

Deliverable D: Conceptual Design

Aiden McCooeye, Gabriel Bercea, Sharmarke Mohamed Said

October 14, 2022

Table of Contents

1	Introduction	4
2	Subsystems	4
2.1	Cleaning.....	4
2.1.1	Cleaning With a Spinning Brush That Moves Across One Line and Vertically	4
2.1.2	Cleaning With a Boot Brush Style	5
2.1.3	Separated Cleaning	5
2.1.4	Cleaning With One Brush that moves Across X,Y,Z.....	6
2.2	Automation	7
2.2.1	Conveyor Belt Style with a Piece that Pushes the Boards	7
2.2.2	In/Out belt.....	7
2.2.3	Two wheels on the side	8
2.3	Size	9
2.3.1	96in X 30 in.....	9
2.3.2	48in X 64in X 3 in.....	9
2.3.3	96in X 30in including UV and drying	10
2.4	User Friendliness.....	10
2.4.1	Light Design.....	10
2.4.2	Two Button System	11
2.4.3	4 Button system with colour and sounds	11
3	Three Possible Solution.....	12
3.1	Solution 1	12
3.2	Solution 2	12
3.3	Solution 3	13
4	Final Solution.....	14
5	Conclusions and Recommendations	15
6	Client Questions.....	Error! Bookmark not defined.

1 Introduction

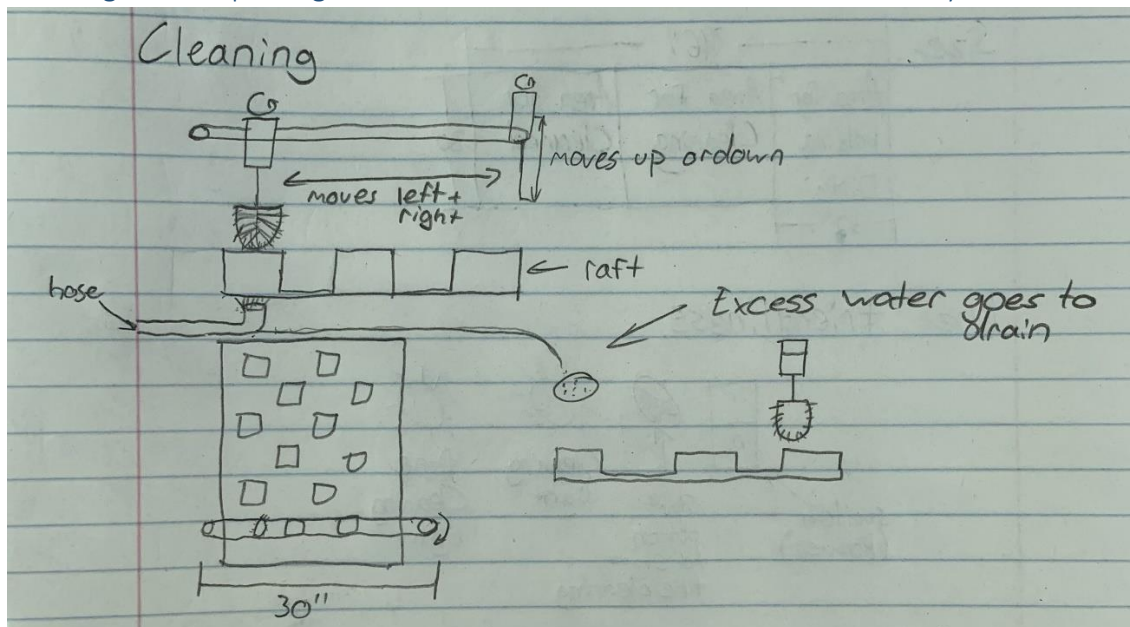
We have reviewed our design specifications, benchmarking and problem statement to create four subsystems for our cleaning device. We created multiple concepts for each of the subsystems and reviewed all our criteria to come to a final solution for our product. This document analyses all our concepts, how we got to the final solution and how our final concept reflects our design specifications and problem statement.

2 Subsystems

For our subsystems we chose cleaning, automation, size and user friendliness. These were our highest priority for the design specifications, and they were all included within our problem statement.

