AC 2011-2520: SAFETY POLICIES AND PROCEDURES FOR ENGINEERING DESIGN COURSES

Junichi Kanai, Rensselaer Polytechnic Institute

After seven years with the Information Science Research Institute, University of Nevada, Las Vegas, where he was an Associate Research Professor, Dr. Kanai joined Panasonic Information and Networking Technologies Lab, Princeton, NJ in 1998. He was a senior scientist developing and transferring new technologies to product divisions. From 2002 to 2004, he was a manager at Matsushita Electric Corporation of America (Panasonic) Secaucus, NJ, providing system integration and software development for clients. Dr. Kanai joined Rensselaer Polytechnic Institute (RPI), Troy, NY, in 2004. He is currently Associate Director of the O.T. Swanson Multidisciplinary Design Laboratory and Clinical Associate Professor of the Department of Electrical, Computer, and Systems Engineering at RPI. His responsibilities include managing the operation of the Design Laboratory and optimizing the experience for students working on engineering design projects.

Samuel Chiappone, Rensselaer Polytechnic Institute


Teaching Activities Undergraduate courses include; Instructor-General Manufacturing Processes, Introduction to Computer Aided Manufacturing, and Course Manager -Advanced Manufacturing Lab I & II. All activities are under the direction of Prof. Linda Schadler, Associate Dean, Academic Student Affairs.


Awards, Conference Proceedings, Technical Papers, and Presentations

10/09 ASME Design and Manufacturing Student Challenge, Atlanta, GA. Advisor for second place team.
8/09 Rensselaer Polytechnic Institute Pillar Award
1/00 Chiappone, S. Educating future engineers on rapid prototyping & tooling capabilities. Rapid Prototyping. SME. (First Quarter 2000 Vol 6, NO.1)
4/99 SME/Rapid Prototyping-99, Chicago, IL, proceedings and presentation on Rapid Prototyping in an Educational Laboratory; Educating Future Engineers on Rapid Prototyping.
10/99 SME Region 4 - Manufacturing Education Excellence Award for AML Activities

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Safety Policies and Procedures for Engineering Design Courses

1. Introduction

It is important for undergraduate engineering education to teach professional practice in addition to technical knowledge [1]. One of the core values of the profession is safety. It is also covered in the program outcome (c) by ABET [2].

Students in engineering design courses often face a variety of safety issues due to the diverse nature of design projects. The program outcome (d) by ABET requires students to attain the ability to function on multidisciplinary teams. Course instructors may not have the expertise to address all safety issues in multidisciplinary design projects. Students and instructors can work with the School of Engineering (SOE) Safety Committee members and other experts on campus to deal with their particular safety needs.

Some safety issues covered in engineering design textbooks are safety related mechanical design issues [3], computer system availability and redundancy [4], and product safety and liability [5]. Examples of analysis techniques are FMEA (Failure Mode Effects Analysis) [5] and probability of failure [3] [4].

Undergraduate students have limited life experience and are often not able to recognize unsafe situations and safety related issues. They also need practical safety related information to successfully and safely compete design projects.

Our safety polices are used in the following hands-on design courses: Introduction to Engineering Design (sophomore-level), Advanced Manufacturing Lab II (senior level), and Capstone Design courses. This paper introduces how the safety policies can enhance students experience in different phases of their design process. The roles of the safety committee in assisting students and their projects are also described.

2. History of the Safety Guidelines and the Safety Committee

The safety program was originally developed for the SoE fabrication shops in 2001 and addressed safety issues associated with fabrication areas. It has grown and matured over the years and provides a variety of support services to engineering design courses. Yet it remains consistent with the following core principles for which it was originally designed to address: 1) the nature and challenges of safety programs in an academic environment; 2) the educational value of teaching students appropriate safety practices; 3) the concept of integrating risk analysis and safety practices into project work, 4) collaboration of Staff, Faculty and Students to accept personal responsibility for the safety of their work areas, and 5) development of safety procedures and training materials.

The SOE Safety Committee at Rensselaer Polytechnic Institute consists of faculty members, the shop manager and instructors, and members of the Environmental Health and Safety office from the Human Resources Department. They typically meet once a semester to review and update the current safety procedures. (A sample of safety rules is shown in Appendix A.) The committee
also proactively addresses safety issues in emerging technologies and topics, such as eye and skin protection in solar energy projects. The guidelines were originally written for shop safety and have expanded to cover design project related safety issues.

