# Final Report

# IPRO 353: Fab Lab
# Spring 2010

## I. Executive Summary

The aim of IPRO/EnPRO 353 was to develop the Fabrication Lab (Fab Lab) located at the Museum of Science and Industry (MSI) in Chicago into a fully utilized facility. The utilization plans were designed to fit the educational aspects of the vision of MSI as well as the entrepreneurial purposes as described by the originators of the Fab Lab, the Massachusetts Institute of Technology's Center for Bits and Atoms.

The project aimed at two main goals: A public outreach program with the purposes of garnering the interests of entrepreneurs, students, and the general public, and an operations program which would create a model which promoted sustainability.

The Public outreach team was able to conduct various studies which gauged public interest. The team took part at the engineering week expo at the IIT rice campus, as well as was the Knapp center Connectiviity exposition in which the group was the key note presenters. Beyond this the group conducted a focus group which brought people with interests in the Fab Lab into the lab in order to experience the abilities first hand.

## II. Purpose and Objectives

Fab Lab, began as a community outreach program at the Massachusetts Institute of Technology (MIT) providing digital fabrication tools for rapid prototyping to the public. In 2008, the Museum of Science and Industry in Chicago completed construction of a state of the art Fab Lab through the financial support of the National Science Foundation, Argonne National Laboratories, and several other donators. The support from these organizations created the finest Fab Lab out of the entire US Fab Lab network. One particular problem arose. The lab is completely underutilized.

In order to remedy this situation, MSI partnered with the Interprofessional Projects Program (IPRO) with the desire to make use of the Fab Lab. In order to accomplish the task of utilization, the team was able to develop a set of goals which would develop the Fab Lab into a utilized lab befitting of the vision of MSI as well as the Fab Lab network. The goals were as follows:

- Promotion and marketing of the Fab Lab in order to build awareness
- Increase the interactivity of the Public
- Develop a trial exhibit
- Bring in machines to display how they function
- Develop fundraising and business plans
- Investigation of private prototyping opportunities
- Present the ideas to the MSI board
- Make use of case-studies/surveys of demographics for usefulness of the lab
- Demonstrate the level of detail of machines by developing complex products
- Develop a historical timeline of/ future plans for the Fab Lab

**III. Organization and Approach**

This semester, IPRO *353* formed three task teams namely Public Outreach, Production and Operations Model teams. Each group implemented different research methods in an effort to meet the team's final objectives.

At the beginning of the project, the entire team conducted historical research by investigating the achievements of previous IPROs at the Fab Lab. This was instrumental in familiarizing the team with the organization of the Lab, the machines and past projects. Also, the team met with Steven Willis, director of the Fab Lab for a question and answer session. This meeting was an important exploration into the potential of the Fab Lab as it relates to MSI's vision and the goals of the team. The group continued to use Steven as resource consulting with him as a liaison throughout the semester while the three task teams conducted more specific research as the project progressed.

<u>The Public Outreach Team:</u>

- Conducted focus groups and surveys during the research phase. These were employed because they allowed participants and target users of the Fab Lab to provide direct commentary that would assist in making the Fab Lab more accessible to the public. This feedback provides the museum with goals that are crucial to making the Lab more accessible to the community. Also, the team developed a website to represent the Fab Lab online.

<u>The Production Team</u>:

- Continued to consult with team members of previous IPROs and contacts at the museum to aid in fabricating semester's projects. These individuals were the great sources of advice on operating the machines. However the team also had to learn how to use each machine by reading the different manuals for each piece of equipment and through first hand operation in order gain familiarity with function and best use of the machines.

<u>The Operations Model Team:</u>

- Used resources such as other Fab Labs around the country, sponsors, MSI marketing contacts and stakeholders to meet objectives of creating an effective business plan for the Fab Lab at MSI. The team also sent surveys relating to operations, safety, and

training to other Fab Labs located around the world. A series of interviews with other national Fab Labs provided the team with essential precedent models that will inform future plans for the Lab. The team also conducted background research into marketing contacts and potential stakeholders to determine the impact these key players would have on a sustainable business model.

## IV. Analysis and Findings

### *A. Report from the Public Outreach Team*

The first major finding is that education is the underlying culture at MSI, therefore those in charge of the Fab Lab would like to focus on targeting the education demographic. This includes targeting students as well as educators.

Based on this target demographic, we ran a focus group consisting of five fellow IPRO students at IIT. From this focus group we can report the following:

1. The variety of software available on the computers can be improved. Currently the main program available is CorelDRAW with which only one of the participants was somewhat familiar. Four students requested additional software be added such as AutoCAD or SolidWorks drafting programs. However, in an effort to reduce cost as much as possible, equivalent open source software such as Archimedes or BRL-CAD could be added to the computers.

