IPRO 333: Fab Lab

Creating Design-Prototype Learning Modules at the Museum of Science and Industry

Spring 2009

Final Report

Instructor David Gatchell

Collaborators Steve Willis - Director, Fabrication Laboratory, The Museum of Science and Industry

IPRO Team
Robert Boyer
Lawrence Chung
Michael Gajdorus
Keenan Gottschall
Rachel Hendricks
Joseph Luciani
Nicolle Mallinger
Paul Marks
Patricia Murman
Anne Nadler
Shunsuke Nakano
Leslie Obst
Treyson Ptak
Ivan Reyes
Adam Winterbauer

Illinois Institute of Technology
May 11, 2009

Abstract

Fabrication Laboratories, or Fab Labs, were started as a community outreach program by the Massachusetts Institute of Technology providing digital fabrication tools for rapid prototyping to the general public. The Museum of Science and Industry has partnered with IPRO to further develop the Fab Lab at their site. IPRO 333 has been rendered the task of working with the administration in the Fab lab of MSI to design methodologies for furthering the use of the laboratory and assisting in determining its end goals for both the museum and the community by working with the lab directors to broaden the possible uses of the lab, promoting membership at the Museum of Science and Industry in Chicago, and involving the community in science and technology programs at the museum.

In order to accomplish our tasks we have broken into three main teams, each of which will focus on a different aspect of the lab. The first team will be responsible for creating events specific to the museum members, creating proposals for low-cost, high-profit activities for the lab, and possibly creating a website where users of the lab may sign up for time in the lab, reserve or order materials, and rent storage space for long term projects they wish to work on. The second team is responsible for integrating the Fab Lab into the current working exhibits as well as future exhibitions. The third team will be responsible for designing and creating new programs for users of the Fab Lab, such as the students enrolled in the Science Achievers program or museum members.

Table of Contents

I. Background

Currently there are thirty-four Fabrication Laboratories (Fab Labs) spread across nine countries. What began as a rapid prototyping platform developed by the *Center for Bits and Atoms* at the Massachusetts Institute of Technology (MIT) in August 2007 has quickly emerged as the future of small scale industry. As such, Fab Labs are meant to encourage local entrepreneurs to take their own ideas from the drawing board to prototypes to starting local micro businesses. More importantly, Fab Labs also teach users critical skills in computing, electronics, programming, and CAD/CAM fabrication techniques; which remain a set of internationally recognized skills. A lab typically contains groups of off-the-shelf, industrial-grade fabrication and electronics tools, wrapped in open source software and programs.

What IPRO 333 aims to do is take the knowledge, education, and fresh ideas of young engineers, architects, and scientists of IIT and pair that up with the resources of the Fab Lab at the Museum of Science and Industry in Chicago (MSI). This partnership hopes to utilize the current Fab Lab at MSI to its fullest potential by designing future projects for museum visitors. While past Fab Lab programs were primarily designed to solve critical issues within the local community, IPRO 333 will concentrate on the education of client groups such as; high-school science achievers, museum guests (children and adults), and members. We will also focus on creating a new advertising and marketing strategy for the lab as well as, possibly creating a robotics component within the lab, creating a website for the lab, proposing new ideas for members only events, and integrating the Fab Lab further into the MSI itself. In doing so, we will introduce people of all ages in the greater Chicago-land area to the MSI and its Fab Lab so that we may stimulate the minds of future generations of scientists, architects, and engineers.

II. Objectives

This semester the objectives of IPRO 333 are to:

- educate the Fab Lab employees on the capabilities of the lab by introducing local expertise in the form of IIT professors and advanced students
- define potential programs for the user groups of the lab to include:
    - pre-lab exercises to introduce users to the lab tools, software, and its safety measures
    - user tutorials to facilitate more independence among the users
    - quick reference cards that provide visual cues to guide a project
    - predefined projects to fit into a specific time frame which are age appropriate according to the standards of the National Science Foundation
- create and implement new marketing strategies for the Fab Lab
- propose ideas for members only events
- integrate the Fab Lab into the current working exhibits as well as future exhibitions
- record a catalogue of all ideas regarding the possibilities of the Fab Lab for future semesters of this IPRO to draw upon

In addition this IPRO aspires to:

- Create a safe workshop in which children can operate the machinery under the supervision of the museum staff.
- Coordinate a program with other Fab Labs that allows for the sharing of ideas, past experiences, successes, and failures.
- Develop a program that allows for the continuation of projects over numerous sessions. This would include museum storage and pertain mainly to museum members.

III. Methodology

A. The Problem

The problem presented to this IPRO is that the Fab Lab is underdeveloped and underutilized. We worked with the MSI Fab Lab to develop plans to improve the lab and expand its usage. We started this semester by beginning to familiarize ourselves with the Fab Lab and its associated problems. Our first visit to the Fab Lab was conducted on January 29, this allowed the group to become familiar with the lab and to better define the scope of our projects for this semester. In this first visit, we determined that the staff of the Fab Lab could benefit from the expertise offered by the students and faculty of IIT as well as any other potential collaborators.

B. Plan of Action

- We made weekly visits to the Fab Lab. In the first half of this semester these visits allowed us to meet with the Fab Lab staff and work with them in developing their goals as well as our own.
- New marketing strategies and styles were developed and implemented for the Fab Lab.
    - Web development (e.g. MSI Website, Wikipedia, Fab Lab network)
    - Mailing lists (e.g. Members, local schools)
    - Advertising (e.g. Teacher workshop, student workshop)
- Some of the programs previously developed were user tested at the MSI Fab Lab. The success of the programs was determined by surveys given to the users before and after their completion of the program. The surveys and observations from the testing were then analyzed, and the results were made into a report and the feedback will be implemented in writing future programs.
- The new programs were completed and ready to be tested for their designated user groups, whether they are for third-grade students or adult museum members.