3. Requirements and Specifications Phase

Students typically work on a design problem that is completely new to them. In other words, they cannot depend on their previous experience to recognize unsafe situations in their design problems. The Safety Committee regularly updates the safety procedures by studying the impact of new and upcoming technologies and projects. Some guidelines in the Electrical, Chemical, and Optical Safety sections of the SoE Safety Guidelines serve as design constraints.

4. Concept Generation and Evaluation Phase

Since the guidelines include fabrication restrictions, they can be used to determine the manufacturability of a design concept. For example, renewable energy systems might require pressure vessels. However, fabrication or modification of pressure vessels by student, staff, or faculty is not allowed. Use of commercially available pressure vessels within their manufacturer-rated operational range is allowed with faculty or staff supervision.

When students are not able to clearly identify all of the safety issues in their concepts, they can contact the safety committee to clarify efforts required for using the technology in their design. In a project, a team identified ultraviolet (UV) light technology as a promising solution to the assigned project. At the same time, they realized the need for eye and skin protection. According to the information provided by the committee, the team chose another approach to solve the design problem and documented their concept selection process.

5. Design Phase

Some guidelines also help students to make safe design choices before the Prototyping Phase. Examples are as follows.

- Lithium-Ion batteries are becoming common. However, they could cause an explosion which would be difficult to extinguish in the case of fire [6]. Hence students are required to use other types of batteries.
- Choosing appropriate materials are important. Materials that may produce toxic substances, such as PVC, must not be heated (Optical Safety #7). The rule was established according to students’ interest in solar energy projects.

6. Safety Training in Prototyping Phase

Students are required to study the latest safety guidelines (Appendix A) and pass a safety quiz consisting of 25 questions at the beginning of each semester. They are not allowed to use the fabrication facility until they pass the quiz. In other words, the safety guidelines are used as a training tool for safely build prototypes.
Before the fall of 2007, it was up to the individual instructor to grade these safety quizzes and maintain records of such. This system did not allow the shop instructors and TAs to easily identify if students had passed a safety quiz for the designated area. To improve this situation, an online safety training system was implemented using WebCT\footnote{WebCT is now owned by Blackboard, Inc. (http://www.blackboard.com/)}\cite{7,8}. If safety training and/or safety documentation are lacking, the university could face fines and/or criminal charges in the case of a serious accident \cite{7,8}. This system also simplifies the process of distributing safety guidelines and rules to students and maintaining safety training records.

Currently over eight courses consisting of approximately 900 students use this system every semester. A week before the semester, an e-mail containing step-by-step instructions for taking the on-line quiz is sent to all students who need to take it. The system presents the safety guidelines and administers the safety quiz. The students must get 100/100 and can take the quiz as many times as needed. The system’s grade book is used to centrally keep the test results. A hard copy of the My Grade Page containing the test result is used as the certificate of completion.

In the fall of 2010, 960 students, including some Architecture students, took the on-line safety quiz. A sample quiz is shown in Appendix B. As shown in Figure 1, approximately half of the students passed the quiz by the first attempt. On average, it took 2.65 attempts for students to pass the quiz.

The step-by-step guide for taking the quiz was clear and effective because no student contacted us for help. Approximately one percent of the students took the quiz more than ten times before passing it. It seems that students tried to guess answers rather than learning the guidelines because each attempt to complete the quiz typically lasted less than a minute.

Figure 1   Number of Attempts to Pass the Quiz

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Number of Attempts to Pass the Quiz}
\end{figure}
7. Operation and Evaluation Phases

Students need to safely operate and evaluate the performance of their prototypes. Common tasks, such as troubleshooting electric circuits and testing solar energy systems, are included in the SoE general safety rules. On the other hand, some projects may include chemical, biological, mechanical or electrical aspects that need clarification. In these cases, in addition to preparing test cases and/or plans, students are required to research policies, draft standard operating procedures (SOP), review the information with an instructor, and request approval from the safety committee prior to beginning the evaluation phase. Examples are as follows.

