TAYLOR'S UNIVERSITY

Wisdom • Integrity • Excellence

School of Engineering

PRJ60403
Design and Innovation

Final Report

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Introduction

Challenges

For this Engineering project, we have identified that film photography is increasing in interest among enthusiast within the photography hobby. With the increasing interest, we see that the process for processing the film and printing the photo from the film is expensive. We see that there is potential Business Value by allowing users to process their own films at home, reducing the overall cost of the process to allow for newcomers to try this new hobby without spending too much money.

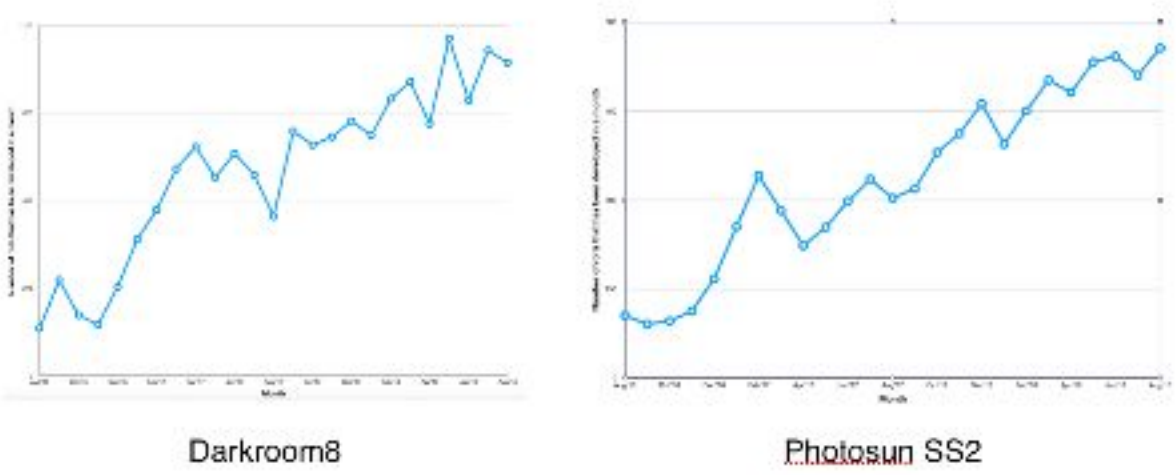

Figure 1: Graphs shows the increasing interest in film photography

We have gathered data from photo labs to confirm that there is a increase in number of people shooting film. Not only professionals are shooting film nowadays, curiosity of amatuer photographers that just got into photography causes them to explore the beauty of shooting film. Partly is due to the influence of professional photographers that make them realise the possibilities to capture something that is not capable when using a digital camera.

Film has higher dynamic range compare to digital cameras. Image can be post process more freely when the dynamic range is high because detail from the shadows and highlights can be pull back in post. This is crucial when shooting an outdoor landscape with strong sunlight where the sky is about few stops of light greater than the ground. Photographers will usually expose for the shadow when shooting with film because film has a greater latitude towards the highlight. Hence, detail in the sky can be recovered. While on digital, due to the lower range in dynamic range, photographers tend to shoot multiple images with different exposure and stitch them in photoshop in order to create the same effect as film. Even that, the result on the digital are still not as good as the one on film according to some senior photographers.

The fact of more and more people are shooting film can also be backed up by companies like Kodak and Leica.[1] In March 2012, Kodak has discontinue their famous Elitechrome. This upset many professional photographers that were still using film that time. Due to the number of request and feedback from the film community, Kodak has revived its Elitechrome film this year.[2]

Leica has noticed the growth in interest among film photographers. Beside professionals, beginners starting to look for film cameras and related accessories. In late 2016, Leica has launch their new fully mechanical film camera, the Leica M-A in order to satisfy the market. With the evidences stated above, the popularity in film photography will only rise in the future.

Bellamy hunt or famously known as Japan Camera Hunter is a film enthusiast based in Japan. He has came out his own formula for a black and white film, JCH StreetPan 400 in early 2016. Since then, it has influence many photographers to went back shooting film despite the fact that film is a little bit more inconvenient compare to digitals.

Besides, Hollywood cinematographers are still using films to shoot recent blockbuster movie such as Movies such as Mission Impossible: Fallout, Interstellar, Star Wars: The Last Jedi, Justice League and etc. [3] Cinematographers noticed the beauty and benefits when shooting with film and willing to sacrifice the inconvenient of it. Some cinematographers even claim that film gives a better skin tone and it's able to produce the emotion that they craved for in their project. [4]

Based on the current pricing that film processing labs are charging users to process films, we think that we are able to cut the cost of user significantly by allowing user to process films at home in a safe manner. Some users may find it troublesome to send the film to the photo lab that require to be developed.