2. The Fab Lab layout was generally considered optimal except for a few suggestions. First, provide better labeling of first aid; one student was only able to see the first aid kit when it was directly pointed out to him because it was not clearly labeled. Second, another student suggested that we create a map of the layout and label each machine with its name, capabilities, and examples of what it can produce.

3. The museum should consider adding additional machines to the space; specifically one student wanted machines capable of metal working such as a water saw, plasma cutter, and a welding station. After a meeting with Steven Willis, he said that he was currently trying to bring a plasma cutter into the space.

4. Online tutorials and videos should be created to show non-users how to use the machines before coming into the space. This way, the non-user will be at least somewhat familiar with the machine before having to use it the first time and will not feel as intimidated.

We presented at the Conectiviity event at the Knapp Center and after generating a list of 19 entrepreneurs that are interested in using the Fab Lab, we discovered that in addition to students and educators, entrepreneurs comprise a large market of potential users. Since

education is the primary goal of the museum, this demographic may not be targeted by the museum, however, it should not be ruled out for development of future Fab Labs in other locations, such as IIT.

Additionally, we were able to generate a few user testimonials about the usefulness of the Fab Lab and the importance of opening up such a great resource to the public.

### *B. Report from the Operations Model Team*

The first thing that the team had to do was to confirm the museum's vision for the lab or we might have gone in the opposite direction than the museum wanted. After an interview with the Fab Lab director Steven Willis, the team discovered that the museum was not necessarily looking for the lab to be a profit center, it instead wanted the lab be used to educate children. The Museum is currently involved with a series of programs called "Learning labs", where educators can bring in their school groups to attend a private session where students can learn about topics ranging from the operation of the heart, to the science behind a crime scene investigation. MSI wants to inspire and teach students so that they can be both creative and technical. This is an overarching theme in the museum, and really provided us with the direction we needed for the operations model. Another key finding from the interview was that the Fab Lab brand and concept is all about information sharing and communicating how things are created in a Fab Lab. Steven believed that these ideas were essential to our work with the lab.

The operations team also found some useful information through the e-mail and phone conversations with other labs. The labs gave us useful information on their staffing, safety, training, and other operational procedures. The main takeaways from the interviews though are that a viable exhibit model can be used, that other labs are largely staff and serviced by a volunteer force, and that training is done in various classes offered by the labs.

The South End Technology Center Fab Lab, located in Boston, Massachusetts, along with the Lorraine Community College located in Ohio, provided our team with some very useful information regarding training and their respective operations models. The SETC is staffed mostly by volunteers which allows it to offer free or low-cost training and access to the Fab Lab. The lab also gives people the chance to make donations so that other people who can not afford the fees will have a chance to learn the machines and create something innovative.

In addition to other Fab Labs the operations team looked at for-profit companies that had very similar machines and operating models to our lab. The main one that we looked at is called TechShop which has three California locations and one in Oregon. TechShop is a "membership based workshop that provides members with access to tools and equipment, instruction, and a creative and supportive community of like-minded people so you can build the things you have always wanted to make." Now although this is a for-profit business, there are very similar characteristics to the Fab Lab which we used to design our operating model and ascertain reference price points which are shown in the appendix.

Based on our observations of the operations of various types of fabrication laboratories within the U.S., the operations team found that the best way to handle member usage is to divide the Fab Lab into six stations which can be reserved on an individual basis. This system would enable the user to reserve one station at a time, where they can work on their project of choice, and would prevent any confusion or conflicts that may arise when two members are looking to use the same machinery at the same time.

The stations are:

- Electrical Station: Tools include soldering rods, oscilloscope, and wave generator supplies include batteries, resistors, capacitors, motors, transistors, and sensors.
- CNC Router (ShopBot PRSalpha): Specify movements in 3 axes (X, Y, Z) for a tool spindle to cut, drill, carve, or engrave 96" x 60" x 6" work area.
- 3D Milling Machine (Roland Modela): Small scale CNC router and 3D scanner best suited for model making 8" x 6" x 2-3/8" work area.
- Vinyl Cutter (Roland CAMM-1 Servo): Print-and-cut reflective vinyl, paint mask, heat transfer, and sandblast material 22-15/16" maximum width.
- Laser Cutter (Epilog Mini 24): High power laser cuts or engraves flat-sheet materials 24" x 12" work area.
- 3D Printer (Stratasys Prodigy Plus): 3D objects are created by successive layers of plastic 8" x 8" x 12" work area.