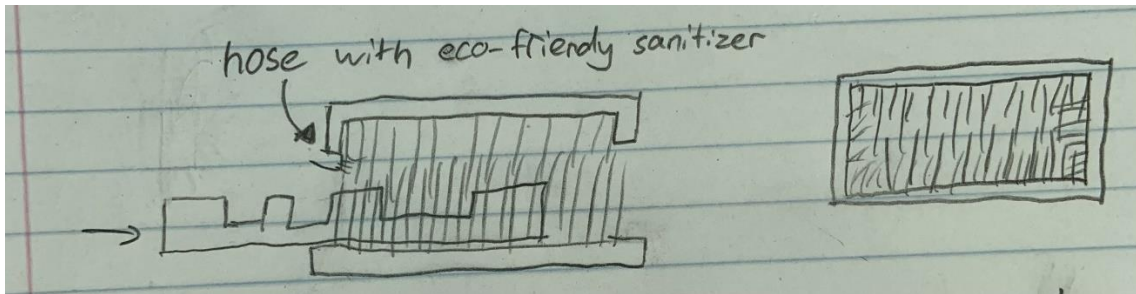
2.1 Cleaning

2.1.1 Cleaning With a Spinning Brush That Moves Across One Line and Vertically



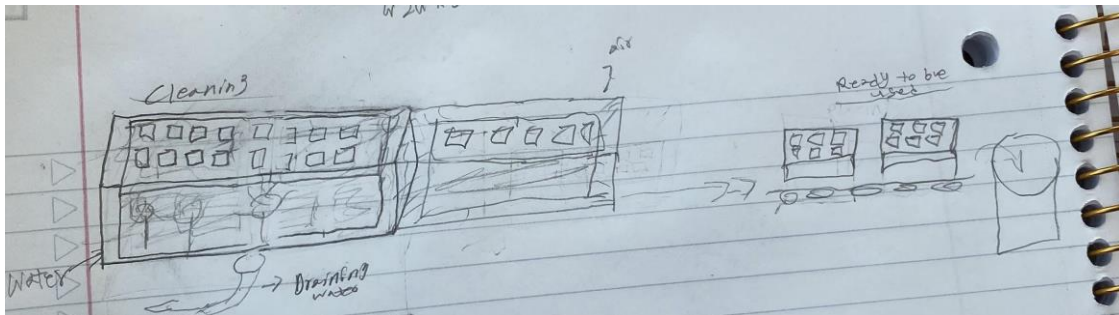
This concept uses the drill brush from our user benchmarking which is expected to work well at cleaning away algae. It moves left and right perpendicular to the board, and up and down so the drill brush can get into the small holes of the board and clean in there. It also can provide us with a more compact design on the table because it doesn't need to be a large box, only a small line. It is also very simple and easy to replace the drill head if it wears out. The downside is that it only has a high-pressure hose on the bottom, so it doesn't clean that side of the board as well.

2.1.2 Cleaning With a Boot Brush Style



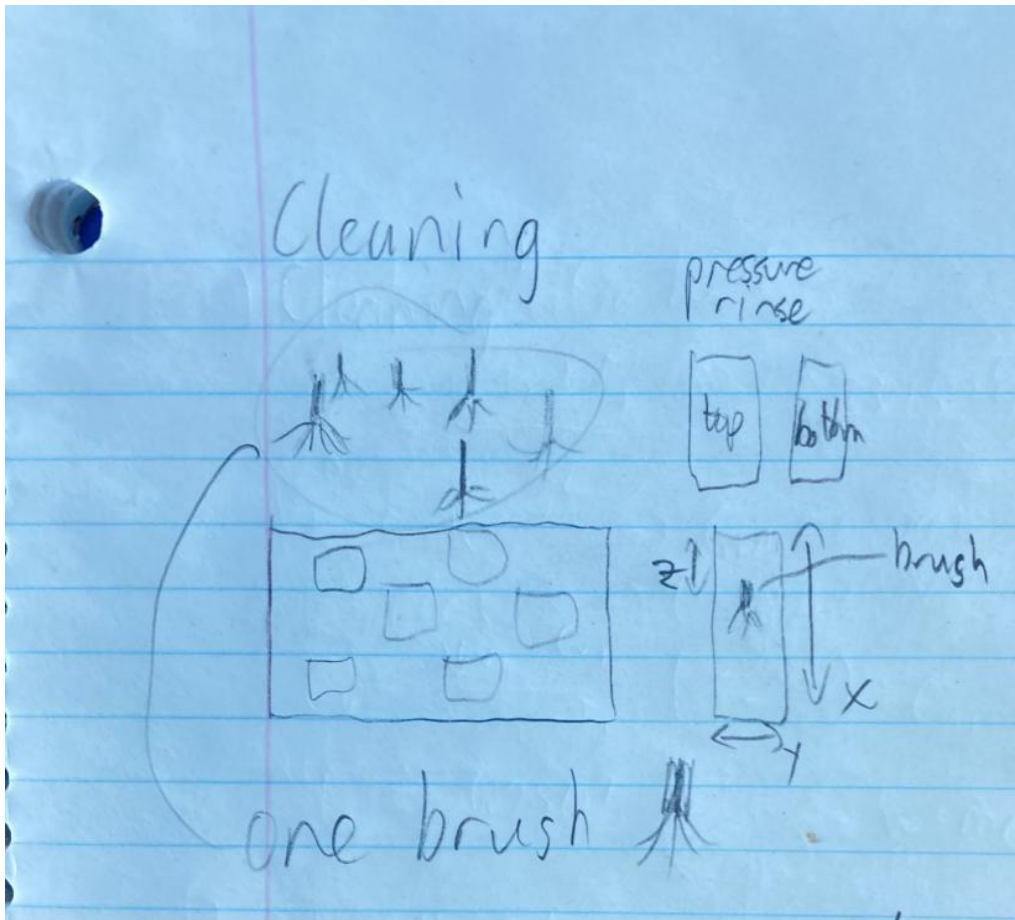
This concept only uses a hose with some eco-friendly sanitizer to kill the algae and a bunch of brushes. The raft gets pushed through the device which has brushes that cover the whole machine. It should be good at cleaning the tops and bottom of the raft. A large downside is that this will either be very hard to replace, which doesn't align with our specifications, or it won't last long because it relies on all the brushes to last long and work long.

