University of Ottawa

Faculty of Engineering

GNG2101 - Introduction to Product Development and Management for Engineers and Computer Scientists

Project Deliverable J: User Manual

Submitted By:

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Abstract

This report provides information about the design process for our entire three-month long project designed with the plan of providing the needs that exist for members of the CEED community while demonstrating how customers' needs were gathered and interpreted. Also, this report describes how prototypes were made, used, and maintained and the work left to be done on them. Furthermore, it includes the lesson learned and recommendations on improvement needed to construct a more suitable design for future work.

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Introduction

Access to quality/standard labs is very essential and should never be taken for granted. Our client, CEED, offers engineering design and entrepreneurship education and experience at the University of Ottawa. Throughout the Spring-summer semester, we worked with CEED to create an interactive, aesthetically pleasing website which will include all information needed to properly learn beginner 3D printing at home. CEED requested that we build a product that will be interactive, user friendly, for anyone in any age demographic, which can be accessed in any given time and we placed it at a price of 30$.

Unfortunately, due to the COVID-19 pandemic, all in-person labs were cancelled until further notice, thankfully, we were given the opportunity to create an interactive website to meet CEED needs; our solution had to meet specific needs of the client and we utilized a budget of $100 to achieve these goals. Thus, our interactive website solves the problem and lets students attend the lab from the comfort of their own home. Our mission is to provide the same type of interactive experience a student or anyone interested in 3D printing would experience if the lab was in-person. Our product allows students and the general public to acquire the knowledge necessary to print objects on their own, which would have otherwise been unavailable.

This report will provide an overview of the design thinking process as our website possesses interactive and self assessment qualities that other websites cannot offer. Our team has fully identified all the needs of our client CEED. The empathise step of the design thinking process was utilized through meetings with our client and we decided to prioritize the needs accordingly. The first priority of the product is to be interactive and replicate the TA and student interaction as much as possible. The second priority is to make the website aesthetically pleasing and accessible to anyone on all platforms. The third and final priority is to provide feedback to the student at the end of the lab session. The goal for ranking these priorities was for the sole-purpose of the student retaking the self-assessment quiz until they are satisfied with their grade after they go through the lab sections they think they know the least about. After a general

design was chosen, prototypes of different levels of detail were built to improve spatial understanding of the design. Then, the last stage is where we tested our prototypes.

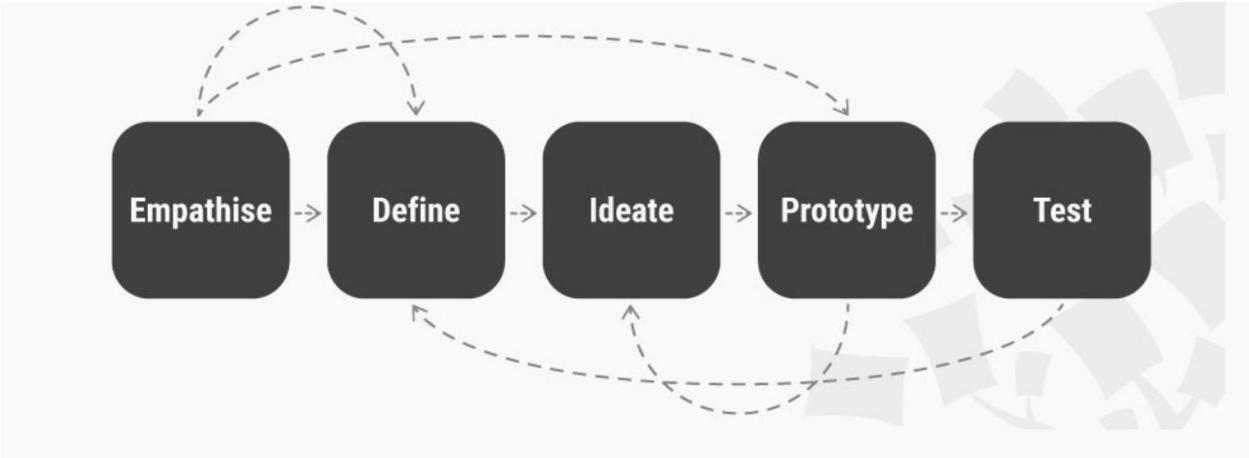


Figure 1. The Five Engineering Design Process Steps

Problem Statement

On the 15th of May 2020, we met with the client, CEED, to discuss the development of online platforms to replace the in-person labs and workshops. The University is facing a challenge as COVID-19 forced all classes and facilities to shut down and move online. With the information that we gathered from our client, we developed the following problem statement: “A need exists for the University of Ottawa’s CEED program to teach students how to apply technical engineering knowledge and machine operation through an online learning tool which is interactive, user-friendly and is available on all platforms”. After meeting with our client, we discovered how our customer wants the product to perform. However, customer needs are non-technical, and they reflect the customers’ perception of the product, not the actual design specifications.