C. Documentation

Throughout the semester, an engineering notebook was used to record the results of our research. The materials produced for our programs (surveys, pre-lab worksheets, step-by-step instructions and photos of finished projects) were included, as well as the results of our program testing. The team members also contributed, in the notebook, to a compendium of ideas for possible implementation in the Fab Lab for future semesters of this IPRO to draw upon. Weekly status reports generated by each team are also a portion of the documentation of this team's work.

IV. Team Structure & Assignments

A. Team Structure Chart

Name	Major	Skills/Interests	Experience	Cluster (1st half/2nd half of semester)
Robert Boyer	Biomedical Engineering (3rd Year)	Possesses strong social, language, and task management skills. Proficient in MATLAB, Microsoft Office Suite.	Marketing and student organization leadership experience	2 2
Lawrence Chung	Biomedical Engineering (3rd Year)	Experienced project team member/leader. Proficient in Microsoft Office Suite, Visio, and MATLAB.	Prior IPRO experience as a presenter and team leader.	2 3
Michael Gajdorus	Architecture (4th Year)	Proficient in CorelDraw, Microsoft Office Suite, and Photoshop	Shop and digital fabrication experience	2 1
Keenan Gottschall	Political Science (3rd Year)	Proficient in AutoCAD, Microsoft Office Suite, and Quicken accounting software	Shop experience, laser-cutter certified, and student organization leadership, previous IPRO experience	2 2
Rachel Hendricks	Biochemistry (3rd Year)	Proficient in Microsoft Office, Sequencer. Time and organizational skills. First aid and CPR.	Safety training, administrative and leadership experience	2 2
Joseph Luciani	Architecture (4th Year)	Experienced in various software platforms used in design and digital fabrication. (Including: Digital Project, Sketch-up) Microsoft Office, Hand drafting and rendering, Free-hand sketching, Model-making, Field measuring, Digital Cameras, Welding, and Custom carpentry.	Design/Build, CAD development and Digital media, and conceptual design & fabrication experience. Intern for Heffernan Holland Morgan Architecture, growing interest in digital fabrication and design.	2 1
Nicolle Mallinger	Civil Engineering (4th Year)	Experienced in use of design software, strong organizational skills, time management, and inter-group relations.	Leadership experience in student organizations.	3 3

Paul Marks	Biology (3rd Year)	Solid communication skills, problem solving mindset, and adept at acquiring new skills quickly.	Electrical, landscaping, and mechanical construction experience.	3 1
Patricia Murman	Psychology Criminal Justice (3rd Year)	Mechanical skills: engines and wiring Basic wood working, Microsoft office, Excel; Photography, Painting.	Worked for a contractor in construction, painting and simple demolition. NJROTC: Leadership and skill development. Academic interest: Forensic Profiling, the technical aspects of a lab and educational methods.	1 2, 3
Anne Nadler	Mechanical Engineering (4th Year)	Experienced in Pro-Engineering and AutoCAD software. Familiarity with Shape Deposition Manufacturing machine. Organization skills, time management skills	Leadership experience in student organizations.	1 3
Shunsuke Nakano	Architecture (5th Year)	Experienced in AutoCAD, rhinoceros, illustrator. Photoshop, 3dsmax, laser-cutter	Familiarity with digital fabrication.	3 1
Leslie Obst	Mechanical Engineering (4th Year)	Strong organizational skills	Previous IPRO experience	2 3
Treyson Patek	Architecture (5th Year)	Well versed in various shop and computer skills, photography, drawing, and music. Interested in light weight building technologies, architecture in general, and philosophy.	16 years of Job experience including military, and various corporate duties, even as a professional stunt man.	1 2
Ivan Reyes	Architecture (5th Year)	Experienced in various software platforms used in design and digital fabrication. (including: Revit Architecture 2008, Pro-Steel 3D V16.3) Power Point, Microsoft Word and Excel	9 years of job experience in architecture / engineering, and drafting abilities. A Master's of Architecture in Landscape.	3 3
Adam Winterbauer	Biochemistry (3rd Year)	Organizational, problem solving, and time management. Proficient in Microsoft Office Suite.		2 1

B. Team Tasks

The initial steps taken in dividing the team involved identifying the major themes requiring the most attention. In that, the classification of task subsets could be established. Ultimately, the first breakdown assessment resulted in following three clusters:

Cluster 1 (Project Development)

- Settings for machines/Tutorials
- Software Tutorials
- Projects Tutorials for K-12
- Procuring materials
- Working with exhibits
- 5 week workshop
- How to Build Anything

Cluster 2 (Communication)

- Web Development
- Advertising and marketing
- Working with other IPROs
- Event to showcase
- Working with other Fab Labs
- Steven's boss and her 57 Companies
- Networking with educational professionals

Cluster 3 (Shop Development)

- CNC running
- Enclosure
- Storage
- Inventory/ Comparing to center for Bits and Atoms
- Funding

Approximately half way through the spring semester the team re-evaluated its progress and decided that new objectives needed to be addressed and thus broke into three new clusters. The results of this breakdown are as follows:

Cluster 1 (Project Development)

- Settings for machines/Tutorials
- Software Tutorials
- Projects Tutorials for K-12
- Procuring materials
- Working with exhibits

Cluster 2 (Marketing)

- Web Development (MSI website, Wikipedia)
- Working with other IPROs and EnPROs
- Working with other Fab Labs
- Networking with educational professionals
- Educational flyers and brochures

Cluster 3 (Event Coordination)

- Presentation for workshops
- Finalize projects for workshops
- Host a teacher workshop
- Host a student workshop

C. Breakdown Logic

First Half of the Semester's Groups

Group One:

As requested by the staff of the Museum of Science and Industry, our group is working to create events specialized to Museum members as well as creating proposals for low-cost, high-profit events; marketing and advertising strategies for the lab; and possibly creating a website where people may sign up for time in the lab, designate projects they would like to do, buy (or reserve) materials, rent storage space for long term projects, and view general information about the lab itself.