Business Value

According to the survey that we have gotten from the public, it is clearly shows that the average cost of production is RM20 if it is produce under commercial lab, but with DIY film developing device, it will cost not more than RM4, so it can says that it has a huge reduction of cost.

Since it is an DIY film developing device, there must be a reduction on **days of inventory**. According to the survey, commercial lab took at least 1 week to produce the product but with DIY film developing device, it only took less than 1 hour to produce the product that the user want.

Besides that, the business value exist in this creation is **headcount reduction/avoidance**. In the commercial lab, they need workers and manager to work in the lab, and there will be labour fees for them as well. For DIY film developing device, it can avoid the workers and manager, it just need the owner itself only.

Furthermore, DIY film developing device also have a business value of **unit cost & other cost avoidance** such as labour fees, transportation fees, toll fees and many more. Sending the product to the commercial lab require all these resources and need additional money, but DIY film developing device can just finish up the final product in your house, so why trouble yourself when you can do it on your own in your house.The summary of the business value is shown on table 1.

	Comercial lab	DIY film developing device
Average cost to develop a single roll of film	RM20	RM4
Time taken to get a roll to developed	~ 1 week	< 1 hour
Accessibility	Depends on user's location	At home

Figure 2: The comparison between commercial lab and DIY film developing device

Analysis of Design Thinking Technique

Observe

Before we have our idea, we first observed the market on where is it now and what can we improve on it in the market. So, we decided to go into film industry and we have made an observation on the current film industry and made up our idea on creating a DIY film developing device.

Upon observation, we have conducted two methods. First is having an **interview** with the professional film photographers. One of our team member had ask them about the future of film industry. He also manage to get some feedback on the industry problem, such as most of the people are lack of knowledge on film developing. The professionals are charging at a very high price because the process of the film processing is costly and time consuming undergoing the old method of developing film.

Second method was **be the user**. One of our team member is a film photographer and he manage to experience how does film developing device works and brings the benefit of it as a user. Based on his observation, he says that he really used up a lot of time on developing film, because he need to spent time on traffic jam, unnecessary money on additional stuff such as petrol, toll when you can develop own film at home is not yet been discovered.

After recording down all the observations, we are clearly know that having the idea for DIY film developer device is good and be a benefit to all the film photographers and other users as well.

Understand

The Ishikawa Diagram is apply by our team to understand the challenge we face while brainstorming the idea of this DIY film developing device.Hence, we have come out a diagram on everything that need to be consider in Figure 1.

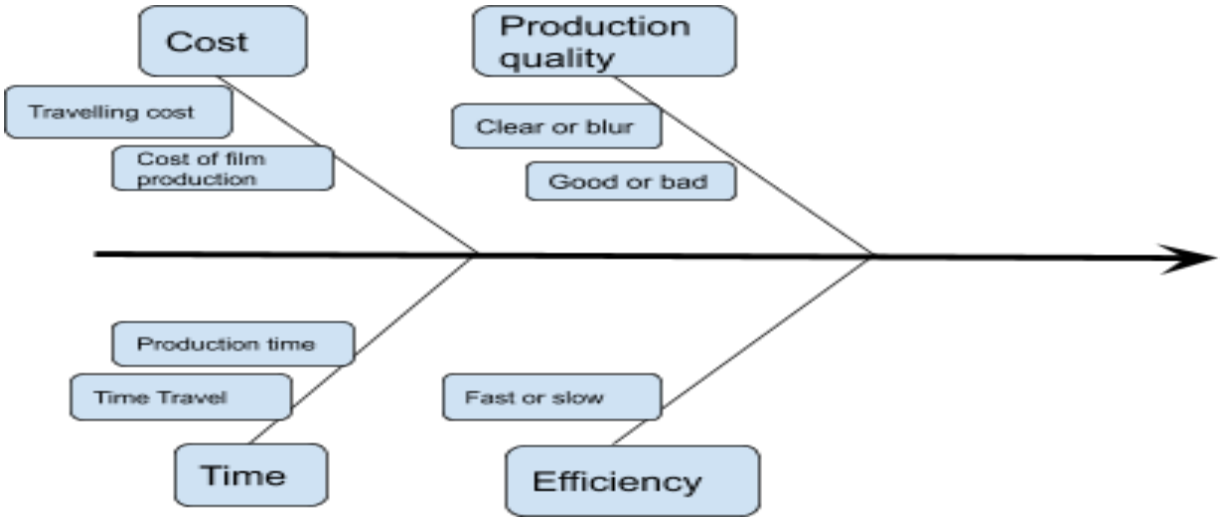

Figure 3: The Ishikawa diagram of DIY film developing device

According to the diagram, cost is the first to discuss. For a professional film photographer, travelling cost and film production cost has been a big issue to them. Some film photographer does not earn as much as the professional, hence they still need to pay for their travelling cost and production cost which gives them quite a headache. So, with the DIY film developing device, they can save up these cost without subsidizing additional money.

