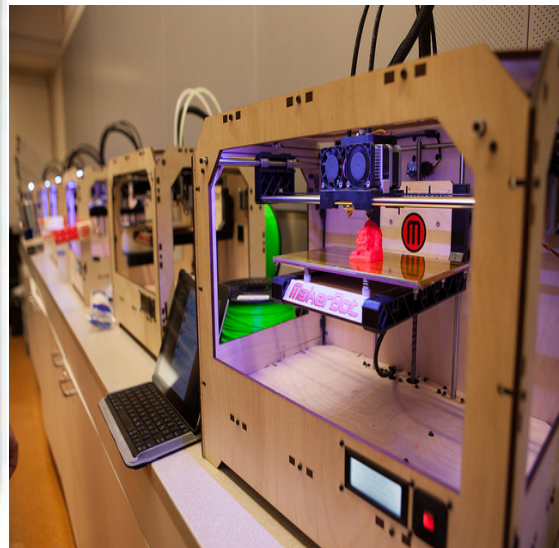


3D Lab At Wayne State



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Executive Summary

The engineering department at Wayne State University does not currently provide any type of 3D printing courses. Even though there are other programs that are being offered for three-dimensional modeling, Like ME 2050, there are not 3D printers used to create such models to help students visualize their creations. Autocad/3D printing proficiency is becoming a major skill required for most Mechanical, Civil and other engineering fields. Courses in 3D printing could give students the necessary skills to help them get hired as entry-level engineers. This technology is advancing at a fast rate. As we interviewed a 3D/ Design Engineer at Takata Inc. he emphasized on how much this technology is helping in the engineering field. We conducted some solutions that allow students at Wayne State to gain knowledge about this matter.

- A 3D course included in the curriculum of the Engineering Department as a required course
- 3D printing lab offered as requirement credit courses at Wayne State
- 3D Courses and labs offered as requirement but attending classes at Henry Ford Community College
- Implementation of an advanced 3D printing lab on campus
- Attending a 3D lab course at University of Michigan

Each option was researched from cost and benefit perspective. We interview engineering faculty and Wayne State students, from different majors. Professors like Hassan Mohseni Nameghi from the engineering department at HFCC that currently provide 3D instruction spoke on how students at HFCC are learning and adapting to this technology. This study concludes that offering a 3D printing lab/courses is the best solution to work with that helps students in the future and allow Wayne State to compete technologically with other institutions.

INTRODUCTION

3D printing is a quickly expanding field, with the popularity and uses for 3D printers growing every day. 3D printing can be used to prototype, create replacement parts, and even print medical implants. It will have a growing impact on our world, as more and more people gain access to these amazing machines. This technology has been advancing for the past years and it's becoming very popular at Universities and not just industrial places. Now 3D printers do what engineers want to visualize and test at a lower cost and less time. They make real physical objects by laying down sub-millimeter-thick layers of material (currently mostly plastic) one after another in a specific pattern ran by a digital design. This allows 3D printer users to make products to their own specifications, so they do not have to "make do" with what is available off the shelf at their local store or even on the Internet. Engineers should not be limited to learning by reading, looking at designs without visualizing it in hands or even creating the models from scratch. As an employer myself in the engineering department at Takata Inc, 3D printing is one of the most useful technology used during new designs and building prototypes.

However this technology is not available at the engineering department for students enrolled in engineering at Wayne State University. As we see this technology grow, more educational institutions are starting to fund such projects. We never noticed a big step forward towards this technology from the mechanical engineer department at Wayne State.

Conducting this feasibility test indicates how valuable and beneficial such a project can be to Wayne State students as it increases Wayne State's reputation with proofs that this institution is willing to improve and compete technologically with other top institutions. Such a technology is very important as we see it developing around the nation and around all institutions, so why Wayne State should not consider take participation within this technology? This feasibility test covers the cost and implementation of running this project on campus. However if this project can't proceed on campus, students should have the option of enrolling in other institutions that are already running 3D courses by making these courses as requirements.