The objective of the vein harvest project was to design and build a surgical tool for harvesting veins destined for use in coronary artery bypass grafting. Students prepared an appropriate SOP, as shown in Appendix C, and were allowed to use a leg of a lamb, not human tissue, for testing. This work was classified as Biological Safety Level 1 work.

Students in a sophomore level Introduction to Engineering Design class developed a procedure to bring a CO₂ powered paintball gun into the classroom for project use. (See Appendix C.) In addition to review and approval from faculty, staff, and the Office of Environmental Health and Safety, this team worked within the guidelines of the Office of Public Safety due to campus restrictions for CO₂ powered handguns. Their procedure addressed safe handling, storage, and supervision. The plan was reviewed and approved by all. The team was able to successfully operate and test their prototype.

A Team of senior engineering students enrolled in the Advanced Manufacturing Lab II class designed a candy dispenser whose shape was a rocket. This team utilized a UV (ultra violet) curable adhesive for bonding plastic components in a manufacturing system they designed. The members conducted preliminary research related to the process and designed a safety procedure for use of the adhesive. The basics of the plan outlined personal protective gear, start-up and shut-down procedures, storage, and handling procedures as described in Appendix D.

Since students have limited experience, they might not see unsafe conditions in their prototypes. Although it is not mandatory, students can request committee members to inspect their system before its inaugural operation. The goal of the eddy current test project in a senior capstone design class was to design and build an electromagnet-based test bed that can quantify the losses due to eddy current. The inspection identified needs for an emergency electric disconnect and a shield to protect the operator from the potential risk of a broken piece that could become a projectile. The team modified their system according to the results of the inspection and updated their design documents. Their system operated without any problem, and the team was able to demonstrate the correctness of their design.

8. Closing Phase – Disposing Prototypes

In general, students choose appropriate materials in the design phase, so that they can be reused, recycled, and/or safely disposed. If students are not sure of correctly handling any material, they can contact the safety committee for guidance. For example, a bio-mass project can use pieces of vegetables to generate fuel. Yet, these materials must be disposed as chemical once the reaction is started. The Safety Guideline (Chemical Safety #1) helps students to learn the correct way for
disposing of such materials from the Environmental Health and Safety office and safely handle
them.

It is impossible to cover all materials that need special handling in the safety guidelines. Hence,
it is essential to make students contact appropriate people whenever they are not sure of any
safety issues.

9. Conclusion

Students in project-based engineering design and manufacturing face a variety of safety issues
due to the diverse nature of design projects undertaken each semester. We use an on-line system
for providing basic safety training to students and documenting the results. Understanding the
safety guidelines helps engineering students to recognize and evaluate safety issues in different
phases of their design projects. Furthermore, the policies help instructors to recognize safety
issues in multidisciplinary design projects.

We try to make sure that following safety guidelines do not create a hindrance to their project
work. Furthermore, assisting in the evaluation of their ideas and design causes the students to
take greater responsibility for safety in their design, safety in fabrication of a system in the shop
areas, and in operation and testing of the system. The safety guidelines and safety committee
enhance hands-on design courses.

References

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Evaluations During the 2010-2011 Accreditation Cycle.*: ABET, 2009.


OSHA-Issues-Nine-Serius-Citations-Following-Laser-Lab-Accident.aspx](http://ohsonline.com/Articles/2009/01/24/24-
OSHA-Issues-Nine-Serius-Citations-Following-Laser-Lab-Accident.aspx)

Appendix A. School of Engineering and School of Architecture  
General Safety Rules and Operational Policies for Manufacturing & Prototyping Areas  
(Rev. 1/13/11)

Emergencies

1. Report all emergencies to your instructor or RPI staff member. If an injury needs prompt medical attention, call Public Safety at campus phone extension 6611 or by cell phone at 518-276-6611.
2. Do not attempt to move an injured person.
3. First-aid kits are available throughout the shop areas for minor injuries.
4. Do not attempt to clean up any bodily fluids under any circumstances.
5. In case of fire or hazardous chemical spill evacuate the premises immediately.