Production quality is the second most important and considerable for professional film photographer. A professional film photographer must be very particular to their quality of product, because poor quality of product will ruin their reputations. Commercial lab has good quality production but their process time is long. DIY film developing device may not be as good as the quality from the commercial lab, but it is good enough for professional film photographer to accept the quality they want. Why so difficult when you can get a similar quality of product by producing it in your house rather than going to the commercial lab.

Time consuming is also another problem every professional film will face. Commercial lab spend more than one week to finish the production but for DIY film developing device, it take less than 1 hour to finish the production, it is a huge difference of production finish time Not only that, the time travel is also been neglected if they have a DIY film developing device in their house, so the professional will finish their product fast and easy.

If the professional will like to neglect the time of production, but they must not neglect the efficiency of the commercial lab. Usually commercial lab has many customers, so it will be a long queue before you and when you need it urgently, it is a bad thing for the professional. DIY film developing device can solve the problem because it is yours and you can use it whenever you want.

Ideate

The main purpose of the create a film developing device that can process films in the comforts of our own home. The device conceived has to reduce unnecessary costs like transportation and time wastage while also maintaining equal or higher quality developed film. Several ideas were brainstormed as to how can the film developing process can be compressed and streamlined to allow even the layman to understand its usage. Using the concept of being able to develop film in a contained device as a focus, the team settled on creating a apparatus that can contain and release the chemicals needed to develop film like the developer and fixer, as well as an extra container for water that can be used to rinse out excess chemicals on the film after developing.

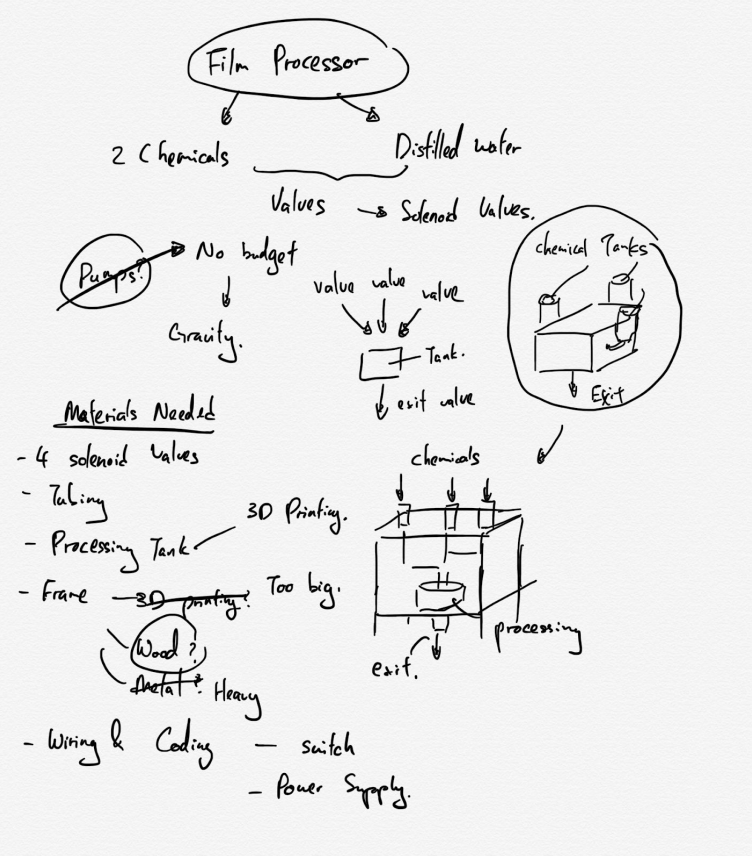

Figure 4: Brainstorming process

Alternative lateral thinking is used to further improved upon the initial idea and design. As the purpose of the film developer is to simplify the process of developing films, an extra function to reduce the workload of the user can be implemented. In this line of thinking, two methods are considered to be included in the prototype, either manual activation or automation.

