

Operating A Residential Hall Makerspace – Lessons Learned from the inVenTs Studio 1

Adam Norman, Callie Zawaski, Bevelee Watford, Susan Arnold-Christian
Virginia Tech, adamen92@vt.edu, zawaca@vt.edu, deuce@vt.edu, susanac@vt.edu

Abstract - In recent years Makerspaces have seen a large increase in popularity among universities, in part due to the hands on experience students can gain, which they do not typically receive in class. Opening in October of 2012, and believed to be the only such facility located within a residence hall at any University in the U.S., the inVenTs Studios in Lee Hall at Virginia Tech have provided an interdisciplinary living-learning space for students of a residential community to explore their ability to envision, create, and transform innovative ideas into action. Inside the inVenTs Studios, students have the unique opportunity to interact and learn from both current upper-class leaders of the inVenTs Leadership Team (ILT), as well as representatives from various industries during Innovation Activities. Studio 1 is primarily utilized as a workshop with innovative equipment and software that allows students to have minimal restrictions on the scope of their ideas. It is also the place where weekly events are held by the ILT, and company representatives put on Innovation Activities. Studio 2 is a smaller space that is ideal for group activities and meetings by use of a multi-media center and whiteboards.

Since the opening in 2012, continual efforts have been made to increase students' understanding of how to best develop their skills inside the space, apply theory from the classroom into innovative ideas, and collaborate with students from different majors. Through a trial and error process, significant progress has been made to help students develop these skills that are not always stressed inside the classroom. The inVenTs Studios have had to adapt significantly since opening, and will continue to do so, to ensure that students are prepared and continue to "Invent the Future."

Index Terms – inVenTs Community, Makerspace

Background

The inVenTs community and inVenTs studio was founded by the Center for Engineering Enhancement and Diversity (CEED) in the College of Engineering, in collaboration with the College of Science at Virginia Tech in 2012. The inVenTs community was created as a living learning community for engineers and scientists to learn to work

together. inVenTs is an umbrella name that encompasses four STEM based residential communities: Hypatia (women in engineering), Galileo (men in engineering), Da Vinci (students in biological and life sciences), and Curie (students in physical and quantitative sciences). The communities are made up of primarily first year students. Each community includes a peer mentoring program and utilizes upper-class student leaders to provide everything from academic support, to social events, to professional development, all designed to facilitate the success of the freshman student residents. All first year students entering inVenTs live in the Lee residence hall, and as of the 2014-2015 inVenTs completely filled Lee Hall. The size of the communities in Lee Hall is as follows; Galileo 348, Hypatia 240, DaVinci 104 and Curie 88 for a total of 780 students.

The inVenTs Studios were created for the community in collaboration with the Division of Student Affairs, Office of Residence Life. InVenTs Studio 1 and 2 are located on the second floor of Lee Hall. The idea was to create a makerspace in an easy to access location for the students to use for both class and personal projects. Additionally, partner companies were invited to come in and use Studio 1 to implement hands on activities with the students and create opportunities for the science and engineering students to collaborate to address various real world problems. inVenTs Studio 2 was created adjacent to Studio 1 as a smaller, quieter, extension of the space for developing presentations and providing space for student teams to meet and collaborate..

Equipment, Supplies, and Training

Studio 1 was supplied with new and donated tools that could be used by students for basic projects and prototyping. Table 1 provides a list of some of the larger pieces of equipment that reside in Studio 1. Of the larger equipment, material for the 3D printer, the plotter, ModelMaker, and the microscope are provided by the studio. Students provide their own material for the other tools and equipment for personal and school projects. Material is provided for all studio run events and projects.

Each piece of equipment piece has different requirements and training for the students to use. The laser cutter, model maker, and CNC router all require training by a graduate assistant or upper class leader before the student can use the

machine.

TABLE I
STUDIO 1 EQUIPMENT/TOOLS AND TRAINING REQUIREMENTS

Equipment/Tools (#)	Training Required
Stratasys uPrint SE Plus 3D Printer (2)	N/A
VLS 3.60 Laser Engraver	YES
Denford Microrouter Compact CNC	YES
2Bot ModelMaker	YES
HP DesignJet 800PS Plotter	NO
ThreeRivers 3D Scanner	NO
PowerTec BS900 Bandsaw	NO
PowerTech BD4600 Belt Disc Sander	NO
Olympus Compound Microscope	NO
Miter Saw	NO
Soldering Irons (4)	NO

Students sign up online for set training times or can ask to be trained in the studio if someone is available. When a student is trained, it is recorded on a training card for documentation and easy access. All the large wood tools require a safety briefing before. A longer training is also offered, but not required, for students who have never used wood working tools. The studio also provides other tools such as drills, dremels, soldering irons, hot glue guns, etc. which were are for students to use without training, but assistance is provided if requested.