The team also performed a cost analysis for the Museum using varying degrees of usage of the machines in order to find the approximate yearly costs to run the lab. In order to acquire these numbers the team used the machine manuals to find the power usages of the different machines

and then used the local electricity prices in order to convert to the cost to run the machines. The information in the chart of the appendix summarizes the cost analysis and the team created a calculator where we can put in various hours of use per day of the machines and acquire the daily and yearly estimated costs for the lab. The team also took staffing costs into account for the overall analysis based on the findings from the other Fab labs. Based on the analysis, the team found that it will cost approximately $110,000 to run the lab on a yearly basis.

### *C. Report from the Production Team*

The Production team utilized the available Fab Lab machines to create products with the intention of supporting the objectives of the other two subteams. The production team also attended the Conectiviity event at the Knapp Center, to which we brought some pieces that had been created in the lab in order to allow the entrepreneurs to gain first-hand insight into the Fab Lab capabilities.

However, before we were able to create materials using the Fab Lab we had to learn to use the machines. Several difficulties were encountered in accomplishing this objective: The limited access to the lab, not all the machines working, and difficulty gaining access to proper instruction. After not being able to obtain ID badges to the museum allowing us into the lab, the problem regarding access could not be properly addressed. This meant that every time we came to the museum to work, there would be about 20 minutes during which we had to wait to gain entry to the lab. We overcame these difficulties by setting up a schedule with the lab overseer, Steven Willis, ensuring that someone would be there to open the door for us, and also by making the most of the machines that are operational.

Concerning the software available in the lab, one of the focus groups raised the point that there should be more popular programs, since most of the software currently installed cannot open very common drawing files. The primary program used for the machines in the lab is CorelDRAW X3, which is unable to open AutoCAD files, which is what is most commonly used to produce designs. Previous IPROs attempted to address these issues to no avail, but by finding an educator's edition of AutoCAD, the time spent converting files and learning new software would decrease, therefore increasing efficiency and potential interest in the lab.

The products created by the production team in the lab included a cube maze, the Mona Lisa etched into wood, a puzzle cube, and the poster and brochure for IPRO day. These objects show what the machines are capable of and the precision with which they work.

### *D. Challenges*

Accomplishing these tasks proved to be more difficult than originally thought due to the inaccessibility of the lab, and lack of contact with our liaison at MSI. Since the beginning of the project contact had been poor regardless of the attempts made. We hadn't had successful contact with our liaison for the first three weeks of the semester, and even after that, communication had either been scarce, or unreceptive. As for access to the lab itself, it felt as if there was no effort made by MSI to allow access to the Fab Lab.

The group however did their best with the project and was able to determine a group of stakeholders with an interest in making use of the Fab Lab, as well as developing a business model which promotes sustainability of the lab, and fits well into the infrastructure which MSI is currently using.

## IV. Conclusions and Recommendations

We have made good progress towards a viable operations model for the Fab Lab at MSI, that is true to both the Fab Lab charter and MSI's mission to inspire curiosity within the minds of young scientists. After researching many possible models, we believe the best way for the Fab Lab to become self-sustainable, is to divide operation time between learning labs and Fab Lab member reservations.(Appendix).

The Fab Lab learning labs will use the same pricing and organizational structure used by MSI's other learning labs.

- Fab Lab learning labs will last 90 minutes, and will be conducted twice daily, 3-5 days a week.
- Learning labs will cost $150 per session and can accommodate school groups of up to 20 students.
- Learning labs will be an engaging experience that educates students about the history of the Fab Lab, capabilities of each Fab Lab station, and the step by step completion of a project selected by the group educator.
- Educators can choose from a variety of different projects, each with their own set of pre-visitation and follow-up activities that can be completed within the classroom.

Museum members range from educators and retired engineers, to talented tinkerers and aspiring entrepreneurs. During periods of inactivity, when learning labs are not in session, the Fab Lab will be available to museum members who upgrade to Fab Lab member status. Fab Lab members will already possess an MSI membership that will ensure members free entrance to the museum, free parking, and a variety of other useful benefits.

- Fab Lab time will be broken into 60 min blocks, and a user must reserve a time block for one of the Fab Lab's six stations prior to their visit, for a fee of $30 per time block.
- Users will pay a quarterly membership fee that will go towards maintenance of the lab and access to online resources.
- First time Fab Lab users will be required to complete training and safety courses that will have on-line components completed off-site.
- The revenue generated from learning labs and member usage can cover the costs of

staffing, maintenance, and potential Fab Lab growth (See Appendix D).