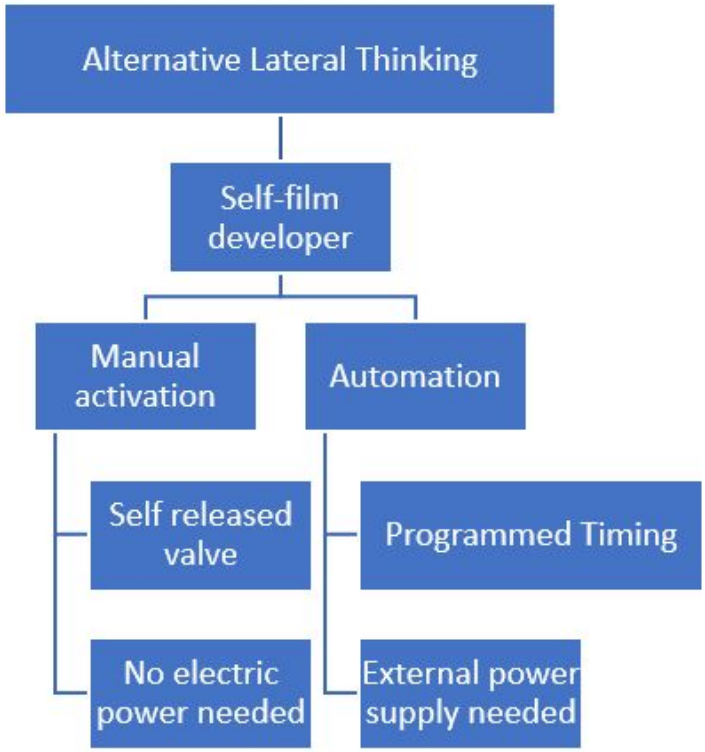

Figure 5: Alternative lateral thinking technique

In the end, after evaluation of the proposed methods, the team has decided that automation suits the purpose of our device more and overall brings more functionality and convenience. Although an extra challenge in programming and acquiring a suitable power source presents itself with this method, the benefits have been determined to outweigh the downsides.

The idea and design we came up with were thoroughly tested and verified using the Six thinking hats technique.

Blue hat (Ground rules)	The device is set on a timer system, with the developing chemicals and fixing chemicals automatically releasing and draining on a pre-programed setting.
Red hat (First impression)	Film Developer that can be used at home is novel and can help new users to try the hobby themselves at home without spending too much money.
White hat (Factual information)	The chemicals and water are held in containers with solenoid valves used to both allow an outlet and to prevent unexpected leakages. The valves are programmed using Arduino and released at specified timings.
Yellow hat (Pros)	The film developer that can be used at home can help reduce the cost for the user as well as introduce the hobby to more users that are sceptical of the hobby.
Black hat (Cons)	The upfront cost will be expensive but the user will benefit more the longer they use the product.
Green hat (Outside the box)	The film developing device is a contained system, removing the need for a darkroom to develop films. The entire developing process can be completed within the device.

Table 2: The six hats thinking technique

Prototype

Design of the processing tank has been heavily brainstormed during the initial phase of the project. The design is visualised in Solidworks to help the team to understand the design and direction the team has planned. A processing film requires multiple chemicals which are required to soak the film and to rinse it after the chemical has reacted with the film. In order to allow for chemicals to flow in and out of the processing compartment smoothly and efficiently, solenoid valves are used to aid the flow of the fluids in and out of the system. These solenoid valves are wired through a mosfet that will be connected to the arduino board. This allows for the programming of the arduino to allow for timing to fully automate the film processing.

First iteration of prototype

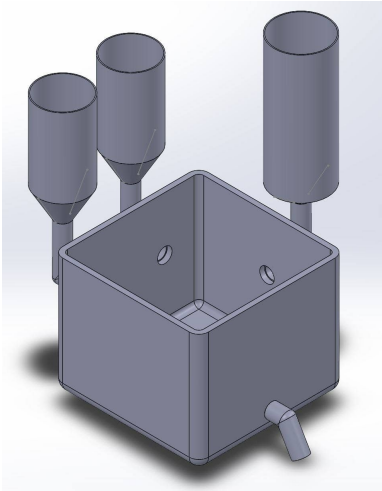

Figure 6: First iteration design

The first iteration of the prototype is relatively simple. Two tanks align linearly on one side and a slightly bigger tank is use to contain water is on the other side. The tanks is then connect to the main developing tank via PVC tube. Solenoid valves are installed in the tube and coding is done to set which chemical or water is going to release into the main developing tank for developing.

Problem

The water that need to be loaded in the water tank is estimated to be 3.5L which is about 3.5kg. According to the simulation, the PVC tube will experience a great amount of stress than it can handle when the tank is loaded with 3.5kg of water which is around 34.335N. It experiences a maximum equivalent stress of 16.37 MPa of the bottom of the PVC tube. The Yield tensile strength of PVC is 15 MPa and it has a safety factor of 0.916N. In that sense, the PVC tube will break when it is loaded with 3.5L of water because it has a safety factor of less than 1.