Patricia Murmon: Team Lead
Treyson Ptak
Anne Nadler
Keenan Gottschall

Group Two:

Considering there are dozens of planned or current exhibitions put on display at the Museum of Science and Industry, Team Two's goal will be to integrate the Fab Lab into the current working exhibits as well as future exhibitions. Our team will focus on the use of small projects that reinforce the interactive learning of both the Fab Lab as a learning tool and the museum as a experience. We hope to establish strong connections & responsibilities within the museum by coordinating with the different departments to present the Fab Lab as a resource for both members and the museum itself.

Joseph Luciani: Team Lead
Shunsuk Nakano
Leslie Obst
Rachel Hendricks
Adam Winterbauer
Robert Boyer

Group Three:

Group three's first goal will be to refine the four main Fab Lab projects purposed last semester. This will include troubleshooting the manuals and delivering a prototype to a test group to be evaluated by mid-semester. A finalized prototype for each project will be integrated into the Fab Lab program for use by members. Group three will also try to develop more projects for the Fab Lab. These new ideas will try to integrate other exhibits in the museum, be educational to different age levels, and be eventually prototyped.

Ivan Reyes: Team Lead
Paul Marks
Nicolle Malinger

Michael Gajdorus
Lawrence Chung

Second Half of the Semester's Groups

Group One:

Considering there are dozens of planned or current exhibitions put on display at the Museum of Science and Industry, Team Two's goal will be to integrate the Fab Lab into the current working exhibits as well as future exhibitions. Our team will focus on the use of small projects that reinforce the interactive learning of both the Fab Lab as a learning tool and the museum as a experience. We hope to establish strong connections & responsibilities within the museum by coordinating with the different departments to present the Fab Lab as a resource for both members and the museum itself.

Joseph Luciani: Team Lead
Paul Marks
Shunsuke Nakano
Adam Winterbauer
Lawrence Chung
Michael Gajdorus

Group Two:

As requested by the staff of the Museum of Science and Industry, this group is working to create events specialized to Museum members, as well as creating proposals for low-cost, high-profit events; marketing and advertising strategies for the lab; and creating a website where people may sign up for time in the lab, designate projects they would like to do, buy (or reserve) materials, rent storage space for long term projects, and view general information about the lab itself.

Rachel Hendricks: Team Lead
Keenan Gottschall
Patricia Murman
Treyson Ptak
Robert Boyer

Group Three:

The purpose of this team was to successfully plan, and host, both a teacher workshop for visiting teachers, and also a student workshop for a visiting science class. In order to do so, this team had to create a presentation the illustrated the functions of the Fab Lab, as well as give an overview of the project that would be done by both groups of users. Additionally, this team worked to attain the materials required for the projects to be created by the users during the workshops, and also this team was responsible for cutting out the materials and making them into kits for each of the users to make the experience more streamlined and well organized. Lastly, this team was responsible for getting feedback from the users; this feedback was then used to create a report and assess the progress of the team.

Patricia Murman: Team Lead
Ivan Reyes
Leslie Obst
Anne Nadler
Nicolle Mallinger

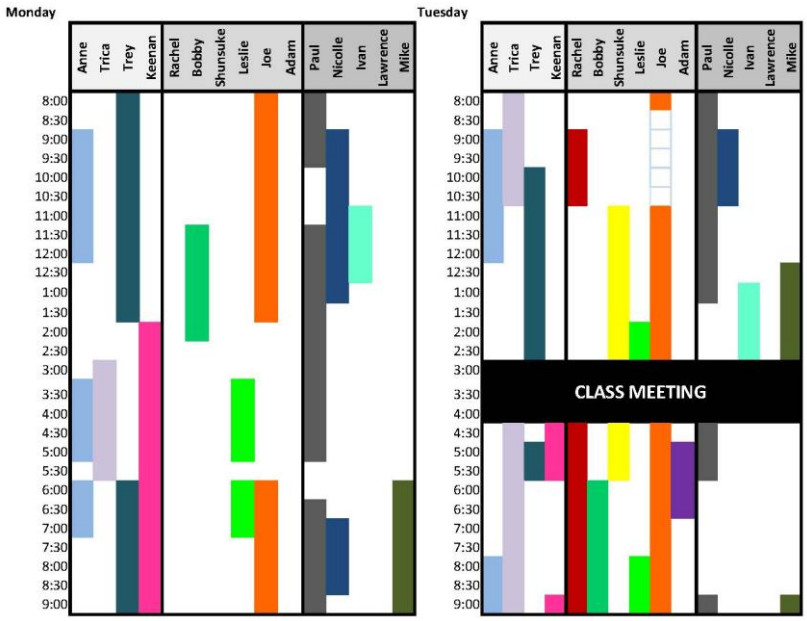
D. Project Monitoring Roles

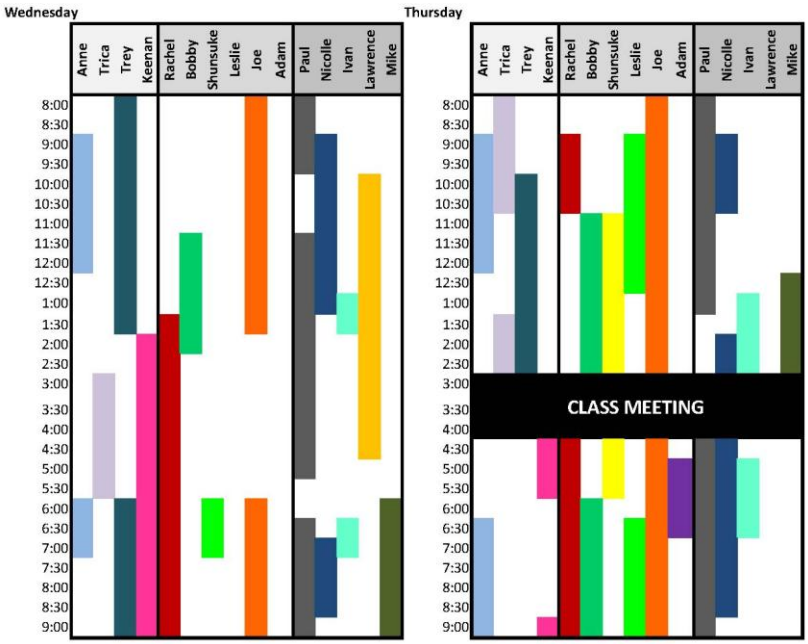
E. Minute Taker: Rachel Hendricks
F. Agenda Makers: Treyson Ptak
G. Deliverable Coordinator: Leslie Obst
H. Weekly Time sheet Collector/Summarizer: Nicolle Malinger
I. Master Schedule Maker: Anne Nadler
J. iGroups Webmaster / Binder Organizer: Lawrence Chung