Also, by creating an exhibit around the Fab Lab, MSI patrons can learn about the elements of a Fab Lab, the capabilities of each station, the history of the Fab Lab, and its potential uses in the future. This feature can help spread awareness about the Fab Lab concept, generate potential user interest, and attract new members who appreciate the potential of gaining access to a facility of this type. By placing the exhibit on the underutilized wall surrounding the exterior of the Fab Lab, MSI can also be assured that Fab Lab projects and learning labs can go on without interruption. Features of the Fab Lab exhibit will include:

- Timeline showing the history of the Fab Lab, the growth of the global Fab Lab network, and the potential future of the Fab Lab concept( i.e. nanotechnology).
- Interactive kiosks showing virtual representation of Fab Lab where users can learn about the capabilities of each machine and create a virtual invention.
- Graphics around the wall detailing each Fab Lab station and the science behind it.
- Viewing portholes into the Fab Lab so that patrons can see the lab in use.
- The end of the exhibit will display website information so that patrons can explore the Fab Lab, inquire about Learning Labs, and apply for Fab Lab membership while off-site.

On the weekends, the Fab Lab at MSI will be able to run family days, where Fab Lab members can schedule a visit with other members, family, or friends for an open time block. Members and their guests will be able to interact with other members, share ideas, and gain access to Fab Lab staff for troubleshooting and feedback. During the summer, MSI Learning labs are not in session. We propose a Fab Lab science camp be added to MSI's current summer science program during this period. Children of members or from special programs within the community, can attend a science camp where they can learn how to use the Fab Lab to work on a fun summer project. Use of the Fab Lab during the summer for a science camp can help generate revenue during what is usually an inactive period.

We believe the Fab Lab at MSI can do very well if marketed as a living and evolving fabrication facility that is constantly improving upon itself, so that there can truly be no limit to what can be created.

During our time in the lab, our main observation was that the lab is currently not as user

friendly as it should be. Existing training manuals are confusing and can be better organized. We feel that training guides should be improved so that they are easier to follow. Also, by placing step by step graphics and instructions on the wall space around each station, the user can have an easily accessible reference source when operating each machine. Along with improved training materials, a wider range of design software should also be made available to users. Based on feedback from the production team and from focus group respondents, we found that a more recognized design application such as AutoCAD, should be included in the Fab Lab software package. This design package could be highly effective if the user were able to access it through the Fab Lab website. Users would be able to create and store their designs while off-site, so that they can maximize the time spent on machinery while in the lab. We have been successful in obtaining the domain name of www.chicagofablab.org, and the site has been progressing daily. The next step will be to create additional links and features to the site where users can complete additional safety and training requirements, keep track of a project's progress, and participate in the open sharing of ideas via the global Fab Lab network.

With the support of the MSI, the Fab Lab can become an exciting and engaging learning center that inspires creativity, and the realization of one's own potential. Further work with MSI could require IPRO teams that are focused on refining the existing training material and creating a training system that is simple and time efficient. This IPRO can be tasked with developing a training system that is designed for children in grades 8-12, which is the grade range for learning labs at the MSI. There has been much advancement made in training through 3-D graphical instructions, where a trainee can witness a 3-D image of the machine in use. Advancements such as this can be useful in designing an easy to follow training process that can be conducted off-site.

We have also found that the location of the Fab Lab within the MSI creates specific constraints which prevent the use of the Fab Lab's full capabilities. The hours of operation, location of the lab, and requirement for the Fab Lab to be youth oriented, limits the use of the lab. Aspiring inventors and entrepreneurs can find a lab of this type to be extremely helpful for creating a prototype of their design. Access to a community of like-minded tinkerers can aid in spreading awareness of their creations, and help troubleshoot areas of difficulty. During the course of our work, we have found that the Fab Lab concept works best when located on the campus of a college or university. We have received genuine interest from current and previous IPROs who could benefit greatly from a lab with these capabilities located in one location. Given the various needs of IPRO teams and the devotion of IIT towards creativity

and entrepreneurship, we feel that the next logical step would be to bring a Fab Lab to IIT's main campus. A digital fabrication facility of this type could be highly beneficial for students working on school projects or aspiring inventors who are in need of a lab with prototyping capabilities. We propose that another IPRO be devoted to researching the requirements for a fully functioning Fab Lab at IIT, designing a floor plan, and creating an operating structure that is based on our work along with the guidelines established by the global Fab Lab charter. A Fab Lab at IIT would be able to attain membership to the global Fab Lab network, where many different opportunities for sharing resources can be realized. IIT may also be able to offer credit courses in digital fabrication that are held within the Fab Lab, granting students who complete the course a certification in the use of Fab Lab machinery. A Fab Lab located on the main campus could be yet another useful resource provided by IIT, which fosters creativity and entrepreneurship within students, alumni, and our associates throughout the IIT community.

## IV. Appendices

Appendix A: MSI Fab Lab Operations Model.
Appendix B: Team members.
Appendix C: Actual budget.
Appendix D: Focus group materials.
Appendix E: Pricing and cost structure.

