Machine and Fabrication Shop is Moderate, meaning that there is a remote probability of a student sustaining an injury that could result in a permanent partial disability.



SEVERITY		PROBABILITY: Frequent A	Likely B	Occasional C	Remote D	Unlikely E
Catastrophic	I	Extremely High	Extremely High	High	High	Moderate
Critical	II	Extremely High	High	High	Moderate	Low
Marginal	III	High	Moderate	Moderate	Low	Low
Negligible	IV	Moderate	Low	Low	Low	Low

Figure 1: Risk Assessment Model from the Department of the Army's Training Circular No. 9-524

The risk assessment for the Department of Engineering and Technology Laboratories was completed in August 2010 and reviewed by the university auditor. The faculty committee is currently developing an extensive safety program for the laboratories which will be reviewed by the University's legal counsel. Once the safety program is implemented and feedback is collected, the committee will disseminate the program and results in future publications.

CONCLUSION

Higher education institutions have a responsibility to protect students from harm in laboratory learning environments as well as protect the organization from lawsuits. Case law pertaining to negligence resulting in injury of adult students in public higher educational environments is somewhat limited; however, one may glean from the law common standards of student care and with that, limit liability due to negligence. New professors may not be aware of tort law due to negligence. Therefore, the following points and recommendations may serve to inform and educate so that the likelihood of lawsuits may be reduced. Additionally, the Department of Engineering and Technology will use the following points coupled with a risk assessment in developing and implementing its comprehensive laboratory safety program.

- All departments with laboratories should have sound and justified laboratory safety standards and guidelines (based on OSHA) for every course requiring a laboratory.
- If the college has full time council on staff, departments should conduct workshops with council to learn the law.

- Once safety policies and procedures have been developed, departments should verify the safety plans with hired council.
- Professors should become familiar with the laboratory safety guidelines and procedures; do not take them for frivolous or menial instructional material. Conduct safety lectures and demonstrations the first day of class.
- Consistently and constantly, reinforce all safety rules and policies.
- All students, prior to beginning any laboratory assignment should be exposed to safety training sessions in which the professor covers general safety procedures and specific safety actions for experiments and assignments.
- Students should show satisfactory completion of a safety examination prior to beginning any laboratory work.
- First aid equipment should be available, recently inspected and certified, and made aware to laboratory students.
- As a general “rule of thumb,” the amount of student supervision required is directly proportional to the potential and foreseeable danger of the laboratory exercise. Student age and experience is inversely proportional to the amount of care and supervision required. Therefore, undergraduate freshman students need more supervision and care than a graduate student with extensive laboratory experience. Extreme potentially dangerous experiments may require direct supervision, especially for younger inexperienced undergraduate students.
- Relying on contributory negligence is sometimes “iffy.” If students do something that is a blatant violation of procedure and rules, then the likelihood on winning a negligence claim goes down.
- Never accept the assignment of teaching a laboratory that you are not professionally prepared to teach. By taking on such a duty, it becomes your responsibility and duty to be competent in the specific field and aware of general to specific safety measures.
- In terms of safety practices and laboratory experiments always ask yourself, “what would be the standard of care rendered by other like professionals under similar circumstances?” and follow those guidelines as applying safety measures.
- In case of an injury, be prepared to render first aid or if emergency services are available on campus, call immediately, do not delay first aid.

If new professors follow these general guidelines, they should minimize the risk of lawsuits due to laboratory negligence. Tort law is changing constantly; it would be wise for professors to stay abreast of the law by periodically reading law review articles in scholarly journals. Additionally, departments should establish a working relationship and open line of communication with the colleges’ hired council. With these measures, professors should minimize the likelihood of lawsuit as well as protect students from injuries.

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