E. IPRO Deliverables

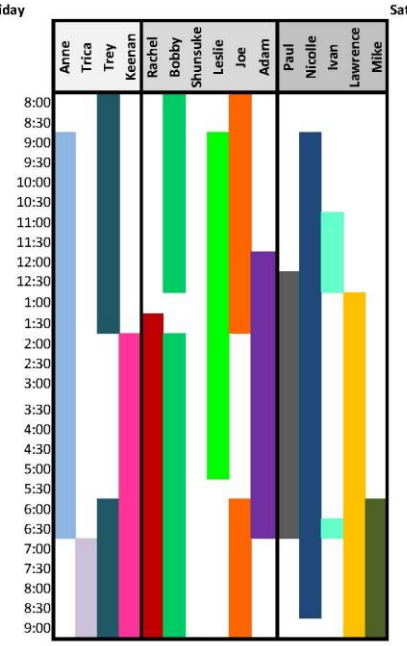
- Abstract: Lawrence Chung, Patricia Murman, Treyson Ptak
- Posters: Michael Gajdorus
- Props: Joseph Luciani
- Presentation: Robert Boyer, Lawrence Chung, Patricia Murman
- Project Report: Lawrence Chung, Keenan Gottschall, Treyson Ptak
- Final Report: Keenan Gottschall
- Notebook: Lawrence Chung