Primary Goals:

1. To keep the product focused on customer needs.

2. To identify not just the specific needs of the customer, but also the latent needs.

This can be done as follows:

- Gather raw data from customers
- Interpret the data in terms of customer needs
- Organize the needs
- Establish relative importance of needs
- Reflect on the Process

Without the customers' input, it would be impossible to identify their needs. The goal is to elicit an honest expression of needs, not to convince the customers of what they need but to use the data we collect to serve as guidelines for product development.

Fundamental Needs

Customer needs identification defines the problem that we engineers need to solve. The most significant defect a product can have is not satisfying the customer. We have built a product that would meet the specifications of the customer, and any extra features that did not contribute to the customer's appreciation of the product were avoided.

Priority ranking:

Scale:

1. Necessary
2. Important
3. Useful
4. Optional

Needs identification:

Table 1. Ranking of Customer Needs

Needs	**Ranking**
Students and users get full knowledge as from an in person workshop	Necessary
TAs or instructors should be capable of understanding how it works easily to provide assistance	Necessary
Very interactive environment with a priority on questions and answers	Necessary
Informative	Necessary
Length of online learning session is less than 90 minutes (length of a lab session)	Necessary
Product Cost is around a 100$	Important
Students (or users in general) pay 20-30$ maximum to get access	Important
An introduction video as a prelab to ensure that students have an idea about the beginner 3D printing before coming into the lab	Useful
Bilingual content	Optional
Mini quizzes to allow students test their understanding	Optional
Bank of pre asked questions to allow user to get answer right away	Optional

Product

Features

- Has six different lab sections.
- Each section possesses a *Questions and answers section*.
- Includes informative videos that are relevant to their own section.
- A self assessment quiz finishes off the previous sections and tests students on their understanding of their new found knowledge.
- *A 3D printing service section* is also included to provide extra fun knowledge on 3D printing which is not necessary but important to note when learning about 3D printing.
- The last section the websites features is a *contact us section* which allows students to get in contact with a CEED TA if they still have any questions regarding the lab or its content

Functions

- Teach the basics of 3D printing.
- Teach the basics of using Tinkercad and Ultimaker Cura
- Replace in-person 3D printing workshops and at the same time, providing full knowledge-based labs.
- Mimic TA and student in-lab interactions.
- Provides self assessment quizzes for users to test their knowledge.

Capabilities

- The site can be viewed on any device with internet access.
- Can be completed in any order and can be finished at the student's pace.
- The site can be edited by the designers at any time using google sites.

Product Development

Our team developed our product in steps. We first started off by making a flowchart diagram which would help us dictate how the website was going to be broken down into sections and which sections we would pick to develop as prototypes.