The uPrint 3D printer is the only piece of equipment the students do not run themselves. There are two reasons for this rule. The first reason is to ensure that students do not abuse the privilege; so a graduate student lab assistant reviews the parts to make sure the students are using the technology appropriately. An example would be a student who is allowed to print a custom cell phone case they designed using CAD as opposed to a cell phone case downloaded online simply because the student doesn't want to pay for one. The second reason is that students typically print smaller items, and printing can take a long time even for a small item. A graduate assistant can put many items in one print job resulting in greater efficiency rather than printing items one at a time.

The largest challenge with the studio equipment is making the equipment less intimidating to students who are not experienced. Students who have used different tools growing up are extremely comfortable coming in and using the equipment on their own or with minimal assistance. It is harder to bring in students who have not had similar experiences. As a solution, the ILT hosts events to use different pieces of equipment to make it less intimidating. However, the events are small (about 10-15 people) only and of those students participating there can be several who already have used the equipment before and thus not impacting a large number of first time trainees.

There are a few challenges associated with the equipment training. The first challenge is getting students to participate. The training with the laser cutter was composed of three short training sessions, each session lasting about 30 minutes. When a new student wants to use the laser cutter, they are often deterred by the time needed for training. The second challenge is that certain equipment, such as the CNC Router and ModelMaker, is not often

requested for training. The trainers for the equipment therefore do not get practice training on that particular piece and can forget how to use or train someone how to use it. This leaves few trainers who are comfortable enough to use and train on that piece of equipment.

Finally, the last challenge with training is encouraging the students to come back and use the equipment frequently in order to become comfortable with it. Students often get trained to complete one item or project and then do not use the equipment again for several months. As a result the student forgets a lot of the important information and requires re-training. In some cases the student will use the equipment anyway and can damage their work or the equipment.

The ultimate solution to all of these challenges is to get students more motivated" to use the equipment on a regular basis. We are in the process of creating an "Idea Book" to help give students inspiration on what can be made with the equipment in the studio. This Idea Book will be available both digitally and in paper formats for students during the next academic year. The Idea Book combined with more hands on studio project events will hopefully help inspire the students to participate in training and use the equipment more frequently.

inVenTs Leadership Team (ILT)

The ILT is a group of undergraduate upperclass students, who have been part of the inVenTs Community their freshman and sophomore years. They help manage and promote the space inside Studio 1. The members of the ILT have three main functions: hosting training sessions on the various tools and equipment, hosting events to inspire student creativity, and general help in the upkeep of the Studio. Near the end of the fall semester, ILT applications are accepted for the following year. The ILT application was initially based on a mentoring application from the Galileo and Hypatia communities. However, the positions do not require the same type of skill sets. When selecting someone for the ILT, it is important for the candidate to have experience with the equipment and tools and well organized. As a member of the ILT, training first year students on equipment use in the Studio is one of their main responsibilities. The ILT member needs to know how to use the equipment, and also have a good idea of how it works in order to be able to convey these things clearly to the trainees. Each ILT member is required to host one event per semester. This includes coming up with the idea, prototyping the event, getting a list of materials, advertising the event, and collecting feedback. To help ensure that the event is successful, organization is key. Although these were skills that were discussed when selecting ILT members, it was not explicitly written that these characteristics that were essential to being a member of the ILT.

One challenge that was faced with the ILT, more notably during the end of semesters, was coming up with

great event ideas. Once the end of the semester nears, it took more time to come up with ideas for events. Those events that were put on late in the semester sometimes were not as well designed and successful as earlier events. To try and alleviate this problem, ILT members are now asked to plan events the semester prior to implementation. In the 2015 Spring Semester, the new ILT members were tasked with creating a prototype for an event and getting a list of materials, along with being trained on all equipment, before the end of the semester. These events will be scheduled for the 2015 Fall Semester with everything prepared except selecting a date and advertising. This cycle will continue in the fall to plan for the spring semester. This gives the ILT a full semester to come up with an idea and plan it out to ensure greater success for all involved

Although it is not required for a member of the ILT to live in Lee Hall, it is extremely beneficial to have at least some of the team living in the building. There are times when events occur outside of normal Studio hours. When this happens it is helpful to have members of the ILT, who have access to the Studio, that are only a couple floors away. This also allows the Studio to stay open longer than the set hours. The ILT members who live inside Lee Hall do not have to worry about catching the bus or walking back to an apartment some distance away. This is extremely beneficial to the Studio during midterms and finals, when students widely use the Studio as a place to study late at night. The other major benefit to having ILT members live inside the same residence hall is that it helps to create a welcoming environment when they hold Studio hours because they are more likely to be known by the first year students. In the past, first year students have told the Studio staff that the space can be intimidating. This is even more true if they are not used to the equipment housed in Studio 1. By having a familiar face of someone else who lives in the dorm, it can help make the space less intimidating