F. Schedule of Availability (listed by person)

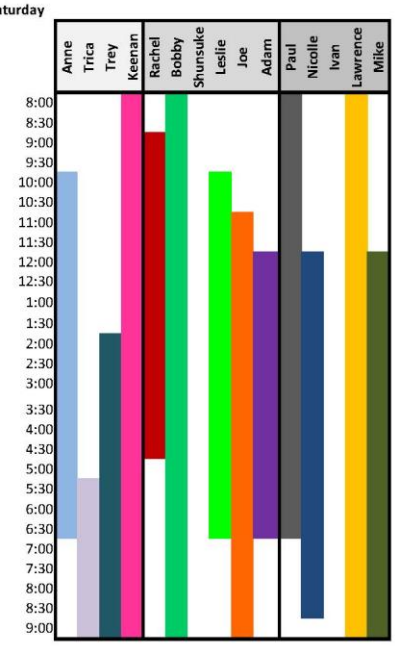




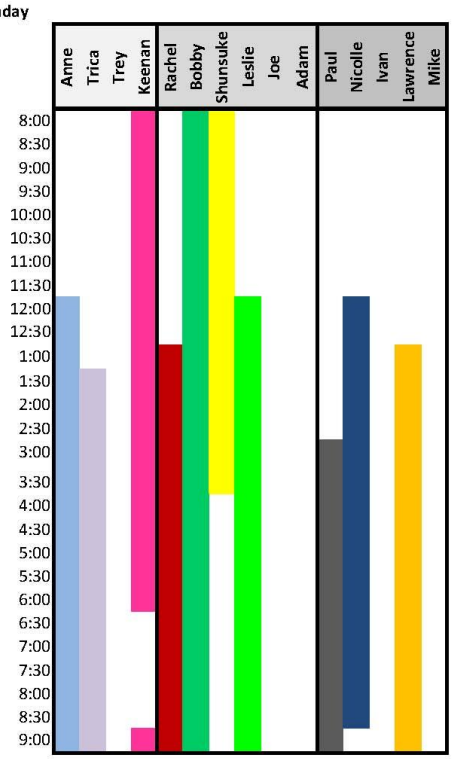
Friday



Saturday



Sunday

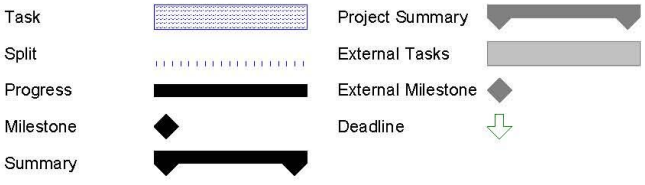


***Color is in accordance to time available**

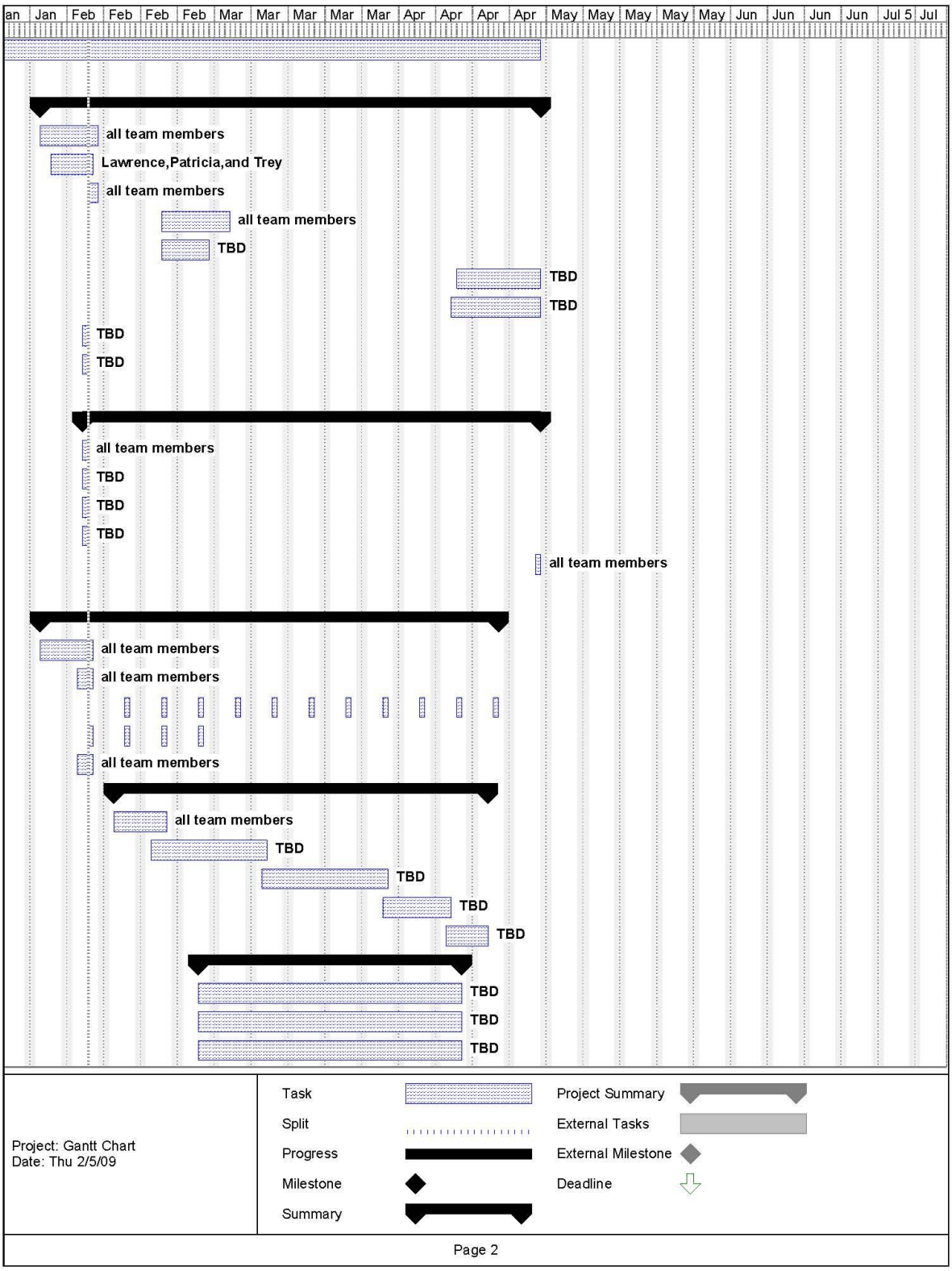
Team 1	Anne	
	Tricia	
	Trey	
	Keenan	
Team 2	Rachel	
	Bobby	
	Shun	
	Leslie	
	Joe	
	Adam	
Team 3	Paul	
	Nicolle	
	Ivan	
	Lawrence	
	Mike	

ID	Task Name	Duration	Start	Finish	Resource Names
1	IPRO 333-Fabrication Lab Project Schedule	74 days	Tue 1/20/09	Fri 5/1/09	
2					
3	**Deliverables**	**69 days?**	**Tue 1/27/09**	**Fri 5/1/09**	**all team members**
4	Project Plan	9 days	Tue 1/27/09	Fri 2/6/09	all team members
5	First Draft	6 days?	Thu 1/29/09	Thu 2/5/09	Lawrence,Patricia,and Trey
6	First Admission Draft	2 days?	Thu 2/5/09	Fri 2/6/09	all team members
7	Midterm Review	9 days	Thu 2/19/09	Tue 3/3/09	all team members
8	Abstract	7 days	Thu 2/19/09	Fri 2/27/09	TBD
9	Posters	12 days	Thu 4/16/09	Fri 5/1/09	TBD
10	Presentation	13 days	Wed 4/15/09	Fri 5/1/09	TBD
11	Report	1 day?	Wed 2/4/09	Wed 2/4/09	TBD
12	Project CD	1 day?	Wed 2/4/09	Wed 2/4/09	TBD
13					
14	**Events/Seminars**	**63 days?**	**Wed 2/4/09**	**Fri 5/1/09**	
15	Team Building Seminar	1 day?	Wed 2/4/09	Wed 2/4/09	all team members
16	Communications Seminar	1 day?	Wed 2/4/09	Wed 2/4/09	TBD
17	IPRO Day Tips	1 day?	Wed 2/4/09	Wed 2/4/09	TBD
18	MIT FabLab Visit	1 day?	Wed 2/4/09	Wed 2/4/09	TBD
19	IPRO Day	1 day	Fri 5/1/09	Fri 5/1/09	all team members
20					
21	**Methodology**	**63 days?**	**Tue 1/27/09**	**Thu 4/23/09**	
22	FabLab Research Review	8 days?	Tue 1/27/09	Thu 2/5/09	all team members
23	IPRO Direction Brainstorming	3 days?	Tue 2/3/09	Thu 2/5/09	all team members
24	**FabLab Work**	**51 days**	**Thu 2/12/09**	**Thu 4/23/09**	**all team members**
36	**Equipment Training**	**16 days**	**Thu 2/5/09**	**Thu 2/26/09**	**all team members**
41	Project Scope Definition	3 days?	Tue 2/3/09	Thu 2/5/09	all team members
42	**Project Development**	**51 days?**	**Tue 2/10/09**	**Tue 4/21/09**	**all team members**
43	Project Proposals	8 days?	Tue 2/10/09	Thu 2/19/09	all team members
44	Design Development	16 days?	Tue 2/17/09	Tue 3/10/09	TBD
45	Prototype Development	18 days?	Tue 3/10/09	Thu 4/2/09	TBD
46	Prototype Testing (Old and New projects	9 days?	Thu 4/2/09	Tue 4/14/09	TBD
47	Project Finalizations	6 days?	Tue 4/14/09	Tue 4/21/09	TBD
48	**Tutorial Drafting**	**36 days?**	**Thu 2/26/09**	**Thu 4/16/09**	**TBD**
49	Software Tutorials	36 days?	Thu 2/26/09	Thu 4/16/09	TBD
50	Project Tutorials	36 days?	Thu 2/26/09	Thu 4/16/09	TBD
51	Equipment Tutorials	36 days?	Thu 2/26/09	Thu 4/16/09	TBD