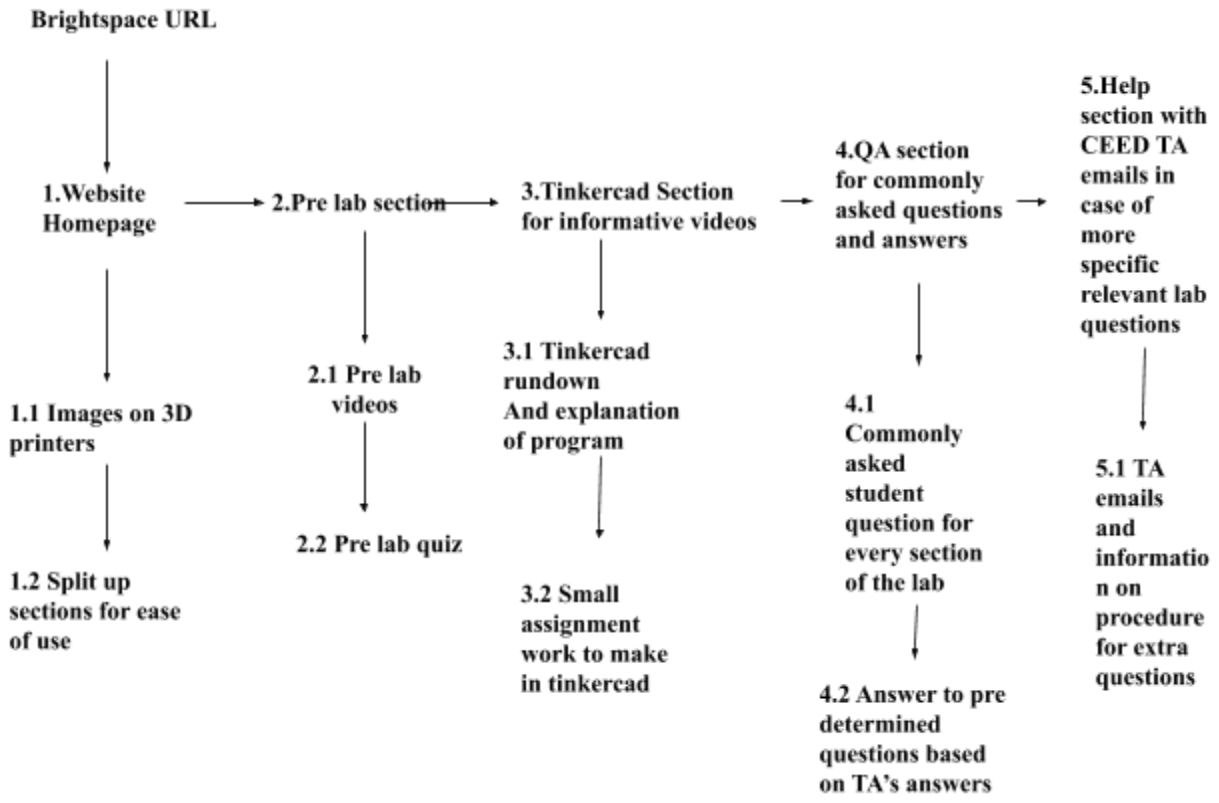


Figure 2. Flow Chart Diagram

Conceptual design:

Each team member developed three concepts for our interactive 3D printing website. Each team member's concepts(three) were evaluated using design criteria and only one concept was then selected. After this, our team evaluated all five concepts and came up with a final concept which ended up being a mix of two of our team members' concepts.

Tristan concept (Question and answers section)

The QA style interactive part of the beginner 3D printing tutorial will be based around the fact that the student wants to get answers to his or her question while watching certain segments of the tutorial videos. This concept will be aimed towards having predetermined questions and answers for seperate parts of the tutorial videos. This will allow the student to have instant answers and will deepen their understanding of certain tasks and concepts related to 3D printing. This QA style interaction is aimed at mimicking what a student would ask a TA during a 3D printing lab and having an answer based on what the TA doing the lab would have said.

Haneen's concept (An android and iOS supported mobile app)

This concept features a mobile app that can be downloaded by students and users through their mobile phones or tablets. The app will feature interactive games, videos and tutorials that will provide the user with the required beginner knowledge of 3D printing. The app will also provide mini quizzes for the users to test their knowledge.

Sankalp's concept (Local Library Website)

This concept involves the idea of learning the fundamentals of 3D printing via a collaborative partnership between local district libraries and universities, whereby students can log in with their uOttawa emails on a local library webpage and be assessed on basic operations, Solidworks, standard VR and the setup of 3D printers through step by step video tutorials, culminating with a small quiz to assess student learning. Upon completion, students can refer to their local library by appointment and have their 3D concepts quickly reviewed by an expert and processed in the library itself. This ensures that students can learn and experience the first-hand operation of a 3D printer despite not being on university campuses.

Divines concept (Website)

This concept enables contents such as texts, images, powerpoints and videos to be displayed on the internet. Representative websites are used for various purposes like to inform potential customers about products and services, to represent the company, to enable contact with different departments, for learning purposes in universities or to distribute goods online.