Overview of Alternatives

Alternative 1:

On campus 3D lab available for students attending Wayne State. This lab stipulates advanced 3D printers, computers and CAD software. Engineering department making 3D/CAD courses as requirements. All engineering majors like mechanical, electrical and civil will be taught 3D printing.

Alternative 2:

Access to an off campus 3D lab from a different institution to be considered as a second option. University of Michigan/HFCC are equipped with advanced 3D lab that are already running and in use. Wayne State will add those course to engineering degrees requirements.

Methods and Results

Method

To construct a valuable argument, we researched and compared the technological advancements between Wayne State and other Universities that run 3D labs. Wayne State was compared to Michigan Technological University and University of Michigan. These other institutions help visualize the ideal solution, because they each have a 3D lab running.

To gather some definite information on 3D printing, we decided to interview Stewart Murray. He is a designer in the engineering department. Murray has been working with 3D printers for over 5 years. We were able to get an over all idea of the benefits of operating a 3D lab.

Along with the interviews, we also ran a survey to gather information on the demand for a 3D lab. We sent out this survey to fellow Wayne State students. The survey was done by a variety of students, ranging from biological science majors to Engineering majors. Also, we viewed a survey that was done by an organization called Statistical Studies of Peer Production.

Our methods of research ranged from different types of academic research. Some information was extracted from Wayne States library research website. Reliable academic search engines like Jstor and gales virtual library helped collect valuable findings that strengthen our report. Academic examples on how other schools where maintaining a fully equipped 3D lab modeled the necessary maintenance, fees, and staff needed to run this lab effectively.

Results

Importance of a 3D Lab for Student Professionalization and Learning

Student Desire

After a number of Wayne States students completed the 3D printing survey, we were able to obtain some helpful results. 42 students participated in his quick survey. 20 students are somehow enrolled in an engineering field. The rest were enrolled in different majors. Some students were enrolled in ME, CE, computer science, engineering technology, industrial engineering, pre-med and information system. The variety of majors was important as we didn't want a bias opinion from ME or CE. A total of 39 students thought that a 3D printing lab is somehow important, which tells us the student interest in his project is quit high. Even though most agreed that it is important to be educated about it, 30 students had never taken any 3D modeling classes at any level. We also concluded that more than half that took the survey are willing to take this course if counted towards their elective courses, which will increase their interest in learning about new developing technology used around the world without feeling that time and class cost are going to waste. On the other hand about 55% of students are not willing to pay extra lab fees, but at that ratio I believe enough students will be willing to attend such a class and pay the extra fee and make it easier on the institution to fund the rest.

Student Benefits (Professionalization and Learning)

After observing the responses of our interview with a designer in the Wayne State Engineering department, we made some conclusions, fully running 3D printers need little maintenance. They are very durable. A 10-year-old printer would usually run as good as new. 3D printing can take up a lot of time. An average project takes about 10-20 hours. This is an issue, because a 24-hour 3D lab is not available. With a 24 hour fully equipped 3D lab, students will be able to conveniently finish projects, without worrying about closing times. The designer emphasizes the necessity for engineers to have easy access to a 3D lab. He explains, "Companies deal with 3D printing, and love to see students who have experience, it's a good topic to learn, if available to students." When students are experienced with 3D printing, companies will be very impressed. 3D printing has revolutionized the manufacturing industry. Equipping these future engineers, doctors, and scientist with this valuable experience will be very beneficial in there future endeavors.

Advances in 3D Printing Technologies at Competing Universities

Other prestigious schools like University of Michigan and Michigan Tech are investing in numerous 3D printing accommodations. The University of Michigan 3D lab is used in many different fields, ranging from computer sciences to Medical fields and of course the Engineering department. The University of Michigan also has a printer that can print projects in color. The ability to efficiently print models has helped researchers develop advancements in medicine, technology, and experimental findings.