Project: Gantt Chart
Date: Thu 2/5/09



Page 1


an Jan Feb Feb Feb Feb Mar Mar Mar Mar Mar Apr Apr Apr Apr May May May May May Jun Jun Jun Jun Jul 5 Jul
all team members
Lawrence,Patricia,and Trey
all team members
all team members
TBD
TBD
TBD
TBD
TBD
all team members
TBD
TBD
TBD
all team members
all team members
all team members
all team members
TBD
TBD
TBD
TBD
TBD
TBD
TBD
TBD
Project: Gantt Chart
Date: Thu 2/5/09
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 2

V. Budget

Item	Estimated Cost ($)	Actual Cost ($)
Transportation Reimbursement	$225.00 (3 vehicles, $75.00/vehicle)	$225.00
Prototyping Materials	$175.00 (e.g. 1' x2' acrylic piece = $15.00)	$175.00
Public Relations	$150.00	$105.80
Participant Support	$100.00	$100.00
Miscellaneous	$100.00	$100.00
Total	$750.00	$705.80

VI. Results

This semester began with a multi-faceted research approach. A majority of the IPRO team began the semester by researching potential projects than can be done by those who visit the Fab Lab. This research included students exploring the various exhibits and brainstorming project ideas based off of some of the elements of certain MSI exhibits. Also related to the research of the exhibit-based projects some of the students had to research materials and building methods for the projects they had brainstormed.

The second aspect of the research from the spring semester included three of the team members visiting the MIT Fab Lab in Massachusetts. The purpose of this trip was for the three students to learn about the software and machinery that are used by the MIT Fab Lab, as well as the techniques that the staff uses to create the productive and educational environment that is an integral part of the Fab Lab experience. Finally, these students brought back their research to the IPRO team and shared with them all of the knowledge they had gained while visiting MIT. Consequentially, this knowledge allowed IPRO team members to become much more successful in using some of the machinery located in the MSI Fab Lab; this new knowledge also allowed team members to begin to use some of the machines that they had never used before, such as the Modela milling machine.

After the research portion of the semester the IPRO 333 team broke down into three teams that focused on marketing the Fab Lab, events hosted in the Fab Lab, and a team focused on expanding upon the brainstormed projects from earlier in the semester. The marketing team successfully put together a brochure for the Fab Lab, launched a Wikipedia site that is linked to many other relevant Wikipedia pages, and began working on an MSI Fab Lab website link with the staff of MSI. The MSI website link formerly never had any mention of the Fab Lab on it, thus, this is a great step forward for the IPRO team. The events team worked diligently to put together a teacher workshop, and later a student workshop, in the Fab Lab. The work of this team included finalizing the project that was to be done by each of the groups, which was a rubber band powered train, getting materials for the projects, creating a presentation and instructions for each of the workshops, and finally actually hosting the workshops. These experiences are the first time that teachers and students have ever used the Fab Lab as an educational tool; once again this is a major accomplishment for this IPRO team. The project development team proceeded throughout the semester polishing some of the previously done projects, and also creating many new projects. Some of the new projects that were completed by this team included a periscope and a U-505 submarine, both of which related directly to the U-505 exhibit at MSI. Another major accomplishment of

this team was when one of the team members repaired the CNC milling machine, which had not been working since the IPRO team arrived at MSI one year ago.

Many of the objectives that were laid out at the beginning of the semester were accomplished this semester. This team successfully implemented a new marketing strategy for the Fab Lab, which included the accomplishments that were aforementioned. The IPRO team also successfully implemented the Fab Lab into exhibits at the museum by creating projects that are supplements to the exhibits. Finally, this IPRO team documented all of its ideas and accomplishments so that they can be passed down throughout semesters to future teams.

On the other hand, this team did not successfully accomplish some of its objectives however these will be completed in the future and were not overlooked. This team was not successful in introducing the experience and knowledge of IIT faculty, although this is due to certain time constraints with departments of IIT and the students on in this IPRO. This team also did not create pre-lab exercises for visitors of the Lab as stated in the beginning of the semester. There were also many other aspects of the objectives that were initially laid out that are in the working phases and cannot be called accomplishments or failures.

VII. Obstacles

The IPRO 333 team encountered only a few major obstacles this semester, none of which were the result of any group problems. The obstacles that were faced are as follows:

- Weak inter-department communication within the Museum of Science and Industry
    - To overcome this obstacle the IPRO 333 team created rapport with many staff members from various departments so that the team could have a list of reliable resources to use when needed.
    - This issue cannot be solved by the IPRO team, instead the team must work hard to maintain its relationships with the various departments at MSI to ensure that the IPRO team is in line with the departments.
- An understaffed Fab Lab; a result of budget and staff cuts made by MSI
    - This obstacle was not fully dealt with, however, for the time being the IPRO team members acted as staff for the Fab Lab by hosting open access events for museum visitors, a teacher group, and a student group.
    - To help solve this problem in the future the team needs to work hard to bring experienced people into the Lab as volunteers to help teach other Lab users, this in turn will also help to create an atmosphere of help thy neighbor which will in the end create a group of knowledgeable volunteers in the Fab Lab.
- Lack of internal funding from MSI
    - To help combat this issue, in the future, this IPRO team will attempt to gain external financial support from local companies and individuals who could have a vested interest in the success of the Fab Lab and MSI.
    - In the future this team needs to follow through on the plan that has been created because this solution will be a major asset to the team because the additional funding will enable the Fab Lab and the IPRO to grow.
- Stock supply shortage

- The IPRO team ordered bulk materials, both for prototyping and project workshops with the help of the IPRO budget that was given to it by IIT. The extra materials are stored in the Fab Lab for future teams to use.
- This team needs to continue to find reasonably price materials and order them in bulk to continue to build up the amount of supplies in the Lab.