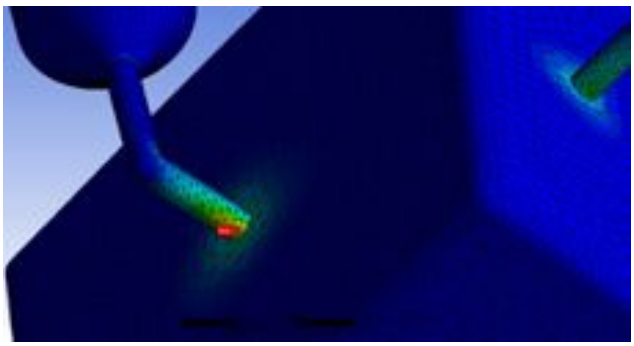

Figure 7: Maximum stress on the tube

Second iteration of prototype

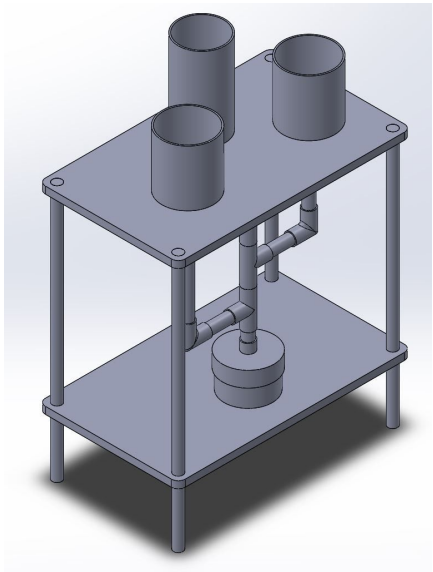

Figure 8: Second iteration design

We had designed a new prototype from scratch. The second iteration of the prototype has improved ergonomic and structure than the previous design. The previous design experience relatively high stress when the water is loaded into the water tank. The previous design has a safety factor of less than 1 when the tank is loaded and it may cause breakage and it will not be safe to use. In our second iteration, a frame made of wood is built for the chemicals and water tank to rest on top of the surface. This design is more feasible as it has a frame to support the tanks and the tubes. The main developing tank has been redesign as well. It is now light tight and has a better design to load the film in without causing any kind of light leak.

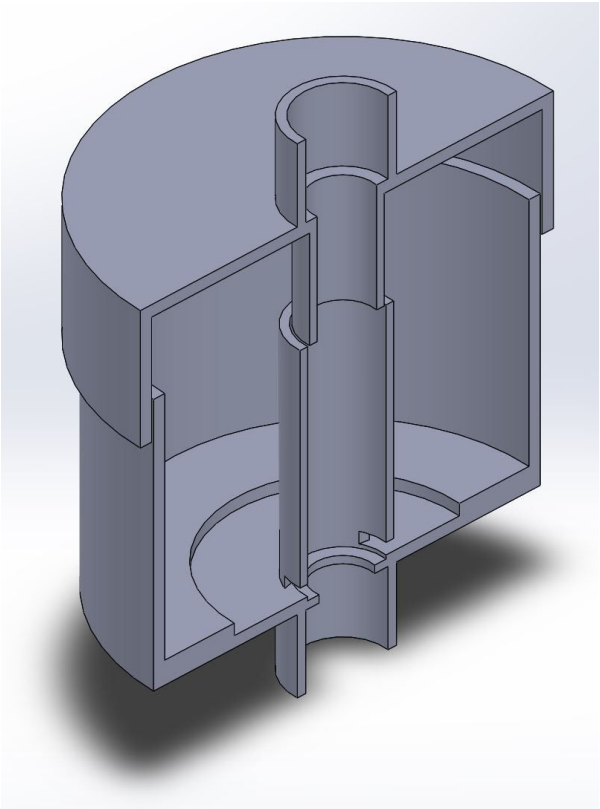

Figure 9: Main developing tank

The main developing tank consist of 2 parts, the lid and the body. The top of the lid is connected to the main PVC tubing which has 2 chemicals and 1 water tank chanels to it. When the valve is in its open position, the chemicals or water will flow through the opening at the bottom of the main tank body. The film will then be soaked in the tank for the chemical process to take place. After each step is done, the fluid will then drain out from the drain pipe where the valve connects to the bottom of the main developing tank will be opened. It will then close after all the fluid has been drained out from the main developing tank. This is to make the main developing tank water tight again in order for the next chemical to be released in.

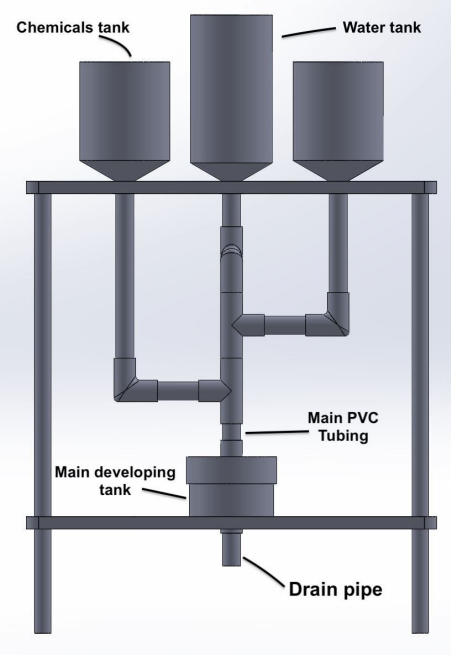

Figure 10: Overall view of device

With having the film processing system fully automated, the user will be able to delegate time to other matters rather than hasling with processing the film themselves. This allows the user to save time as well as saving money with the film processor. Fully automating the system can also help the user to reduce the time in contact of the chemicals if the user is not confident around chemicals. This helps ensure that the user is safe when operating the film processor.