General Operational Policies

1. Students are not permitted to work alone in the shop areas without the supervision of an instructor, staff member, or teaching assistant (TA).
2. Only current RPI faculty, staff, and students who have been properly trained and authorized are allowed to directly operate equipment (machine tools, welding equipment, robots, assembly systems, and electronic equipment) or any other type of power equipment in the manufacturing and prototyping areas within the Schools of Engineering and Architecture.
3. Use the buddy system and watch out for other people. If you are aware of an unsafe situation, please report it to your instructor or staff member.
4. Do not tamper with projects, experiments, machine setups, or prototypes that are not under your jurisdiction.
5. Use of tobacco products, alcohol, and illegal substances is prohibited in the shop area.
6. Do not operate any machines if your abilities are impaired for any reason (examples: personal illness, lack of sleep, drugs, or alcohol).
7. Everyone is responsible for housekeeping and cleaning up after themselves. Project work is to be done in the designated workbench areas only and properly stored for safe keeping after use. Aisles, doorways, and stairways are to be kept clear for purposes of safe passage.
8. Do not run in the shop area or distract the work of others with unnecessary yelling, loud music, etc.
9. Report any cases of vandalism or theft to your instructor, staff member, or TA.
10. Students should not perform any type of maintenance on equipment in the shop areas.
11. Eating is only allowed in designated areas.

General Safety

1. Safety glasses with side shields are mandatory in all areas at all times. Persons not wearing safety glasses will be asked to leave.
2. Students should purchase their own safety glasses with side shields. You can purchase glasses at the campus bookstore, Pfeils Hardware (63 3rd St. in downtown Troy), or Home Depot.
3. Wear appropriate clothing for the task you are working on (example: long pants or proper personal protective gear, such as gloves, etc). Ask an instructor, or staff member if you are not sure if you are dressed correctly for the task at hand.
4. Loose clothing, neckties, long hair, personal stereo wires, and jewelry can become entangled in rotating equipment leading to serious injury or death! Make certain that such articles are removed or securely fastened to avoid entanglement.
5. Machine and fabrication shops are noted for the hazard of dropped objects; because of this, work boots are the preferred footgear. Persons wearing open toe shoes, open-back shoes, ripped
sneakers, sandals, crocs, formal “strappy shoes,” high-heeled shoes, etc. will be asked to leave the area.

6. Use appropriate safety equipment (i.e., welding gloves, ear protection, aprons, welding helmets, face-shields,) while working in the area. See your instructor or a staff member for guidance.

7. Report all spilled fluids immediately (since they are an extreme slip hazard).

8. Personal communication and music systems (MP3 players, cell phone, text messaging, etc.) are not allowed when operating manufacturing equipment and power hand tools.

9. Do not use open flames in shop areas except the welding area in the student shop (JEC 1012) (e.g. Soldering or brazing torches, candles, cigarette lighters).

10. Systems using a projectile must be approved by a faculty member or staff member.

11. Powered/operating projects may not be left unattended. Should long-term testing be required, it must be arranged on a case-by-case basis with permission of an instructor and lab manager (i.e. Sam Chiappone)

**Mechanical Systems, Machinery, and Power Tools**

1. Do not use machinery or power hand tools without the proper training. If you do not know how to operate a power tool or machine, or do not fully understand the instructions you have been given, ask an instructor or staff member for help.

2. Do not use gloves while operating machinery; they can become entangled in rotating tools.

3. Do not touch any rotating component of a machine until it has completely stopped.

4. Use care when handling tools. Cutting tools are very sharp! Wrap tools in a rag when removing or installing cutting tools.

5. Do not distract people operating machines; which includes speaking to them. Do not allow yourself to be distracted. If you must talk, bring machinery to a complete stop first. If you are asked to stop the operation of a machine, then do so immediately! Do not leave machines running while unattended.

6. Personal power and hand tools may be used only with the permission and supervision of your instructor or staff member.

7. Many hazards exist in a machine shop. Before you move a heavy object, swing a hammer, or engage any machine power, think about the consequences of your actions. How and where are you going to put the heavy object down? Are your fingers going to get caught? Are somebody else’s fingers going to get hurt? When the power comes on, will tools fly? Will cutting tools run into things they aren’t supposed to hit? PLEASE THINK BEFORE YOU ACT!