Michigan Tech also has a very impressive 3D lab. 3D printing isn't just cheaper, it's also greener, says Michigan Technological University's Joshua Pearce. Michigan Tech believes hardly on the idea that 3D printing is a win-win situation for all parties. Printing prototypes cheaper and less harmful to the environment. Having these prototype objects made from metal and plastic in factories releases great pollution from manufacturing and shipping. As said by a Michigan Tech. Representative” 3D printing may herald a new world that offers consumers many more choices as everything can be customized.” 3D printing is the future, and its time for Wayne State to take a big step to help fully advance the students experience.

Advances in 3D Printing Technologies at Wayne State

Recently Wayne State University’s Mortuary Science Program received \$10,000 grant for 3D technology project from Service Corporation International. Mark T. Evely, director of Wayne State’s mortuary science program states, “ Students will use 3D technology to explore elements of anatomy and practice reconstructing parts of the human body, which improves their marketability and prepares them to address real-world issues.”

Last year three Wayne State students placed 2nd place in an international 3D printing contest. These students were biomedical engineering majors. They printed an object and called it, “The Diabetic Testing Station”. This invention was eventually created and used by diabetics worldwide. These three students were able to change the world through 3D printing. With more exposure to 3D printing, by way of building a fully equipped 3D lab, students will be able to create even more advanced technologies.

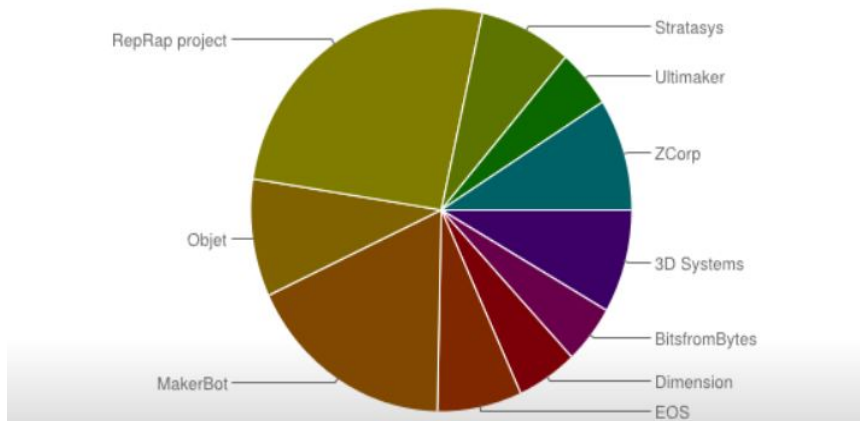
Evaluation

On Campus Stationary Lab

Our main focus in this project is a stationary fully equipped 3D lab at Wayne State University. We emphasize on having a stationary lab so students at Wayne State can have easy access to the lab at any given time. Running a major project can be difficult, time consuming, high costs and issues that need attention before proceeding.

Criteria 1: Cost Analysis

Technology is advancing on many levels. There are many 3D printers available for consumers at different levels. This technology ranges from industrial cost to educational or personal. After few researches we found 3D printers that function at a very advanced technology level which also can be used for an educational equipped lab. The price of each unit is roughly \$6,000 USD. The plan is to equip the lab with about 4-5 units, which brings the total cost to roughly \$35,000 USD including 5 years warranty and delivered. Robotshop provides and delivers top quality technology. MakerBot is one of the biggest 3D printing industry that Robotshop provides its products. A conducted survey about 3D printing done by Statistical Studies in 2012 shows that about 400 participants used MakerBot along with other top manufacturers.



In order for the 3D lab to run successfully, it has to be equipped with good design software. Each different CAD software plays a different role in the lab. There is a numerous amount of design software that companies or educational institution use. CatiaV5, AutoCAD and SolidWorks are among the top users.