Can's concept (Collaboration with educational platforms)

This concept features a paid collaboration with well-known educational platforms such as CheggStudy, CourseHero,Skillshare etc. After the subscription to these websites are finalized, the user gains access to the beginner 3D printing module and starts to learn it via quizzes, interactive lectures with polls and tests. In general, these platforms are pretty cheap around 12-15

$ a month and even some of them are free like Khan Academy. After they've finished the exercises on the platform, it'll automatically transfer the grade to Brightspace.

Concept evaluation

Table 2. Concept Evaluation

Criteria	Weigh t	Tristan's concept	Haneen's concept	Can's concept	Divines concept	Sankalp's concept
Interactive	**30%**	**5**	**5**	**3**	**5**	**5**
Cost for student	**15%**	**5**	**3**	**2**	**5**	**5**
Cost for developpement	**10%**	**5**	**2**	**3**	**5**	**3**
Informative	**20%**	**5**	**5**	**3**	**5**	**3**
Aesthetic	**10%**	**3**	**4**	**3**	**4**	**4**
Easy to use	**15%**	**5**	**5**	**3**	**5**	**4**
Total points	**100%**	**4.8**	**4.3**	**2.85**	**4.9**	**4.8**

After running each concept through our design criteria table we decided to pick a combination of Tristan and Divines concept. Even though Snakalps concept was just as valid, the practicality of the concept during the COVID-19 pandemic led us to go with a more realistic approach.

Chosen concept (Website + QA sections)

Divine's concept provides resources in form texts, images, powerpoints and videos to be displayed on the internet. Tristan's QA style interactive concept integrates into this idea by being put onto the website after the online videos CEED has already created. The interactions are based upon the fact that the student wants to get answers to his or her question while watching a certain segment of the tutorial videos. This concept will be aimed towards having predetermined questions and answers for seperate parts of the tutorial videos. This allows the student to have instant answers and will deepen their understanding of certain tasks and concepts related to 3D

printing. This QA style interaction is aimed at mimicking what a student would ask a TA during a 3D printing lab and having an answer based on what the TA doing the lab would reply.

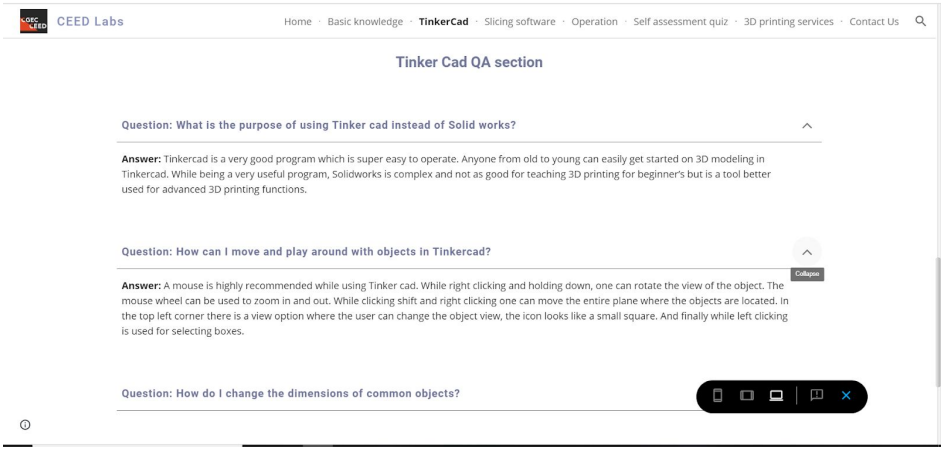
Prototype 1

Our first prototype is a *Questions and Answers section*. In this prototype, we will break down each section of our website and interview students to see what typical questions they would have for each section. After that, our team discussed the best possible answer to each question to ensure the student had full comprehension of each section before moving forward into the next section of the lab. This was the first prototype, therefore constant re-evaluation and work was done in the QA section of our webpage. Further questions and answers were added to help improve how informative that part of our concept was.

How it works

- Students will enter the QA section and will select a section they wish to have an answer to.
- Then, they will click on a commonly asked question and receive the answer instantly in the form of a drop down text window.
- After successfully getting the answer the webpage will take into account how many times a specific question has been accessed.
- The student will be able to access the QA section of the website at any time.
- If they have further questions on a section, they may address those questions to the TA in the *help section* of the website.