2.1.3 Separated Cleaning



The cleaning part of the automated cleaner cleans rafts pretty well since it washes with water and the water pressure can get rid of the algae. Also, it has multiple brushes top and bottom that can wash the rafts well and it makes the rafts spin slowly so that every part of the raft gets to be cleaned. It has a part that dries the rafts. Hot air comes out from the top and bottom which quickly dries the rafts. It has a draining part that can get the used water and drain it into a tank or a big container. It cleans 1 raft each time and then dries 1 raft each other. It is capable of drying a raft while washing a raft.

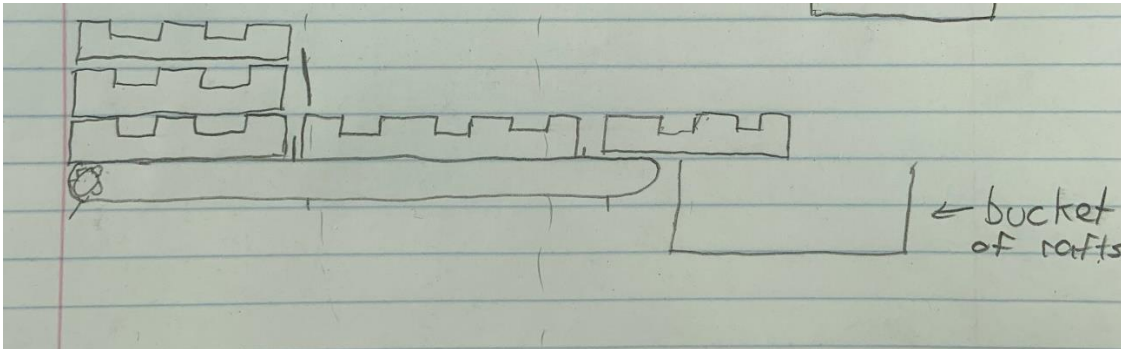
2.1.4 Cleaning With One Brush that moves Across X,Y,Z



The cleaning system includes four main parts (brushing, pressure rinsing, drying, UV disinfecting). A rotating brush begins cleaning each raft hole while 2 pressure washers mounted at the top and bottom of the machine spray the raft. This ensures algae that is loosened by the brush is effectively removed from the raft. By having a brush entering each raft hole it cleans spaces that are harder for a pressure washer to reach further ensuring optimal cleaning. While not critical, this system also dries the raft at the end which means the users no longer need to dry the boards with towels. Finally, UV disinfecting guarantees the raft is cleaned from grime not visible to the human eye. A disadvantage would be that the brush only cleans the holes of the raft the rest of the algae on the raft is cleaned by the pressure washer. There might need to be brushes that go on the surface of the raft to make sure the surface is cleaned properly.