8. Fabrication or modification of pressure vessels by student, staff, or faculty is not allowed. Use of commercially available pressure vessels within their manufacturer-rated operational range is allowed with faculty or staff supervision.

9. Fabrication or modification of rotating components (e.g. flywheels, tires used as launchers) with stored energy over 100J is not allowed without special permission from faculty or staff member.

**Electrical**

1. Working with line voltage or voltages greater than 24v must be done under the direct supervision of an instructor or staff member.

2. Do not work on electronic circuits when the power is on, unless it is absolutely necessary and under the supervision of an instructor or supervisor. Low power analog and digital circuitry (e.g. ≤ 250 mA) are the ONLY exceptions to this rule, provided the power supply or battery is fused at 1 amp or less.

3. Use the one handed rule when working on active circuits. Electric currents of less than 100 milliamps can cause death.

4. Electrolytic caps and other large capacitors can hold voltages for several hours. Be sure they are discharged with an insulated clip lead before working on the circuit.
5. Certain components such as power resistors and semi-conductors get very hot. Give them a chance to cool before touching them.

6. When soldering, wear safety glasses and do not flick the soldering iron to remove excess solder. You may burn your colleague.

7. All batteries must be manufacturer labeled and their battery chemistry (type) listed. Lead-Acid batteries must be of the sealed, non-spill, "gel cell" or "AGM" type – Liquid electrolyte lead acid batteries (e.g. Motorcycle and CAR BATTERIES) are PROHIBITED.

8. Any batteries not of the standard consumer type (e.g. AA, AAA, C, D, 9v, 6v lantern battery, etc.) must be approved by a staff member or instructor.

9. Lithium-based batteries (labeled “Lithium,” “Li-po,” “Li-Ion,” “Lithium-Polymer,” “MnO2-Li,” etc.) may not be used without approval of both your instructor and the lab manager (i.e. Sam Chiappone).

10. Batteries and power supplies must be fused appropriately

11. Batteries must not be left unattended while charging. DO NOT ATTEMPT TO CHARGE NON-RECHARGABLE BATTERIES!

12. All extension cords should be visually inspected for damages prior to use. Any cords suspected of having a defect should be turned in to a faculty or staff member.

13. Do not plug a 3 prong electrical cord into a two prong extension cord.

Chemical

1. Do not drain/dispose any chemical without first consulting an instructor or staff person.

2. All painting is to be done in the paint booth (with the ventilation system turned on) regardless of application method. The paint booth is located in the Design Lab Fabrication and Prototyping Area, JEC 2332.

3. Any paint or chemical compounds requiring mixing and or the use of a respirator requires approval and direct supervision of a shop staff member. Please contact Sam Chiappone at 276-8295 (JEC 3100) or Scott Yerbury at 276-8290 (JEC 2332) for assistance.

4. All chemical containers must be labeled as to their contents

5. Material Safety Data Sheets (MSDS) are available on line at www.msds.rpi.edu.

6. Oil soaked rags or rags with any type of solvent are to be disposed of in proper containers. Do not dispose of these items in regular trash containers

7. Hazardous or regulated materials such as batteries, computer components, and chemical reagents must be disposed of in accordance with Rensselaer’s Hazardous Materials Disposal Program. An online version of the Hazardous Materials Disposal Program is located at http://hr.rpi.edu/update.do?artcenterkey=383.

8. Bio-reactors, live cultures, decomposing organics, or other potential gas sources must be properly vented or stored in a fume hood. Gas exposure, pressure buildup, flammability, and explosion risk must always be carefully considered and addressed with such projects.

Optical Safety

1. Intense visible and invisible (UV, IR) light can be produced by lasers, arc lamps, high output LEDs and concentrated sunlight. This light may cause physical burns or severe eye damage.

2. Wear appropriate eye and skin protection when concentrating direct sunlight, operating intense light sources such as lasers, arc lamps, high output LEDs, and when using laser cutter/engravers for engraving mirrors and coated metals such as enameled brass and anodized aluminum.