## *Appendix A: MSI Fab Lab Operations Model*

**Assumptions**

- Initial funding will be sought out from prior donors and interested parties, including Argon, The National Science Foundation, and The Pritzker family, to provide for initial staffing, inventory, and exhibit construction.
- One Lab manager and two lab assistants will be required at all times to oversee Fab Lab operations. Model is based on the successful operations of similar Fab Labs.
- Member volunteers will be sought out to aid with day-to-day activities.
- Primary revenue goal is to break even, with a potential to cover upgrades when necessary.
- Expectations are that Fab Lab learning labs will be utilized at a minimum of 50% of capacity (The break-even point is at about 40% utilization).
- Membership requirement will limit Fab Lab usage to approved museum members in order to alleviate any problems caused by admission or parking fees.
- Pricing structure is intended as an incentive, especially when compared to for profit labs of this type.
- Relevant costs are staffing and energy usage, as fixed costs will be the same regardless of operational system. The energy costs were calculated based on the power requirements of the various machines and the local electricity price of $.134/hr. The machines were assumed to be turned on for a full 8 hour day in the base case. Staffing costs were calculated based on an annual salary of $50,000 for the lab manager and then an hourly wage of $15 per hour for the lab assistants.

After researching many possible models, we believe the best way for the Fab Lab to become self-sustainable, is to divide operation time between learning labs and Fab Lab member reservations.

**Learning Labs**

The Fab Lab learning labs will use the same pricing and organizational structure used by MSI's other learning labs.

- Fab Lab learning labs will last 90 minutes, and will be conducted twice daily, 3-5 days a week.

- Learning labs will cost $150 per session and can accommodate school groups of up to 20 students.
- Each session will be an engaging experience that educates students about the history of the Fab Lab, capabilities of each Fab Lab station, and the step by step completion of a project selected by the group educator.
- Learning labs will be facilitated by the Fab Lab manager with the help of potential volunteers or paid MSI staff.
- Educators can choose from a variety of different projects, each with their own set of pre-visitation and follow-up activities that can be completed within the classroom.
- Learning labs will be reserved in advance via the fab lab website, where educators can select the time and specific focus of the session.

**Member Usage**

An hourly fee will be charged to Fab Lab members for use of the Fab Lab when learning labs are not in session. Fab Lab members are required to have a MSI membership, that will help grant members free entrance to the museum, free parking, and a variety of other useful benefits.

The Fab Lab will be divided into six stations which can be reserved on an individual basis. This system would enable the user to reserve one station at a time, where they can work on their project of choice, and would prevent any confusion or conflicts which may arise when two members are looking to use the same machinery at the same time.

Stations will include access to one of the twelve computers within the Fab Lab, where users can utilize included design software, and access the Fab Lab network. Fab Lab time will be broken into 60 min blocks, and a user must reserve a time block for one of the Fab Lab's six stations prior to their visit, for a fee of $30 per time block. First time Fab Lab users will be required to complete training and safety courses that will have on-line components which can be completed off-site. Materials to be used within the Fab Lab will be provided and sold through the Fab Lab manager at a reduced cost. The revenue generated from learning labs and member usage can cover the costs of staffing, maintenance, and potential Fab Lab growth.

**New Fab Lab Exhibit**

MSI patrons can learn about the elements of a Fab Lab, the capabilities of each station, the history of the Fab Lab, and its potential uses in the future. This feature can help spread awareness about the Fab Lab concept, generate potential user interest, and attract new members who appreciate the potential of gaining access to a facility of this type. By placing the exhibit on the wall surrounding the exterior of the Fab Lab, MSI can also be assured that Fab Lab projects and learning labs can go on without interruption. Features of the Fab Lab exhibit will include:

- Timeline showing the history of the Fab Lab, the growth of the global Fab Lab network, and the potential future of the Fab Lab concept (i.e. nanotechnology).
- Interactive kiosks showing virtual representation of Fab Lab where users can learn about the capabilities of each machine and create a virtual invention.
- Graphics around the wall detailing each Fab Lab station and the science behind it.
- Viewing portholes into the Fab Lab so that patrons can see the lab in use.
- The end of the exhibit will display website information so that patrons can explore the Fab Lab, inquire about Learning Labs, and apply for Fab Lab membership while off-site.