Studio Events

In order to get freshman acclimated to the equipment in Studio 1 the ILT and staff host Studio Events at least once per week. These events are primarily designed to give students hands on experience, but we have also hosted social events. The social events were designed to provide the science and engineering students an opportunity to meet and get to know each other in order to make the hands on events more successful. The events are separated into two main categories: build events and non-build events. Build events are events that use any of the equipment in Studio 1. For example the Rice Hand Warmers event is considered a build event because it utilizes the sewing machine even though nothing was “built” per say. Non-build events are all other types of events that do not use any of the equipment in Studio 1, i.e. movie nights. When comparing the average percentage of participants for each event out of the maximum available sign up slots, the build events have a much higher attendance as seen in Table 2.

The build events have almost a 20% higher overall attendance than the non-build events. One explanation for this is that there is more planning and organizing done for a build event which is clearly felt by the participants. This includes making a prototype which can identify potential problems that may not have been thought of when initially planning the event. Another reason could be that the other upper class leaders and mentors also provide many social events for the community and the first year students don’t see the need to come to a design studio for social interaction.

TABLE 2
COMPARISON OF MAXIMUM ATTENDANCE PERCENTAGE OF BUILD EVENTS AND NON-BUILD EVENTS

Build Events	Non-Build Events
61.55%	43.25%

In previous years, it was not required for the ILT to have a minimum of one Studio event per week. However it was determined that by requiring one event per week, it would provide first year students could have opportunities for greater experience inside the space and are therefore more willing to come back and take on a project of their own. Figure 1 shows a comparison of the attendance per semester for the past three years that Studio 1 has been open. This past year, attendance has dramatically increased in each semester. In the 2014 fall semester there were a total of 1503 students who came to Studio 1, a 43% increase from the previous year (no data was collected for the last three weeks of the semester due to an overwhelming number of students seeking to complete projects for class). In the spring of 2015 there were a total of 1663 students who came into Studio 1, a 104% increase from the previous semester. There are many factors that could have influenced the increase in participation in the past year, however, the increased number of events obviously plays a major role. As stated previously, with more events being held students are allowed to become more familiar with equipment in the space. This can help them to come up with their own ideas and to continue to come back to Studio 1.

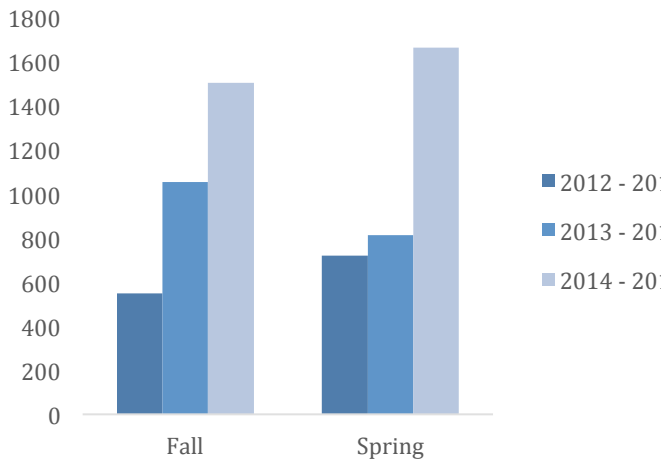


FIGURE 1. COMPARISON OF STUDIO 1 ATTENDANCE PER SEMESTER FOR THE PAST THREE YEARS

Company Events

Along with Studio Events, various corporate-sponsored events are held throughout the year. These events can be separated into two different categories: Innovation Activities and Information Sessions. Innovation Activities are longer activities (about 3 to 4 hours) where a company leads a hands on project. Information Sessions are shorter (about an hour) and allow company representatives talk about their company and possible opportunities for students to do internships or co-ops. Table 3 shows the comparison of attendance of Innovation Activities and Info Sessions. On average the Info Sessions had a much higher turnout than the Innovation Activities. A large reason for the difference is the time commitment for an Innovation Activity. It is much harder to get a student to commit three to four hours on a Saturday or Sunday (typically when Innovation Activities are held) than an hour in the middle of week for an Info Session.

TABLE 3
COMPARISON OF ATTENDANCE FOR INNOVATION ACTIVITIES AND INFO SESSIONS

Innovation Activities		Info Sessions	
Company	Attendance	Company	Attendance
1	21	7	57
2	21	8	15
3	24	9	40
4	17	10	16
5	14		
6	15		
Average	19.17		32.00

Many student organizations such as ASME, ASE, etc. also work with company representatives to host information sessions, especially near career fairs. The main difference between the student run organizations and inVenTs is the hands on aspect of Innovation Activities. With Innovation Activities, students are able to get a glimpse into some of the projects representatives may be working on, enabling them to envision themselves participating on similar projects.