3. Lasers used in projects must be properly labeled (i.e. manufacturer's labels, listing output wavelength, power, and class).
4. Lasers for project use may not exceed Class 3R (post-2002 classification), or Class IIIa (pre-2002 classification). For visible CW lasers, this sets an absolute maximum output of 5mW. UV and IR lasers are more dangerous, as they produce radiation that is invisible to the human eye. Wear eye protection appropriate to laser wavelength. See ANSI Z136.1 for laser safety.
5. Do not attempt to modify or disassemble laser systems (e.g. laser cutter/engraver) at any time.
6. Always read the manual and caution labels carefully before operation of any laser or laser-based device
7. Do not laser-cut or heat materials that may produce toxic substances such as PVC and Teflon. If material is questionable DO NOT expose to laser (i.e. laser cutter/engraver) or sunlight (i.e. solar concentrator, solar oven).

**Woodworking Safety**

1. Be aware of the direction of moving blades. (Rotation of blades toward, away and parallel to you have differing consequences)
2. Point chisels and other sharp hand tools AWAY from the body and other people.
3. Secure your work before operating woodworking power tools.
4. Wood and wood dust are flammable, take proper precautions.
5. Use the proper equipment for ripping and crosscutting operations. Cross cuts are across the shortest length and ripping cuts are parallel to the longest length
6. Treated Lumber must not be cut in the Architecture Fabrication Shop (GR 1st Fl) or School of Engineering shops.
7. Medium Density Fiber (MDF) board should only be cut on equipment in the Architecture Fabrication Shop with appropriate ventilation.

In reviewing this sheet and signing the class safety sheet list, I acknowledge that I have carefully read and fully understand the general safety rules and operational policies of the School of Architecture and School of Engineering’s Manufacturing & Prototyping Areas, and I will comply with them. I also realize that other, undefined hazards will exist in the fabrication & prototyping areas and therefore, my safety, and that of others, is ultimately my own responsibility.

Please contact Sam Chiappone, Manager of Fabrication & Prototyping (chiaps@rpi.edu), if you have questions relative to the policies, testing process, or projects outside of the scope of these policies for School of Engineering projects. Bill Bergman, Manager Wood Shop (bergmw@rpi.edu), is the contact for projects in the Architecture Fabrication Shop, School of Architecture.

**NOTE: Persons violating safety rules or operational policies are subject to appropriate disciplinary action and/or immediate dismissal from the area.**
# Appendix B School of Engineering Manufacturing and Prototyping Areas