***Appendix B: Team members.***

Advisors:

- James Braband
- Blake Davis

Sub-teams:

Group 1: Public Outreach Team
Group 2: Operations Model Team
Group 3: Production Team

| Name | Group |
|---|---|
| Nikolai Arendovich | 1 |
| Anthony Bartolomei | 2 |
| Joel Meno | 1 |
| Muqadas Munir | 3 |
| Maksym Ostapenko | 1 |
| Anne Pham | 3 |
| Joseph Sanchez | 2 |
| William Sawyer | 3 |
| Jesse Stepniewski | 2 |
| Terez Sturrup | 1 |
| Jimmy Ton | 3 |
| Patrick Zhu | 3 |

***Appendix C: Actual budget.***

| Item | Cost ($) |
|---|---|
| Transportation Reimbursement | $180.6 |
| Blick's Art Store | $8.39 |
| Acrylic from Petersen's Plastics | $99.23 |
| Balsa wood, acrylic, battery, copper ball, color film, chipboard | $80 |
| Web hosting | $15 |
| Public Relationship (meetings, marketing supplies, etc.) | $50 |
| **Total** | **$433.22** |

***Appendix D: Focus group materials.***

Letter to the entrepreneurs.

Dear _____,

Have you ever wanted to make something using high-tech machines? Want to create a sophisticated prototype or just a really cool design? Well the Fabrication Laboratory (Fab Lab) at the Museum of Science and Industry can make that dream a reality.

Hello, my name is Joel Meno and I am involved with a project at the Illinois Institute of Technology. The goal of our project is to present the Museum of Science and Industry with an operations model to open their Fab Lab to the public. In order to achieve this goal, we first need to run a few case studies and focus groups to determine the best way to do this.

That's where you come in. We need your help.

I received your name and email address from a list of individuals made at the Connectiviity Event at the Knapp Entrepreneurship Center on March 18, 2010 that were interested in using the Fab Lab at the Museum of Science and Industry.

I would like to extend a special invitation to you to participate in a focus group. The focus group is designed to show you the capabilities of the machines. We will walk through an informative demonstration of how to build a product and then engage in a discussion about any comments or questions you may have.

Here are some specifics about the Fab Lab. There are:
• Two Modela milling machines
• Two vinyl cutting machines
• Two laser cutters
• One Computer Numerical Controlled (CNC) machine
• One 3D printer
• 12 computers

Unfortunately, due to time constraints there will not be enough time to work on any outside projects. However, if after participating in the focus group you determine that you could use some of the machines, we may be able to set up a special time for you to utilize the lab.

The date and time for this focus group will be Friday April 9th, 2010 from 10:30am to 1:00pm. If you are interested in participating in this focus group, please RSVP for more information by Wednesday April 7th, 2010 by going to the following link:
http://spreadsheets.google.com/.../

We can only take the first 10 people to respond so please act quickly.

Your participation in this focus group is vital to making such a great resource available to the public.

For more information on the machines and history of the Fab Lab please visit our Wikipedia page: http://en.wikipedia.org/wiki/Fab_Lab_MSI.

If you have any questions please feel free to email me at jmeno@iit.edu

Thank you and I hope to hear from you soon,
Joel Meno

Letter to the IIT students.

Dear fellow students,

Want some **free food** and **free admission** to the Museum of Science and Industry? Then please keep reading.

Hello, my name is Joel Meno and I am a member of IPRO 353. The goal of our project is to work closely with the Museum of Science and Industry in Chicago to open their Fabrication Laboratory (Fab Lab) to the public. In order to achieve this goal, we first need to run a few case studies and focus groups to determine the best way to do this.

Could you or your IPRO use a prototype? Have you ever wanted to make something using high-tech machines? Well the Fab Lab at the Museum of Science and Industry can make that dream a reality.

That's where you come in. We need your help.

I would like to extend a special invitation to you to participate in a focus group. It's really simple to participate! All you have to do is show up, work on easy to learn machines, make some really cool stuff, and answer some short questions about your experiences before and after using the machines. Plus you'll get some **free food** and **free admission** to the Museum of Science and Industry for a day!

Here are some specifics about the Fab Lab. There are:

- Two Modela milling machines
- Two vinyl cutting machines
- Two laser cutters
- One Computer Numerical Controlled (CNC) machine
- 12 computers

The date and time for this focus group will be Friday March 19th, 2010 from 10:00am to 12:30pm. We will meet in the Yellow Room at the MTCC promptly at 10:00am, have some

food, and drive to the Museum of Science and Industry. The session will end at 12:30pm, however, you can stay in the museum for as long as you would like.

If you would like to participate, please RSVP (by email) by Wednesday March 17th. We can only take the **first 10 people** to respond so please act quickly!

Materials will be provided for creating small products that demonstrate the usefulness of the machines. You will be allowed to make any larger products you would like, however, you will have to bring your own material. Acrylic and wood are the two most common materials used in the laser cutting machines. No PVC is allowed.

Your participation in this focus group is vital to making such a great resource available to the public. If you have any questions or concerns, please do not hesitate to email me at jmeno@iit.edu.

Thank you and I hope to hear from you soon,

Joel Meno

Focus group pre-survey.