Demonstration of Prototype 1



Prototype 1 Testing

Prototype 1 Testing:

Criteria #	Criteria	Units	Target	Person #1	Person #2	Person #3	Person #4
1	Informative	1-5 points	5	4	5	5	4
2	Easy to access	1-5 points	3	4	4	3	4
3	Interactive	1-5 points	5	5	5	5	5
4	Easy to use	1-5 points	3	3	3	3	4

Point system:
1-Failed to meet requirements
2-Marginal
3-Okay
4-Acceptable
5-Meets requirement

Figure 3. Prototype 1 Testing

Testing goal

To evaluate the QA sections to check for pertinent and informative questions.

Testing outcome

Interviewed customers deemed the QA sections informative and easy to access. Because of this retroaction we implemented a QA section into each lab section.

Prototype 2

The goal of our second prototype is the completion and development of our website homepage and lab sections. The completion of the lab sections will also give us direct feedback on the content of these sections. This will allow us to know if each user is getting all the information necessary to complete the CEED beginner 3D printing labs and will tell us if the website is interactif enough for each user's liking. This feedback will determine what changes need to be

made to our lab section and therefore is crucial for the completion of our final product. The completion of the website will evaluate where we are at in our overall workload.

How it works

With this prototype we are aiming to have the overall lab broken down into subsections which allows students to easily complete the lab in chronological order or allow users to roam as they please. Its purpose is to fill each lab section with informative videos, interactive QA sections, fun assignment and extra information regarding 3D printings applications and services and also to test the functionality of our website and conduct surveys with other students to see if they like the way the website is formated.