**Safety Quiz – Rev.8/16/10**

<table>
<thead>
<tr>
<th>T, F</th>
<th>1. Working alone in a shop or fabrication area is okay if you are not using powered tools or electronic devices.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T, F</td>
<td>2. Safety glasses are only required when working with power equipment. You do not need glasses when you are working at an electronics bench in a shop area.</td>
</tr>
<tr>
<td>T, F</td>
<td>3. In case of a fire or hazardous chemical spill evacuate the area immediately.</td>
</tr>
<tr>
<td>T, F</td>
<td>4. You are responsible for housekeeping and cleaning up after you are finished working on a project.</td>
</tr>
<tr>
<td>T, F</td>
<td>5. You must report all injuries to your instructor, TA, or staff person.</td>
</tr>
<tr>
<td>T, F</td>
<td>6. You can use the shop or fabrication area whenever you find a door open even if your class TA or professor is not present in the lab.</td>
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<tr>
<td>T, F</td>
<td>7. You can cut any type of plastic on the laser cutter.</td>
</tr>
<tr>
<td>T, F</td>
<td>8. Painting can be done at your workbench.</td>
</tr>
<tr>
<td>T, F</td>
<td>9. You should not drain dispose any chemical without first consulting an instructor or staff person.</td>
</tr>
<tr>
<td>T, F</td>
<td>10. Work with line voltage above 24V must be supervised by a staff member, faculty member, or teaching assistant.</td>
</tr>
<tr>
<td>T, F</td>
<td>11. Lead-Acid batteries must be of the sealed, non-spillable, &quot;gel cell&quot; or &quot;AGM&quot; type.</td>
</tr>
<tr>
<td>T, F</td>
<td>12. Working on a powered electrical circuit is only allowed when proper supervision (staff member, faculty, or TA) is present.</td>
</tr>
<tr>
<td>T, F</td>
<td>13. The best way to learn how to use a power tool is trial and error; no need to ask for instructions.</td>
</tr>
<tr>
<td>T, F</td>
<td>14. Personal power tools can be used without restriction.</td>
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<tr>
<td>6611</td>
<td>15. The Emergency phone number for RPI-Public Safety is 276-[ ]- [ ]. A campus phones uses the last four digits only.</td>
</tr>
<tr>
<td>T, F</td>
<td>16. The shops and fabrication areas are places to learn so you are encouraged work on projects that are not your own.</td>
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<tr>
<td>T, F</td>
<td>17. Students are allowed to fabricate pressure vessels from plastic pipe and common plumbing fittings.</td>
</tr>
<tr>
<td>T, F</td>
<td>18. All electrical devices using a 3 prong plug AC line must be connected to a 3 conductor extension cord or 3 conductor outlet.</td>
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<tr>
<td>1, 2, 3, 4</td>
<td>19. Select all acceptable foot gear in the fabrication areas.</td>
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<tr>
<td>T, F</td>
<td>20. Safety is everyone’s responsibility and you should report any unsafe act or situation to your instructor or staff person.</td>
</tr>
<tr>
<td>1, 2, 3, 4</td>
<td>21. While using a chisel it is safe to do the following:</td>
</tr>
<tr>
<td>T, F</td>
<td>1. Hold work piece in my lap, 2. Hold work piece with other hand in front of chisel, 3. Clamp work piece to bench, 4. All of the above</td>
</tr>
<tr>
<td>1, 2, 3, 4</td>
<td>22. Treated lumber can be cut in the Architecture Fabrication shop.</td>
</tr>
<tr>
<td>1, 2, 3, 4</td>
<td>23. MDF (Medium Density Fiber) board can be machined:</td>
</tr>
<tr>
<td>T, F</td>
<td>1. In the Processes lab, 2. The Design Lab, 3. Architecture Fabrication Shop, 4. AML</td>
</tr>
<tr>
<td>1, 2, 3, 4</td>
<td>24. Who is the Manager of Fabrication &amp; Prototyping?</td>
</tr>
<tr>
<td>Yes, No</td>
<td>25. I acknowledge that I have carefully read and fully understand the general safety rules and operational policies of the School of Engineering’s fabrication &amp; prototyping areas, and I will comply with them. I also realize that other, undefined hazards will exist in the fabrication &amp; prototyping area and therefore, my safety, and that of others, is ultimately my own responsibility. Yes, I agree. No, I do not agree.</td>
</tr>
</tbody>
</table>
Appendix C. ENGR 2050- Introduction to Engineering Design  
Paintball Marker Operation Policy

**Situation**- The use of a paintball marker is necessary to complete a proposed design in ENGR 2050. Paintball markers are typically not permitted on campus.

**Mission**- Our objective is to integrate the use of a paintball marker into a group’s proposed design for ENGR 2050 in the safest possible manner.

**Execution**- In order to prevent injury, damage, etc., the following safety protocol will be followed in the use of a paintball marker for design and demonstration of this project:

1. The marker will have a gun lock on it when not in use or whenever design or construction allows
   a. The keys to the gun lock will be in possession of the class instructor
   b. Whenever transported to or from campus, the gun lock will be on
2. A stand-in for the actual paintball marker will be used whenever feasible
3. The paintball marker will be locked in the class instructor’s office between use and will only be removed under his supervision
4. While on campus, the paintball marker will only be used in the IED classroom, design lab, and final testing site
   a. The class instructor will always be present when the marker’s gun lock is unlocked, as well as for the final demonstration
5. The system will only be targeted at a specifically designated and designed target
6. The following standard weapon safety policies will be observed:
   a. Treat every weapon as if it were loaded
   b. Never point a weapon at anything you do not intend to shoot (e.g. people, animals, buildings)
   c. Keep your finger straight and off the trigger until you are ready to fire
   d. Keep the weapon on safe until you intend to fire
7. With the sole exception of final testing and demonstration, the marker will always be unloaded (no paintballs or compressed air attached) and on safe with a barrel-blocking device in place
8. The firing mechanism will be controlled by a separate remote trigger, preventing accidental firing
9. Only standard paintballs will be used as projectiles (standard paintballs are made of biodegradable materials that wash away with the first rain)
10. Any demonstration or test that requires actually firing paintballs will be conducted outdoors and only with permission of appropriate authority
11. Cleanup will be the responsibility of the IED group
12. Any person down range or within 15 feet of the project will be required to wear an ASTM-approved face mask
13. Muzzle velocity will be kept below 250 fps (standard paintballing velocities are approximately 290 fps)
14. The testing area will be clearly marked and blocked from pedestrian traffic during demonstration and testing