SolidWorks is sold in three separate versions: **Premium**, **Professional** and **Standard**. The plan is to have at least 20 computers equipped with this software. Since this lab is strictly for educational purpose and not mass or prototype production, we believe a standard license should be purchased to run the systems. After contacting SolidWorks we requested an immediate pricing quote and they were able to automatically quote what we asked for:

Design	License	Subscription
10 SolidWorks Standard	\$3995	\$1295
10 SolidWorks Electrical 3D	\$5995	\$1695
Design Validation		
1 SolidWorks Simulation Professional	\$6995	\$2275
Total Price (USD\$)	\$106895	\$32175

With the purchase of any SolidWorks product, a complete curriculum, including a Teacher Guide and Student Guides are included, that make teaching easier at every level.

Since we know that the lab will be equipped with 20 computers, we don't know if Wayne State have units to use on site instead of purchasing new units. However if desktops are in need, Dell Inspiron desktops will be available at \$700 per unit. Visiting Computing & Information Technology, we see that Dell and Wayne State have an agreement to discount purchases made by Wayne State institution and faculties. The total cost is \$14,000 USD in order to purchase 20 units. Each unit comes with Windows 8, Intel Core i5, 12GB memory and 2TB hard drive. The unit mentioned above meets the requirements for running the CAD software along with 3D printers. This lab will also require tables and workstation chairs for students. Worthington Direct provides furniture such a workstation tables and working chairs. A 2 monitor workstation table equipped with tower holders costs \$600 USD. This lab will require 10 tables which brings the total cost to \$6,000 USD. Each individual workstation chair is roughly \$140 USD and that adds \$2,800 USD to the total cost.

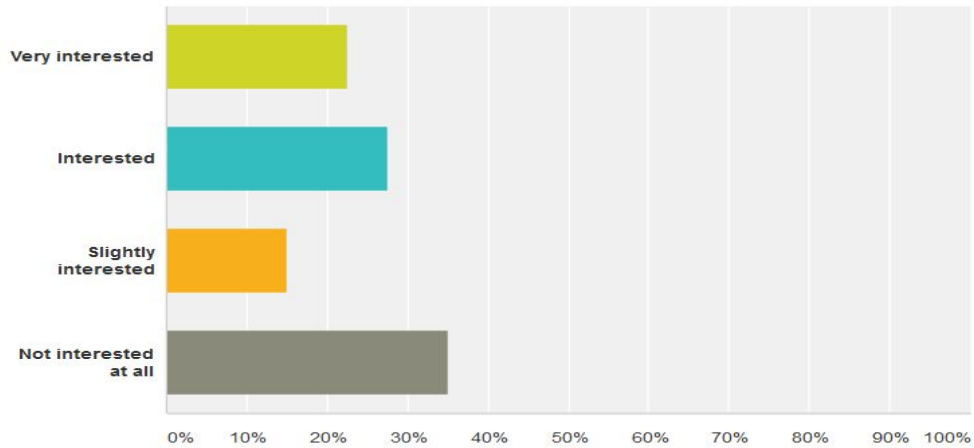
Professor's main tool in class is the overhead projector. Having one installed in this lab is very important. At the price of \$500 USD, the lab will have a projector that instructors can use to get information across or to help troubleshoot any issues.

Criteria 2: Student benefits / Desire

A stationary lab at Wayne State main campus would benefit current students attending the university since accessing the lab will be as easy as visiting the cafeteria. Students majoring in any Engineering field can benefit from visiting the lab and getting homework done if any assigned. Surveys results showed that majority of students that participated in the survey are will to take this type of class if credited towards their electives. These results clearly indicates the demand and the desire students have towards such a project. Approximately 65% of participants showed interest as the figure below demonstrates it graphically. The exact location of the lab is not yet decided but will be most likely located in the Engineering building.

Are you interested in taking any CAD classes if credited towards your elective courses?

Answered: 40 Skipped: 2



Criteria 3: Implementation/ Faculty

The 3D lab will be equipped with at least 5 printers and 20 computers. Our focus here is space availability. After researching some labs we realized that space availability is very important. We believe that finding the space on campus should be a top priority task. Once approval is confirmed, furnishing the lab should start immediately. Companies delivering the equipment should have an available space for the units to be installed and mounted. Once the lab is fully furnished, it can also be used by other professor teaching computer classes and such without operating the 3D printers unless needed. Since CAD classes are already offered at Wayne State, faculties teaching those courses will most likely offer additional lab sections to each course. The additional sections will primarily focus on learning 3D printing. However if faculties can't offer additional sections hiring new faculties will be in demand. Wayne state can also hire Engineering students with CAD/3D experience as Co-op/ Interns to help.