Project Review

Cost

Part #	Item	Description	Qty	Source	Unit cost	Cost
1	Arduino UNO R3	Input voltage : 5V~12V DC Output voltage : 5V DC	1	robotedu.my	RM24	RM24
2	Solenoid Valve	Input voltage : 24V Power : 15W Current : 1.25A	4	Carousell	RM26.30	RM105.20
3	On/Off sensor Switch	Size : 11*22mm Voltage : 3.5V, 5V	4	Carousell	RM8	RM32
4	Jumper wire	Length : 0.3m	12	Lowyat	RM0.50	RM6
5	Drone servo	Dimension : 70*35mm	1	robotedu.my	RM35	RM35
6	Solderless Breadboard	400 tie holes	1	Carousell	RM3.30	RM3.30
7	PVC Fitting PT SOCKET	Thread material : Copper Size : 15mmx1/2”	4	Lazada	RM9.80	RM39.20
					Grand total	RM 244.70

Table 3: The Bill of Materials

Timeline

Table 4: Comparison of planned Gantt chart and actual timeline

WBS Code	Activities / Number of weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.0.0	**Understand and Observe**														
1.1.0	Project Research														
1.1.1	Identifying Challenges based on Business Values														
1.1.2	Gather Information from Sources														
1.1.3	Initial Concept and Identify Challenges														
1.1.4	Discuss the root cause of challenges														
1.2.0	Project Investigation														
1.2.1	Brainstorming ideas														
1.2.2	Selection of ideas														
1.2.3	Planning timeline of work process														
1.2.4	Drafting proposal														
2.0.0	**Ideate**														
2.1.0	Drawing & Modelling														
2.1.1	Rough sketch of the design														
2.1.2	Finalizing design														
2.1.3	Detailed design by using Solidworks														
2.1.4	Further research on materials														
2.1.5	Deciding on materials														
2.1.6	Submission of project proposal														
3.0.0	**Prototype**														
3.1.0	Construction														
3.1.1	Purchase of materials														
3.1.2	Construction of base and frame														
3.1.3	Connecting pipes and valves														
3.1.4	Completion of manufacturing phase														

3.1.5	Connecting wiring system														
3.1.6	Coding system														
3.2.0	Performance Modification														
3.2.1	Functionality testing														
3.2.2	Safety and risk testing														
4.0.0	**Enhance**														
4.1.0	Final changes and modifications														
4.1.1	Prototype final testing														
4.1.2	Coding final testing														
4.1.3	Minimize the modification of prototype														
4.1.4	Engineering Fair														
4.1.5	Drafting Final Report														
4.1.6	Submission of Final Report														

KEY:

Deadline	
Planned + Accomplished	
Delay + Accomplished	
Additional task	

According to our planned Gantt chart, the team's overall progress is good as most of the tasks were completed within the planned time frame. The blue highlighted boxes represents tasks that the team has planned and accomplished within the time planned while orange highlighted boxes represent tasks that are delayed from the planned timeline but were completed after some time. Deadlines are indicated as red highlighted boxes while purple highlighted boxes are additional tasks that is not proposed in the planned Gantt chart at first.

Project research and project investigation were completed within the time planned on gantt chart. Idea was accepted as it has high business value which members had researched on and got accepted by the lecturer.

Some delay has occurred for the first 2 weeks the team was trying to finalize on a design that was feasible and the team agrees on. Researches were done accordingly to get the finalized design. The project also had to be delayed as the team had to wait for the 3D printed material to be printed for testing. This can be improved by printing the 3D plastic earlier.

Purchasing of materials was delayed for 1-3 weeks as the finalization of designs was delayed. Due to the delaying time for the team members to purchase the materials, the overall construction for the prototype was affected and delayed. However coding was not affected is because the codes can be written and tested without the need of the actual prototype. The team managed to test for the safety and functionality of the prototype on time as the prototype had been done on the week before.

Furthermore, there is no delay on finalizing the coding and prototype of the system. The codings were finalized as testings were done accordingly. Final report was done on Week 13 which was on the right track.

In conclusion, although there were some delays on finalizing the designs, materials and constructing the prototype, but team members were able to complete the prototype within the 14 weeks time.