**IPRO *353* – Fab Lab Focus Group**

*Pre-Survey*

Name: _____

Please rate your experience with the following types of rapid prototyping machines

(1 = no experience at all, 5 = nearly an expert):

| | |
|---|---|
| CNC Router | 1 2 3 4 5 |
| 3D Milling Machine | 1 2 3 4 5 |
| 3D Printer | 1 2 3 4 5 |
| Laser Cutter | 1 2 3 4 5 |
| Vinyl Cutter | 1 2 3 4 5 |

Further comments:

Please rate your experience with the following graphics design programs

(1 = no experience at all, 5 = nearly an expert):

| | |
|---|---|
| CorelDRAW | 1 2 3 4 5 |
| AutoCAD | 1 2 3 4 5 |

Please list any other related programs with which you are familiar (include rating):

Have you ever heard of the Fab Lab brand?

Did you know that there is a Fab Lab at the Museum of Science and Industry?

Why are you participating in this experience at the Fab Lab?

What are your expectations of the Fab Lab?

Focus group post-survey.

**IPRO *353* – Fab Lab Focus Group**

*Post-Survey*

Name: _____

1. Please rate the experience of the Fab Lab meeting your expectations.
(1=Disappointed…3=Met…5 = Exceeded):

1 2 3 4 5

Further comments:

2. What is the likelihood of you returning to use the Fab Lab in the future?
(0 = Not at all, 1=Unlikely…5 = Very Likely):

0 1 2 3 4 5

Further comments:

3. How would you change the Fab Lab? Answer all that apply.
Layout of space:

Number / Types of Machines:

Software Available:

Other:

4. What is the strongest aspect of the Fab Lab that should be promoted to interest you more?

Focus group outline.

## Fab Lab Focus Group Outline (3/19/10)

9:45-10:00am Set up in the Yellow Room (food, sign in sheet, name tags)
10:00-10:20am Welcome people to the focus group, answer any questions
10:20am Leave IIT for MSI
11:00am Arrive in Fab Lab at MSI

***If 6-8 people attend:***

11:00-11:10am Brief explanation and history of Fab Lab
Includes showing other capabilities

*Break into 2 groups of 3-4 people*

11:10-11:40am

| | Laser Cutter | Vinyl Cutter |
|---|---|---|
| Group | 1 | 2 |

11:40-12:10pm

| | Laser Cutter | Vinyl Cutter |
|---|---|---|
| Group | 2 | 1 |

12:10-12:30pm Large group discussion

***If 9-12 people attend:***

*Break into 3 groups of 3-4 people*

11:00-11:20am

| | Laser Cutter | Vinyl Cutter | Fab Lab History and Capabilities |
|---|---|---|---|
| Group | 1 | 2 | 3 |

11:20-11:40am

| | Laser Cutter | Vinyl Cutter | Fab Lab History and Capabilities |
|---|---|---|---|
| Group | 3 | 1 | 2 |

11:40-12:00pm

| | Laser Cutter | Vinyl Cutter | Fab Lab History and Capabilities |
|---|---|---|---|
| Group | 2 | 3 | 1 |

12:00-12:30pm Large group discussion

12:30pm Leave MSI for IIT
1:00pm Arrive at IIT

Focus group discussion report.

**IPRO *353* – Fab Lab Focus Group**

19 March 2010
Discussion Report

***Summary of Events***

| | |
|---|---|
| 10:00 | Welcome & brief introduction |
| 10:20am | Leave IIT for MSI |
| 10:40am | Arrive in Fab Lab at MSI |
| 10:55am | Tour of Fab Lab |
| 11:10am | Laser Cutter Tutorial (Anne) |
| 11:30am | Vinyl Cutter Tutorial (Will) |
| 12:00pm | Discussion |
| 12:45pm | Explore Museum |
| 1:00pm | Leave for IIT |

***Discussion Central Ideas***

- **Expectations & Last Impressions**

*Elezar* – Didn't expect to see electronics stations and Modelus machines. He was impressed and eager to see other machines working. Suggested that online info available before one comes to the Fab Lab would be useful.

*Sang* – Disappointed mainly due to interests in seeing 3d printer & CNC in action. Also interested in other 3d manufacturing options for architecture studio project.

*Michael* – Impressed by Fab Lab machines and set up but disappointed because he wanted to do 3d printing & prototyping for an IPRO project (water filter).

*Cong* – Satisfactory impression of Fab Lab. Expected more demonstration on the machines by focus group moderators to show how machines work by taking the average person and working on a project or toy such as plane/car. Felt that collaboration on a mini prototype during the focus group would make it more interesting.

- **Public Access to the Lab**

*Elezar* – Sounds like a good idea and supported the IPRO look into establishing where patrons pay to use that lab under the supervision of volunteers. Also suggested that we look into contacting other Chicago college groups that may be interested in using the equipment.