The overall goal of an Innovation Activity is to expose the students to the type of work/projects different companies are working on, while getting hands on experience. During the activity students will progress in their ability to develop innovative designs and solutions to the proposed problem. To be able to derive this innovative solution, students use the design process they learn during the first few weeks of their freshman engineering course.

In an effort to assess what the students learn from these activities, an evaluation is completed by the staff members during the Innovation Activity. The assessment is composed of questions related to their ability to think critically, develop innovative designs, communicate these designs to their peers, and transform these ideas into prototypes. The students are graded on a scale of 1 – 5 for each of these questions. In the spring semester, focus groups are then held to record how students define and describe innovation. Currently there is insufficient data to determine how much students gained from the activities.

Both company Information Sessions and Innovation Activities are open to any member of the inVenTs community. However, a majority of the students who attend are freshman. From a sample size of two Innovation Activities and two Info Sessions, 88% of the students who attended were freshman. Out of the two sampled Innovation Activities, 93% of the attendees were freshman.

In previous years Innovation Activities had been more hands on than what was experienced in the last year. Of the companies that put on Innovation Activities, only half were hands on with the student participants. The idea of what an Innovation Activity entails is often difficult to convey to the company representatives. The staff was not very involved in helping the representatives come up with a good idea, contrary to past years, and the events suffered because of this. For future years a list of what is expected from the company for an activity and what help they can expect from the staff will be more clearly communicated. This will hopefully improve the students’ experience with Innovation Activities.

Combining Engineering and Science

One of the purposes of the inVenTs community and Studio space was to combine science and engineering projects. This has probably been the largest challenge the Studio has faced. The inVenTs faculty, leaders, and staff have been

continuously working to find the best way to get the communities of Galileo and Hypatia to work with Curie and DaVinci. So far, events have been created to try and gain interest from both communities. However, one community always dominates over the other. An example would be building a book end to promote the use of tools and mostly attracted the engineering communities. Another event that was a DNA necklace and learn DNA extraction mostly attracted the Curie and Da Vinci students. A majority of the events attract more engineering students rather than science students, however this is affected by the disparity in community size. It has been a difficult journey trying to find projects that interest all members of the community. Next year there will be some focus on removing community labels on any projects. There is also a proposed Grand Challenge that will take place which will involve both communities (discussed in the next section).

There is also a physical divide inside Studio 1 between science and engineering. In an effort to recruit more science students to visit the Studio, more science equipment was added to the studio. All of this equipment was placed in what is now labeled as the “Science Corner.” Although there is nothing stopping engineering students from using this equipment or area or the science students from using the entire Studio, it creates an unwanted separation when the goal is one inVenTs community.

Looking Forward

Looking ahead there are still many ways that students’ experience in Studio 1 can be improved. One major area that continues to be iterated upon is the first year engineering students’ interaction with the science students. Currently there is a segregation between the types of build events that are being held in Studio 1. A majority of the events held are focused on what interests engineering students, and the science side is somewhat neglected. Since we strongly desire to be one cohesive inVenTs community there needs to be greater collaboration on multiple levels. To try and remedy this, an inVenTs Grand Challenge will be held starting in the fall of 2015. The Grand Challenge will look to eliminate the engineering vs science issue and have students work together towards a common goal. This will be accomplished by having the challenge focus on helping the greater Blacksburg Community. The hope is that the first year engineering students will learn to work with science students as well as other engineering disciplines, an experience most other students will not get until their senior year if at all.

There are two other team projects that the inVenTs community hopes to continue/start. The first is the High Powered Rocketry Team. This team was started in the fall of 2014 by an ILT member. The team was put together to build an H-class motor rocket with an inertial measurement payload to compete in NASA’s Space Grant Midwest High-Power Rocket Competition. The twelve person team was composed of almost all engineering students. A new ILT

member will be taking over this team in the fall of 2015 and look to recruit new freshman (particularly science students) to participate.

In an effort to increase the collaboration between science and engineering students, the studio staff will also start an iGEM program within inVenTs. The iGEM competition is a student competition in synthetic biology. The difficulty in starting to participate is the schedule of the competition. The competition starts in the spring semester and runs through the summer, ending in October. Getting students to commit to a project over summer could be challenging, especially considering they would be receiving no university credit. However, the Studio staff is still working to set up a schedule for creating an inVenTs iGEM team.

We believe all of these efforts described will move the students in the inVenTs community towards feeling more confident and comfortable accessing and utilizing Studio 1.

AUTHOR INFORMATION

Adam Norman, inVenTs Studio Staff, Virginia Tech, adamen92@vt.edu

Callie Zawaski, inVenTs Studio Staff, Virginia Tech, zawaca@vt.edu

Bevlee A. Watford, CEED Director, Virginia Tech, deuce@vt.edu

Susan Arnold Christian, CEED Assistant Director, Virginia Tech, susanac@vt.edu