- Limited hardware and software experience, as well as limited hardware and software instructional manuals
  - To help solve this issue team members worked diligently to create both hardware and software manuals for future team members, as well as Fab Lab users. During this process many team members gained experience using the software and hardware that they were not at first proficient with. Also this team sent three members to the MIT Fab Lab, and they brought back knowledge on how to use some of the hardware and software located at the MSI Fab Lab.
  - This team needs to work to refine the tutorials that were created so that they will be more user-friendly and simpler forms need to be posted in the Fab Lab so that they are more easily accessible to users.
- Non-existent marketing scheme
  - To deal with this issue the marketing team created a marketing strategy and also began to implement some of the ideas on the strategy, such as the Wikipedia website, flyers, and brochures.
  - This team needs to continue to monitor its marketing campaign's current accomplishments, and also work to implement all of the ideas from the marketing strategy.
- Time constraints, and the inability of team members to gain access to the Fab Lab at any time
  - This issue was caused both by the location of the Lab with regards to campus, and also by the students not being allowed to enter the Fab Lab on their own. To deal with the first aspect of this issue team members left early from campus many days so that they could have more time in the Fab Lab to work on projects. In an attempt to minimize the impact caused by the second aspect the team created a list of museum staff members and their phone numbers so that they could call these people to gain access when they needed to work in the Fab Lab.
  - This issue is going to be something that will be continually faced by all future IPRO teams however, the way it was handled by this team was very successful.

VIII. Recommendations

- The first recommendation for future Fab Lab IPRO teams is to continue to work to make the Fab Lab an open access museum exhibit by refining software and hardware tutorials, creating new projects that relate to museum exhibits, and by working out a price of admittance that correlates with the expectations of MSI
- Future IPRO teams should begin to create short-term design programs for Fab Lab visitors. These programs could be anywhere from one 90 minute session to a two to three day project. These programs will help users to gain experience using multiple tools and also to become

acquainted with the layout of the Fab Lab.

- One of the most important recommendations for future teams is that they continue to market and advertise for the Fab Lab both within MSI and in the community. This marketing and advertising will help to gain a steady user base for the Lab, as well as it will start the process of gaining enough support from non-IPRO members so that this IPRO can be completed. Additionally, the purpose of marketing and advertising is to help create a funding inflow from donors and Fab Lab users.

IX. References

Research on Projects:

"3D sculptures" How to. Universal Laser. 2008. <http://www.ulsinc.com/.>

"3d Signage" How to. Universal Laser. 2008. <http://www.ulsinc.com/.>

"4-4-0." Wikipedia. 2008. <http://en.wikipedia.org/wiki/4-4-0.>

"A Puzzle" How to. Universal Laser. 2008. <http://www.ulsinc.com/.>

"CorelDraw" How to. Universal Laser. 2008. <http://www.ulsinc.com/.>

"Mammoth Puzzle." Epilog Laser Co. 2008. <http:// epiloglaser.com/sc_mammoth.htm>

"Multi-Layer Appliqué" How to. Universal Laser. 2008. <http://www.ulsinc.com/.>

"Multi-tile Murals" How to. Universal Laser. 2008. <http://www.ulsinc.com/.>

"Photo Engraving" How to. Universal Laser. 2008. <http://www.ulsinc.com/.>

"Fab Lab MSI" Wikipedia. 2009. <http://en.wikipedia.org/wiki/Fab_lab_msi/>

"Personal Power Plant" Instructables. Circuitry. <http://www.instructables.com/id/personal-powerPlant/>

Various projects used http://www.instructables.com for ideas on projects.

Notes taken while visiting the lab, trouble shooting the CNC with IIT administrator Brett Balogh. February 09, 2009.

Notes taken at IIT Rice Campus presentation. February 21, 2009

Notes taken while visiting the MIT Fab Lab in Massachusetts. March 12 and 13th.

Research on Equipment:

"CNC Mill Tutorial" Illinois Institute of Technology. 2008.
<http://www.iit.edu/~shoptech/bridgeport_guide.pdf.>
"Laser cutter tutorials" Illinois Institute of Technology. 2008. < http://www.iit.edu/~shoptech/>

"Owner's Manual For Epilog Mini/Helix-Model 8000" Epilog Laser Co. 2008. <www.
Epiloglaser.com/downloads.htm. >

"Shop Tutorial" Illinois Institute of Technology . 2008. <http://www.gl.iit.edu/grc/resources/safety.htm>

Video recording: (whole sites)
http://www.turbodemo.com/eng/index.php
http://www.sameshow.com/democreator/create-software-demo-samples.html
http://www.allcapture.com/eng/index.php
http://www.fraps.com/

Research on Learning Standards:
<http://www.nsf.gov/.> (whole site)

"Chapter : Elementary and Secondary Education, Standards and Student Coursetaking." *Science and Engineering Indicators 2008. 2008 <http://www.nsf.gov/statistics/seind08/c1/c1s2.htm.>*

Colwell ,Rita Rossi. "Excerpts from her keynote address at NSTA national convention." The National Science Foundation and Education. 2008 <http://www.actionbioscience.org/education/colwell.html.>
Cook County Schools. <http://www.cook.k12.ga.us/.> (whole site)
"Curriculum and Instruction." Illinois State Board of Education. 2008.
<http://www.isbe.state.il.us/curriculum/default.htm.>

"Evaluation of the Illinois Learning Standards." 2008. http://www.ed.uiuc.edu/ils/.
"Illinois Learning Standards." Illinois State Board of Education. 2008.
<http://www.isbe.net/ils/science/standards.htm**.>**

"Illinois Professional Teaching Standards" 2008. **<**http://www.isbe.state.il.us/profprep/PDFs/ipts.pdf.>