Project Task Distribution

Table 5: Linear responsibility chart

WBS Code	Activities / Name	NY	ZF	MZ	SL	JL
1.0.0	**Understand and Observe**					
1.1.0	Project Research					
1.1.1	Identifying Challenges based on Business Values	5	5	5	5	5
1.1.2	Gather Information from Sources	5	5	5	5	5
1.1.3	Initial Concept and Identify Challenges	5	5	5	5	5
1.1.4	Discuss the root cause of challenges	5	5	5	5	5
1.2.0	Project Investigation					
1.2.1	Brainstorming ideas	5	5	5	5	5
1.2.2	Selection of ideas	5	5	5	5	5
1.2.3	Planning timeline of work process	5	5	5	5	5
1.2.4	Drafting proposal	5	5	5	5	5
2.0.0	**Ideate**					
2.1.0	Drawing & Modelling					

2.1.1	Rough sketch of the design	5	5	5	3	3
2.1.2	Finalizing design	5	5	5	3	3
2.1.3	Detailed design by using Solidworks	5	5	5	3	3
2.1.4	Further research on materials	3	3	3	5	5
2.1.5	Deciding on materials	3	3	3	5	5
2.1.6	Submission of project proposal	5	5	5	5	5
3.0.0	**Prototype**					
3.1.0	Construction					
3.1.1	Purchase of materials	5	5	5	5	5
3.1.2	Construction of base and frame	5	5	5	5	5
3.1.3	Connecting pipes and valves	5	5	5	5	5
3.1.4	Completion of manufacturing phase	5	5	5	5	5
3.1.5	Connecting wiring system	5	4	3	1	2
3.1.6	Coding system	4	5	3	1	2
3.2.0	Performance Modification					
3.2.1	Functionality testing	2	3	4	1	5
3.2.2	Safety and risk testing	5	4	3	1	2
4.0.0	**Enhance**					
4.1.0	Final changes and modifications					
4.1.1	Prototype final testing	5	5	5	5	5
4.1.2	Coding final testing	5	4	3	1	2
4.1.3	Minimize the modification of prototype	5	5	5	5	5
4.1.4	Engineering Fair	5	5	5	5	5
4.1.5	Drafting Final Report	5	5	5	5	5
4.1.6	Submission of Final Report	5	5	5	5	5

5 Person in charge ~ 1 Assistance

KEY:
NY = Nick Yap Jin Teck
ZF = Lim Zi Feng
MZ = Tang Ming Zhao
SL = See Siew Lee
JL = Wong Jiun Liang

The table above is the linear responsibility chart that had been updated. The distribution of tasks were not much difference from the original planned linear responsibility chart. The purple highlighted parts were the additional task that is not inside the original planned of linear responsibility chart.

The additional tasks are the final report as team members need to finish writing the final report and hand in during week 13. The linear responsibility chart is making sure that every team member are doing their tasks and responsibility accordingly to ensure the project can be done in 14 weeks time.

Current status of prototype

The current progress of the prototype 80% complete. The construction of the prototype has been complete and the team is busy testing for leaks of the prototype. The team is also troubleshooting electrical issues regarding MOSFETs and their activation currents. The team might approach knowledgeable people in this area to help the team to troubleshoot other possible errors when troubleshooting the problems that the team is facing to finish up the prototype. The connections of the tubing has been sealed permanently with hot glue for the prototype due to the lack of experience of the team in regards to working with plumbing. The frame has been constructed out of wood and the whole frame has been coated with lacquer to prevent water seeping into the wood frame. Housing for the electrical wiring is also being constructed to isolate the wiring from the chemicals and liquids.

Economic Viability and Environmental Sustainability

The design of this film processor prototype is economically viable as the components used for the construction of the prototype is highly accessible and relatively cheap. Noticeable parts such as solenoid valves are the most expensive items in the project but the overall cost of the prototype is still cheap. The use of a wooden frame here helps to reduce the weight of the prototype and allows for easy handling of materials as dangerous equipement are not required to cut the frame into size.

The design of the prototype is somewhat environmentally sustainable as the frame of the prototype is constructed in wood. The team has coated the frame with lacker to prevent water seeping into the wood, causing the wood to mould. The mechanics of the prototype are mostly made of plastic to reduce the change of chemicals corroding the plumbing of the prototype.