*Michael* – Supported public access to the Lab.

- **Layout of the Lab**

*Cong* – Nice layout. Counter space is messy, so there needs to be more organization.

*Elezar* – First aid equipment should be more clearly marked. Overall impressed with the layout.

*Michael* – Impressed with the layout, especially the teleconference area.

- **Other machines that may be added to the Lab**

*Michael* – Micro controllers for electronics

*Conrad*– Upgrade electronics wall. As a side note suggested that there should be a list of available software and files that can be supported on Fab Lab computer stations. Some of the suggested software includes autoCad, and Solidworks

*Cong* – Suggest that video screens/monitors be added to display video manuals next to machines

*Elezar* – Look into equipment with ability to machine/cut metals

- **Likely use of Fab Lab in the Future**

*Elezar* – Likely to use for small projects (hobby)

*Michael* – May use it in the future but concerned about who owns intellectual property.

*Conrad*– Will try to use it to make circuits. Asked about the possibility of purchasing materials from the Lab.

Focus group results.

- Participant Fab Lab Familiarity: yes / no
With Fab Lab Brand:
With Fab Lab at MSI:

-Participant Machine Experience Averages:

Laser & Vinyl Cutters:


3D Machines:


-Participant SoftwareExperience Averages:

CorelDRAW:


AutoCAD:


-Participant Feedback:

Fab Lab Experience


Likely Return:

***Appendix E: Pricing and cost structure.***

| SETC Pricing Model: | Month | Year |
|---|---|---|
| Individual Membership | $125 | $1,200 |
| Add a Family Member | $25 | $250 |
| Student Membership | $75 | $700 |
| Corporate Membership (3 people) | $350 | $3,120 |

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| | | |
|---|---|---|
| Single Day Visit | $25 (guest) | $50 (individual) |
| Training Sessions | $75 per hour (2 hour minimum)<br>$30 for additional attendees | |
| Personal Consulting | $85 per hour (2 hour minimum) | |
| Personal Prototyping | $95 per hour (2 hour minimum) | |

SETC Pricing Model:

$8.00 for One hour or your hourly rate
$48.00 for One day or your day's pay
$240.00 for One week or your weekly pay
$960.00 for One month or your monthly pay
$1,680.00 for One season/ term or two month's pay

Fab Lab Cost Structure:

Cost of electricity $0.134/hr

| Machine | # of | Energy Usage Each (kW) | Hours Used | Kilowatt-hours | Cost |
|---|---|---|---|---|---|
| | | | | | |
| Dell Optiplex 745 | 20 | 0.22 | 8 | 35.2 | 4.7168 |
| Roland Vinyl Cutter | 2 | 0.03 | 8 | 0.48 | 0.06432 |
| Modela | 2 | 0.04 | 8 | 0.64 | 0.08576 |
| Epilog | 2 | 2.55 | 8 | 40.8 | 5.4672 |
| Prodigy Plus 3D printer | 1 | 1.8 | 8 | 14.4 | 1.9296 |
| Soldering Irons | 2 | 0.06 | 8 | 0.96 | 0.12864 |
| CNC | 1 | 3 | 8 | 24 | 3.216 |
| Bandsaw | 1 | 0.156 | 8 | 1.248 | 0.167232 |
| Drill Press | 1 | 0.72 | 8 | 5.76 | 0.77184 |
| Dust Collector | 1 | 1.49 | 8 | 11.92 | 1.59728 |
| Lights | 30 | 0.06 | 8 | 14.4 | 1.9296 |
| | | | | ***DAILY*** | ***20.07427*** |
| | | | | ***YEARLY*** | ***6263.173*** |

Income Statement

| **Revenue** | | |
|---|---|---|
| Learning Labs | | |
| Cost per session | $150.00 | |
| Sessions per day | 2 | |
| Days Utilized | 3 | (50% of capacity) |
| Weeks per year | 52 | |
| Total from Labs | $46,800.00 | |
| | | |
| Reservations | | |
| Cost per Station | $30.00 | |
| Number of Stations | 5 | |
| Operating Hours | 4 | |
| Days Utlized | 3 | (50% of capacity) |
| Weeks per year | 52 | |
| Total from Open Access | $93,600.00 | |
| Labs | $46,800.00 | |
| **Total Revenues** | $140,400.00 | |

| **Costs** | | |
|---|---|---|
| Lab Manager | $50,000.00 | per year |
| Lab Assistants | $54,080.00 | per year (2 assitants) |
| Costs of Operation | $0.00 | |
| **Total Costs** | $104,080.00 | |

| **Income** | |
|---|---|
| Revenue | $140,400.00 |
| Costs | $104,080.00 |
| **Total Income** | $36,320.00 |