"Learning in Illinois." 2008. <http://www.illinois.gov/learning/k-12.cfm.>

"Learning in Illinois." 2008. <http://wwwa.illinois.gov/learning/.>

"The Firm Background." Illinois Education Law. 2008.
<http://www.tuethkeeney.com/PracticeAreas/il_education.html.>

"Resources on Early Learning: Illinois Early Learning Standards". Illinois Early Learning Project. 2008.
<http://illinoisearlylearning.org/standards/index.htm.>

"Science Curriculum." Brookfield LaGrange Park, Illinois School District #95. 2008. <http://www.d95.w-cook.k12.il.us/curriculum/science.php.>
Science standards: for 4th- 8th. The Illinois School board.
Train info with respect to school research and study:
<http://www.cadinschools.org/index.php.> (whole site)

Research on Fabrication Laboratories:
"How to make (Almost) anything." MIT Open Course Ware. 2008. <http://ocw.mit.edu/OcwWeb/Media-Arts-and-Sciences/MAS-863How-to-Make--Almost--AnythingFall2002/CourseHome/index.htm.>
"Fab Lab." Wikipedia. 2008. <www.en.wikipedia.org/wiki/Fab_lab.>

Khan ,Sabiha Essa. "Nitty-gritty: How fabrication labs will work." Sci-Tech World. 2008.

<www.dawn.com/weekly/science/archive/050827/science8.htm.>

Surveys:
The teachers, administration, and students of the Mark Sheridan Academy, and Robert Healy Elementary.
The Science Achievers group at the Museum of Science and Industry.
Professor T.J. McLeish, and IIT Shop Technician Bret Balogh.

Books:
Gershenfeld, Neil. FAB The Coming Revolution on Your Desktop--From Personal Computers to Personal Fabrication. New York: Basic Books, 2005.

X. Resources

A. Budget

Item	Cost ($)
Transportation (to and from MSI)	**$225.00**
Prototyping Materials	**$175.00**
Milling wax	$25.00
Acrylic	$75.00
Cardboard	$50.00
Metal rods	$20.00
Acrylic glue	$5.00
Public Relations (for food, open access materials)	**$105.80**
Participant Support (food for event volunteers)	**$100.00**
Miscellaneous (extra material and transport expenses)	**$100.00**
Total	**$705.80**

B. Time

Semester Hours Summary

[Click to Print]

User	1/11 - 1/17	1/18 - 1/24	1/25 - 1/31	2/1 - 2/7	2/8 - 2/14	2/15 - 2/21	2/22 - 2/28	3/1 - 3/7	3/8 - 3/14	3/15 - 3/21	3/22 - 3/28	3/29 - 4/4	4/5 - 4/11	4/12 - 4/18	4/19 - 4/25	4/26 - 5/2	5/3 - 5/9	5/24 - 5/30	Semest Total
Rachel Hendricks		3.5	2.0	2.0	2.5	3.5	3.0	7.0		3.8	4.5	1.5	3.5	3.0	4.5	18.9	2.0		65.2
Nicolle Mallinger		3.0	2.0	3.5	3.0	4.0	5.0	1.0	4.5		6.5	4.5	5.0	4.5	9.5	13.0	2.5		71.5
Paul Marks		1.5	1.0	4.5	3.5			2.5		5.0	6.5	10.0	17.5	1.0	1.0	12.5			66.5
Lawrence Chung	1.5		1.0	5.0		2.5	18.0	1.0	4.5				4.5	2.5	1.2	3.0			44.7
Anne Nadler		2.0	4.3	3.2	2.7	2.8	17.5	1.5	8.0		1.5				2.0	4.0	5.5		55.0
Leslie Obst	2.3	1.5	2.0	1.5			15.0	2.0	9.0		0.5	1.0		5.0	2.0				41.8
Adam Winterbauer		2.0	3.0	5.0	2.0	10.0	1.0	4.0			0.5	1.0		0.5	2.5	10.5			42.0
Patricia Murman			2.0	6.3	6.0	3.8	10.0	3.1		7.0	2.8	6.0	8.3	12.0	7.0	18.0	4.0		96.3
Joseph Luciani			2.3	1.5	3.0	4.0	2.0	3.0	3.0		7.0	10.0	6.0	11.0	18.0	31.0			101.8
Shunsuke Nakano				1.0	4.5		6.0	3.0			3.5	1.5	5.0	4.0	2.0	7.5	2.5		40.5
Robert Boyer		1.5		3.0		9.0	1.5			6.5		0.5	3.0	1.0	2.5	8.0		6.0	42.5
Michael Gajdorus			2.3	2.0	1.5	4.0		3.0			2.5	13.0	6.5						34.8
Ivan Reyes			1.5	1.9	1.8	2.0	1.8	6.2	3.5			7.8	3.6	8.0	8.8				46.9
Treyson Patek				8.0	5.0	4.5	5.5	6.0	3.0		5.5	5.0	5.5	6.0	1.0				55.0
Keenan Gottschall				2.0	1.3	2.4	3.8	2.5	4.5		2.5	2.0	4.3	4.1	4.8	8.2	9.8		52.2
Week Average	1.9	2.1	2.1	3.4	3.1	4.4	6.9	3.3	5	5.6	3.7	4.9	6.1	4.8	4.8	12.2	4.4	6	
Week Total	3.8	15.0	23.4	50.4	36.8	52.5	90.1	45.8	40.0	22.3	43.8	63.8	72.7	62.6	66.8	134.6	26.3	6.0	856.7

XI. Acknowledgements

Steven Willis – Fab Lab Director/Coordinator of Science Achievers (MSI)

Pam Barry – Director of Educational Services (MSI)

Sarah Tschaen – Sr. Coordinator of Student Experiences (MSI)

Steven Beasley – Web and Interactive Media Manager (MSI)

Steven Aspacher – Director of Member Management (MSI)

Al Lang – Teacher at Joseph Brennemann School

Center for Bits and Atoms

Museum of Science and Industry