Risk Assessment

Category	Risk	
Use of equipment without proper knowledge	Improper mixture of chemicals causing the chemicals to be too concentrated for the process. (15)	User spilling chemicals when diluting the chemicals for the process. (11)
Carelessness of users	Wrong technique of assembling the tubing to the processing tank will cause the prototype to possibly fall onto the user or might break. (20)	User might tear the wiring that is connected to the solenoid valves when attaching the processing tank. (14)
Improper schedule maintenance.	Frame collapsing due to poor coating on the wood, causing the wood to fail. (8)	Poor wood quality might cause splinters when user is handling the film processor. (15)

		Severity Levels (S)			
		I CATASTROPHIC	II CRITICAL	III MARGINAL	IV NEGLIGIBLE
Likelihood of Occurrence	A - Extremely Likely	1 (High)	3 (High)	7 (Serious)	13 (Medium)
	B - Likely	2 (High)	5 (High)	9 (Serious)	16 (Medium)
	C - Occasional	4 (High)	6 (Serious)	11 (Serious)	18 (Low)
	D - Unlikely	8 (Serious)	10 (Serious)	14 (Medium)	19 (Low)
	E - Extremely Unlikely	12 (Serious)	15 (Medium)	17 (Medium)	20 (Low)

Human Injury Risk Value	Category	Human Injury Risk Waiver Authority (Acceptance Level)
1-5	High	Component Acquisition Executive (CAE)
6-9	Serious	Program Executive Officer (PEO)
10-17	Medium	Program Manager
18-20	Low	As Directed

Figure 11: Risk assessment matrix

The risk of the film processor is categorized into 3 separate categories. Due to the nature of the project is targeted towards newcomers to the hobby, the team has to anticipate users that are not knowledgeable to the equipment and materials that the user will need to handle in order to process their own films. Improper dilution of the chemicals might cause the chemicals used for the process to be too concentrated. This does not oppose any risk to the user as the team has

tested the chemicals with the materials used for the project and concluded that the chemicals will not corrode the materials that are being used for the project. Improper dilution of chemicals can happen occasionally but the risk of the incident is negligible. Spilling of the chemicals might also happen as the user might be filling the film processor in a not safe manner depending on the placement of the film processor. Due to the diluted nature of the chemicals, the damage of the incident will be negligible. The team has had the chemicals spilled during testing and has observed no noticeable reaction on the human skin. Although precaution is still taken due to the chemical nature of the chemicals that are used for the process. Users are still advice to wash parts of body in contact with the chemicals thoroughly. Due to the marginal severity of the incident and its occasional likeliness, the risk of the incident is serious. It is advisable to wear gloves when in contact with the chemicals.

Carelessness of the user also needs to be taken into account when assessing the risk of the film processor. The user will be operating the plumbing most of the time while operating the film processor. Improper techniques while handling the plumbing might cause the plumbing to put too much force onto the processing tank which might cause the structure to fail and fall onto the user. This incident is highly unlikely due to the simplicity of the film processor.

Improper schedule maintenance of the film processor may also oppose risk to the user. This should be taken into account when designing the prototype. One of the incident that might happen is the frame might collapse on the user due to poor coating of lacquer causing the wood to root and the structure to be weaken. To prevent this the team has coated several layers of lacquer to ensure all surfaces of the frame are coated. Due to the nature of the risk, the risk is deemed serious and should be taken seriously. Poor wood quality when constructing the film processor might also oppose a risk to the user as the user might be injured by a splinter when handling the film processor. The severity of the incident is negligible but the chance of occurrence for the incident is occasional due the different quality of wood that is available to the market. The risk value for the incident will be deemed low.

Design Flaw and Improvements

The personal film developer tank requires the users to fill the tank with different chemicals. This may need users to be there and operate the system to make sure that the film developer tank is operating smoothly so that the film can be developed fully.

Besides this, the tank may experience leakage as the 3D printed containers are not fully waterproof and may have flaws or gaps due to unexpected errors during the printing process. In addition, the solenoid valves used are of subpar quality and may not be able completely withstand the water pressure that is required of it. This in turn will result in small amounts of the chemicals and water leaking from the valves at different timings than the programmed settings. This will affect the developing process of the film and ultimately will show on the quality of the final product, which in this case is the developed film.

In personal film developer, a secondary rechargeable power bank with 10000mAh is used. This is due to the use of a high voltage solenoid valve. This can be prevented by using a step down transformer to step down the voltage supplied to the solenoid valve to power the arduino board. The use of a lower voltage solenoid valve can also be used to reduce the need of a step down transformer and use the build in voltage regulator to power the arduino board. The use of a power bank in this prototype shows that the user will need to ensure that the power bank is fully charged to reduce the chances of the film processor to stop suddenly due to the lost of power to the arduino board.

However, improvements can be made, such as to lower the voltage of solenoid valve to the recommended 12 volts which will allow for the valve to be connected to the arduino in order to read the code and successfully open and close the valve without failure.

Furthermore, there are some maintenances need to be done over some period in order to make sure that personal film developer tank can be fully function all the time. The tank must be cleaned once in 2 weeks in order to avoid some chemical mixture in the pipe where it may affect the film developer process to be affected. At the same time, the control system which consists of arduino and valves with the connections of wires may breakdown as connections of wires with valves or arduino may become loose and break the circuit. So, connections of wires must be checked every month to ensure that the film developer process can be successful.

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