Third Party Access-Off Campus

Most universities nowadays are equipped with high-tech 3D labs. However these labs are only accessible for students attending the institution. Having access for Wayne State student to those labs is a second option for the Engineering department to consider.

1-Cost

We know that having access to high tech lab is not as costly as starting a new one since printers and software are already operating. Wayne State can reach out to University of Michigan or Henry Ford Community College since both institutions are already equipped with 3D labs. At University of Michigan students can have access to a “walk-up” 3D printing lab. Teaching CAD classes at Wayne State will give students skills on understanding 3D models. After the student completes a model, he or she can visit U of M and access the 3D lab. Once the model is submitted, brief instructions are given at the lab regarding the printers. Then students are asked to take a test to verify their knowledge. Once test is taken, the students can work in the lab and depending on the size of the model, a pricing quote will be given. A curriculum agreement between Wayne State and U of M will allow students to use the lab but prices are covered by Wayne State. The second option is registering at Henry Fold Community College.

The figure below gives an idea of fees that students are expected to cover for a credit hour at HFCC:

Tuition Per Credit Hour:	
Dearborn School District	\$87.00
Out of District	\$149.25
Out-of-State & International Students	\$154.25
Service Fee Per Credit Hour	\$15.00
Technology Investment Fee Per Credit Hour	\$2.00

2-Student benefits/ Desire

As we mentioned earlier benefits of accessing a 3D are the same whether the lab is on campus or at a 3rd party. Since the lab is off campus, students might have difficulty attending the site due to transportation problem. However if those courses are made as requirements by the engineering department, students must complete those requirements. On the other hand students are willing to pay less for a credit hour compared to Wayne State but still count towards their requirements. Since HFCC has an agreements to help students who want to transfer to other institutions once they have completed their studies at HFCC. Articulation agreements ensure that graduates from HFCC can transfer their credit to another institution and work towards a bachelor's degree

without a loss of coursework completed at HFCC. The agreement includes a number of institutions including Wayne State University. Students will consider this option also beneficial to them as they save on tuition costs and obtain credits towards their required courses.

3-Implementation/ Faculty

An access to 3rd party lab will be the easiest and quickest way to get students started. Since the lab should be already furnished and ready to operate. There will be no demand on faculty as the 3rd party had an equipped lab with instructors giving lessons. Sections should be available to register for once registration and classes begin.

Conclusion

The conclusions are based on factors that were obtained during this research and the study of this project. According to the survey conducted most students showed interest in taking a 3D course if counted towards electives. The existing engineering programs and other technology class do offer CAD classes however using 3D printers is yet to be offered. For Wayne State to keep succeeding and building a stronger technological reputation a 3D printing lab should be implemented. The proposed project must be a top priority towards building a strong curriculum. Our first alternative which is a stationary 3D lab is the preferred option as the survey showed the same results. Students having an easy access to on site campus lab.

Recommendation

After our research we believe that both of our solution are effective and will benefits students and Wayne State.

- Implement a stationary 3D lab on campus
- Add 3D courses to Engineering degree requirement and student attending institutions already equipped with 3D labs.

Even though not both solutions are cost effective, they are both still beneficiary and will have a huge impact on students. The stationary lab will improve the institution reputation from a technological perspective. The following actions should be taken to implement the results of this study so that Wayne State is an institution equipped with an advanced 3D printing lab and competing technologically with other institutions:

- Start a meeting to discuss the implementation with the engineering department
- Locate an available space to start furnishing once approved
- Complete review of the cost breakdown
- Announce final decision on the plans
- Announce approval and start supporting funds

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