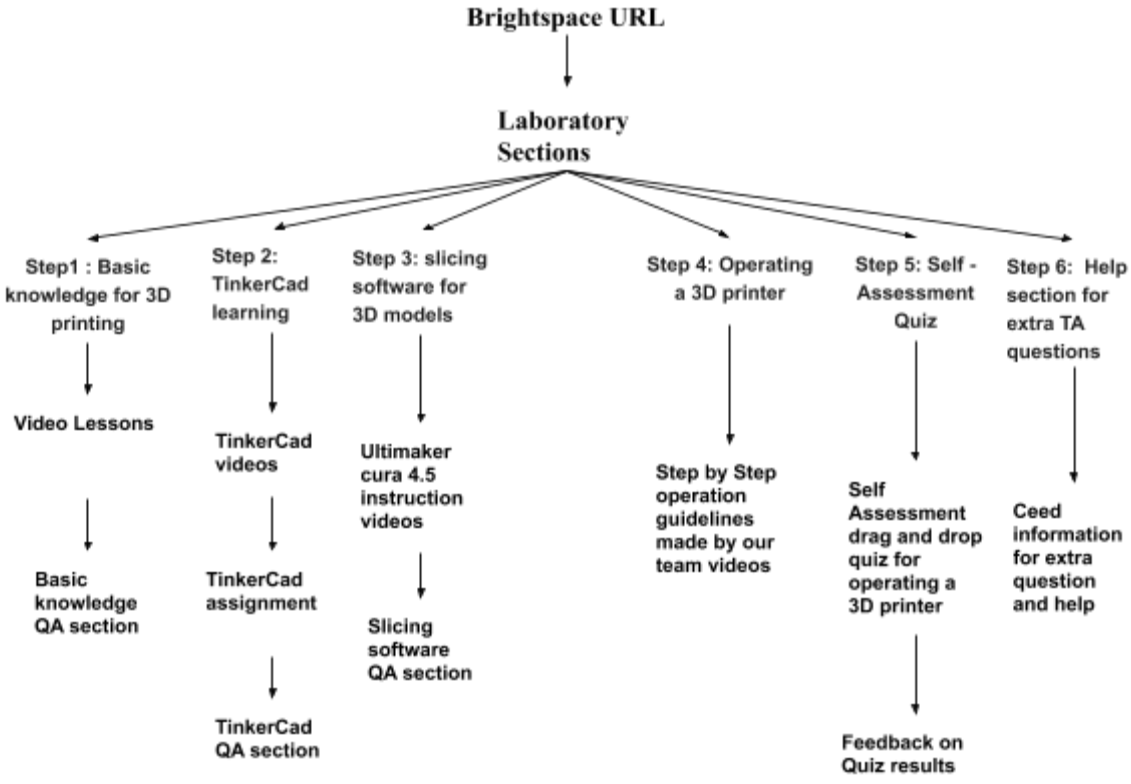


Figure 4. Updated Flow Chart Diagram for Prototype 2

Demonstration of prototype 2

Figure 5. Website Homepage

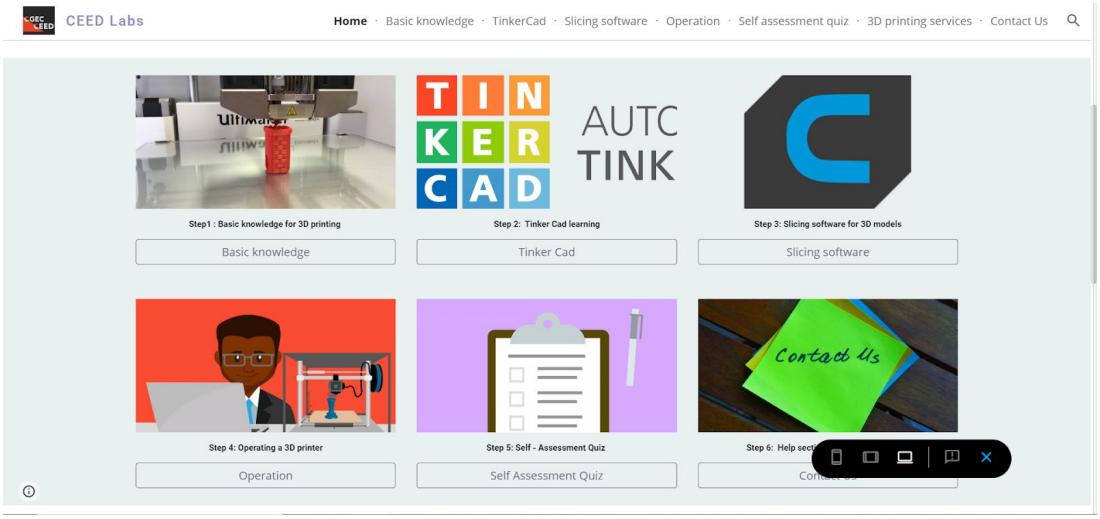


Figure 6. Website Lab Sections

Figure 7. Website Extra Information

Prototype 2 Testing

Criteria #	Criteria	Units	Target	Person #1	Person #2	Person #3	Person #4	Person #5
1	Cost of prototype	Can $	< 30$	0	0	0	0	0

Figure 8. Prototype 2 Testing

Testing goal

To test if the website is interactive, informative and easy to operate.

Testing outcome

Interviewed customers deemed the webpage easily accessible, cost efficient, interactive, easy to use and very informative

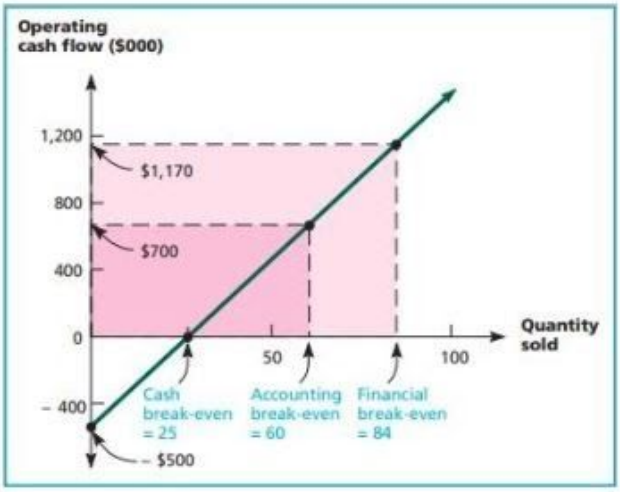
Economic Prototype Analysis

NPV analysis/ Break even point

	A	B	C
1	NPV Break Even Analysis		
2			
3	Price	45	
4	Demand	2500	
5	Unit Cost	30	
6	Fixed Cost	1750	
7	Revenue	112500	
8	Variable Cost	75000	
9	Total Cost	76750	
10	Profit	35750	

Break Even Analysis done in Microsoft Excel

Cash flow, Accounting and Financial break even points signifying our operating cash flow for running our online interactive 3D service.