**Administration and Logistics**- These guidelines must be approved prior to bringing the paintball marker on campus. Campus Safety will be notified when outdoor demonstrations occur. The demonstration area will be marked with standard yellow caution tape and the range will be cleared before testing.
The IED group members are as follows:

- Name, Major, Class of 20xx

Points of Contact:

- Student’s Name- IED Group Representative
  - Student’s Email
- Cecile Mars- Director of Environmental Health and Safety
  - marsc3@rpi.edu
- Sam Chiappone- Manager, SOE Fabrication and Prototyping Facility
  - chiaps@rpi.edu
- Mark Anderson- IED Class Instructor
  - anderm8@rpi.edu
- Jerry Matthews- Director of Public Safety
  - matthj3@rpi.edu
Appendix D. SOP UV Glue Dispensing System

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine Tool</td>
<td>PVA ST90 Syringe Dispenser</td>
</tr>
<tr>
<td>Timer Range</td>
<td>0.01 – 1 sec</td>
</tr>
<tr>
<td></td>
<td>0.1 – 10 sec</td>
</tr>
<tr>
<td></td>
<td>0.3 – 30 sec</td>
</tr>
<tr>
<td>Cycle Initiation</td>
<td>Maintained or Momentary</td>
</tr>
<tr>
<td>Repeat Tolerance</td>
<td>±0.5%</td>
</tr>
<tr>
<td>Size</td>
<td>23.8 x 15.0 x 6.0 cm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.74 lb</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>110-115 V ac</td>
</tr>
<tr>
<td>Internal &amp; Foot Pedal Voltage</td>
<td>24 V dc</td>
</tr>
<tr>
<td>Air Input</td>
<td>1-100 psi</td>
</tr>
<tr>
<td>Air Output</td>
<td>1-100 psi</td>
</tr>
</tbody>
</table>

Set-Up

1. Connect dry and filtered air supply to the unit’s air input plug (max 100psi).
2. Connect footswitch receptacle in the back of the unit.
3. Connect footswitch cable to relay for automatic operation with Staubli robot.
4. Connect the supplied power cord to a grounded, properly rated voltage outlet.

Dispensing

1. Attach disposable stainless steel blunt end dispensing tip to the bottom of a 10cc polypropylene syringe barrel.
2. Fill empty syringe barrel with Dymax® UV light curing adhesive.
3. Insert 10cc polypropylene air plunger into syringe barrel.
4. Attach syringe barrel to the end effector on the Staubli robot.
5. Plug adapter hose into the front of the ST90 controller and into the SnapLok™ barrel on the robot’s end effector.
6. Turn PVA ST90 on.

7. Set operation mode switch to manual.

8. Set air pressure to 90psi by turning air pressure knob.

9. Adjust the knob until just enough vacuum is applied to prevent dripping of UV glue. Do not over adjust this, as you will trap more air into the syringe, causing more dripping issues. Also, glue can be pulled all the way back into the unit which can damage the ST90.

10. The ST90 can now be signaled to dispense UV glue with footswitch or by using the robot.

11. To dispense glue with robot use assigned signal number based on the relay that the ST90 is connected to.

**For troubleshooting see Precision Valve & Automation Inc. ST90 Syringe Dispenser Operation Manual located in the AML.

UV Shielding for Candy Rocket Project
The team has chosen to encapsulate the entire area in non-light permeable fabric shielding. There are a total of 4 curtains surrounding the assembly cell. They are each 6.5’ tall to avoid any accidental flashing on either the mezzanine or staircase of the AML. Three of the curtains are made of either a Black Felt material, or dark blue vinyl. The fourth is made of a polarized smoky plastic that is especially designed for observing processes that involve intense amounts of UV light such as wielding or UV light applications.

The system has been tested to ensure no UV light exits the area (when implemented correctly).