Final prototype

The goal of the third and final prototype for our project was to finish and refine our site so that it would be fully functional by design day. The third prototype consists of an online platform that students can access via a link posted in brightspace. After selecting the link it will bring them to the websites homepage where they will be directed into the lab sections. The lab sections are in chronological order and placed in such a way that the level of difficulty rises through the sections. Each section includes informative videos and a QA section. After completing all lab sections the student will then complete an online self assessment quiz designed by our team. This will provide them with the feedback necessary to show them how much of the lab they understood and if it is necessary for them to revisit sections. After finishing up the self assessment quiz the student is free to roam as they please as they are finished with the beginner 3d printing CEED lab.

Demonstration of the final prototype

Our third and final prototype is a fully functional website that completely replicates physical lab experience for the CEED 3D printing beginner lab. This online domain both fundamentally introduces users to the basic operations of a 3D printing build and provides vivid examples users can run through for a brief production overview (or potentially some building motivation).
To access the lab, click on the link below:
https://sites.google.com/uottawa.ca/3dprinting/home?authuser=1

Product Maintenance

- Updating the site by posting recent changes or news to make the business more likeable to our users.
- Fixing the homepage, navigation bars, headers, logo, and images from time to time.
- Reviewing our website content frequently to ensure our customers are engaged effectively.
- When CEED takes our interactive website online, optimizing our website for SEO (search engine optimization) is an important process that will help deliver a consistent flow of traffic to our site.
- Creating a sense of community for the purpose of making our customers feel most connected.
- Reaching out to other people to make sales by using social media to promote our website for free.

Health And Safety Guidelines

- Staring at a computer screen for too long can cause:

  -Eyestrain

  -Cyber sickness

  -Blurry vision

  -Trouble focusing at a distance

  -Dry eyes

  -Headaches

  -Neck, back, and shoulder pain

- To protect your eyes after staring at the computer screen for a long time:

  -Make sure your glasses or contacts prescription is up to date and perfect for staring at the screen for a long while.

  -Move the screen so your eyes are at the same level with the top of the monitor. That lets you look slightly down at the screen.

  -Choose a comfortable, supportive chair. Position it in such a way that your feet are flat on the floor.

  -Try to avoid glare from windows and lights. Use an anti-glare screen if needed.

  -If your eyes are dry, blink more or try using eye drops.

  -Rest your eyes every 20 minutes. Look 20 feet away for 20 seconds. Get up at least every 2 hours and take a 15-minute break.

- To increase your computer's security, try to use the incognito window even though our website is fully secured (lock sign).

Troubleshooting / Technical instructions

The probability of technical or operational failure of our product is extremely low. The only possible problem, with a low probability of occurring is that the user could experience crashing of the website due to multiple users running it all at the same time. In this case, the user is advised to exit and restart the website. If the user still encounters this problem after following those steps, the user is then advised to contact an instructor through our *contact us section.*

Design files

All design files are accessible in Makerepo with the link below:

https://makerepo.com/Brady/beginner-3d-printing-laboratory

This link will provide a relevant summary from all group deliverables of our greenhouse during the semester.

Conclusion

In conclusion, we have worked for three months on developing an online platform to replace the in-person beginner 3D printing workshops. Our group has overcome many obstacles and internal conflicts which resulted in teaching us more about group work and product development. Our group became skilled in website development though listing prototypes followed by testing and evaluating them. Our group also learned project management through scheduling, distributing tasks and producing weekly gantt charts. Finally, our project got to recognize that some things cannot be done alone but in a group and we also got to understand the importance of diversity and different personalities within a single group.

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Appendix

Glossary

Term	Definition
Domain	A domain name is an identification string that defines a realm of administrative autonomy, authority or control within the Internet.
Empathise	It involves consulting experts about an area of concern through observing, engaging and empathizing by asking open ended questions (interview) with clients to gain empathic understanding of their experiences and motivations.
Define	Involves putting together the information created and coming up with the problem statement.
Ideate	It involves creating a solution to the problem already identified, getting feedback from the client and adjusting the problem statement if need be.
Prototype	Inexpensive versions of a product for the purpose of re-investigating and improvement on the basis of the client's feedback.
Test	Alterations and refinements that are made in order to rule out problem solutions and derive as deep as understanding of the products, its users and conceive a solution.
Webpage	A collection of web pages and related content that is identified by a common domain name and published on at least one web server.
Business Model	A design for the successful operation of a business, identifying revenue sources, customer base, products, and details of financing.
URL	Stands for: Uniform Resource Locator. A domain name is part of a URL.