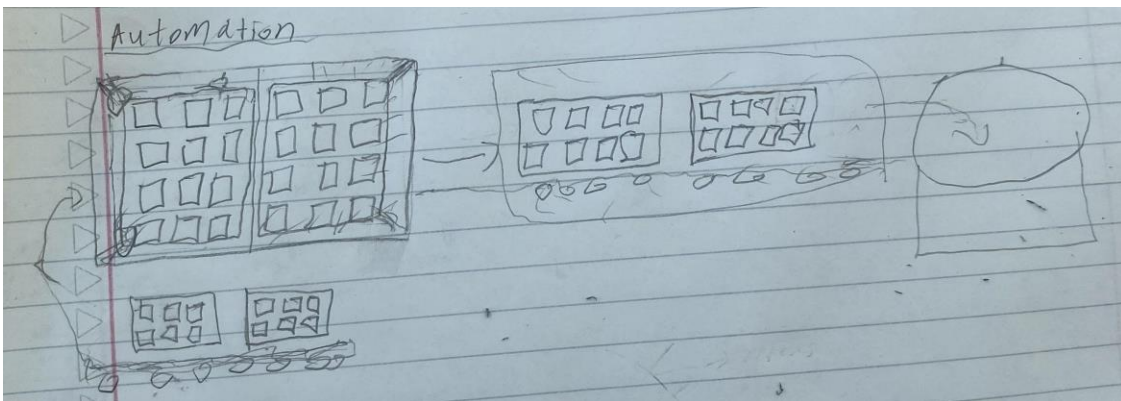
2.2 Automation

2.2.1 Conveyor Belt Style with a Piece that Pushes the Boards



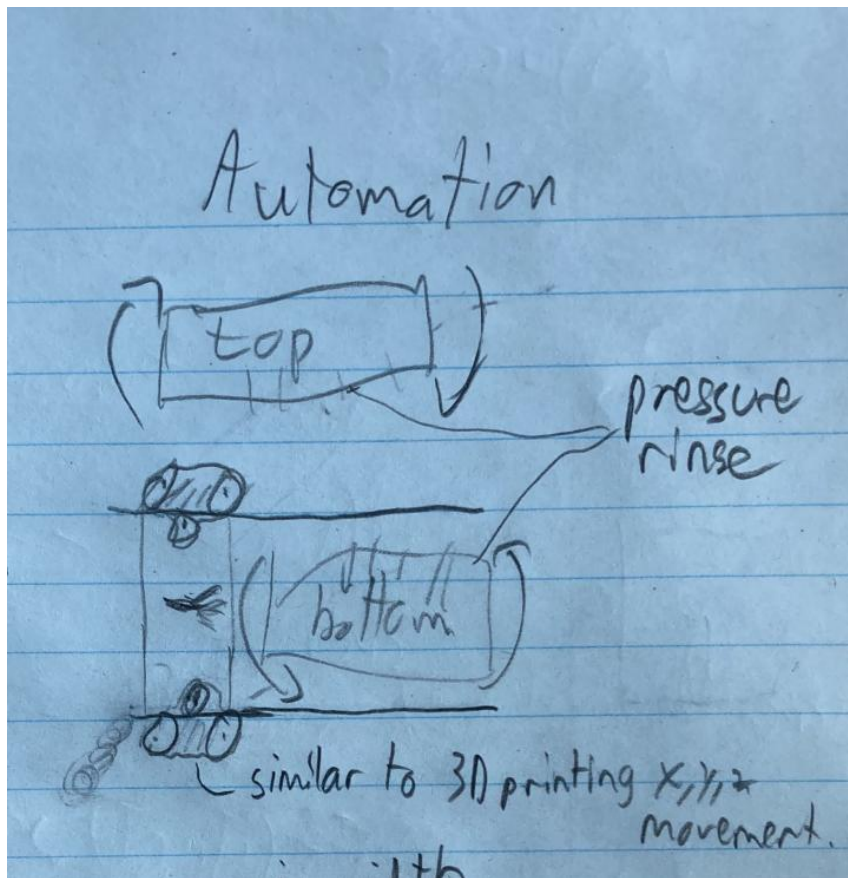
This design uses a conveyor belt with pieces that stick out to push the boards forward through the machine. It provides a way for the farmer to place their stack of dirty rafts on one side of the device, start the machine, and walk away which aligns with our specifications. The piece that sticks out is helpful because if the belt becomes slippery, which it will because water is involved, you do not need to rely on friction to move the boards through the device. All the finished boards end up in a bucket at the end of the table. It may not function as intended because the weight of the boards may be too much for the belt and the motors moving the belt may not have enough torque to make the belt move properly.

2.2.2 In/Out belt



It has an automated part that can move the rafts without any problem. It is capable of washing rafts without needing anyone to press buttons or anything like that. It moves slowly so that the rafts get enough time of being cleaned but that could be a disadvantage when it comes to our user needs. We want something that cleans fast and this part doesn't meet that requirement. Also, it has a different automated part that takes out rafts and places them into a container. It has a moving part that takes rafts and put them into the washing machine. The only thing that needs to be done by a person is to empty the container once it's full or replaces it with another container.

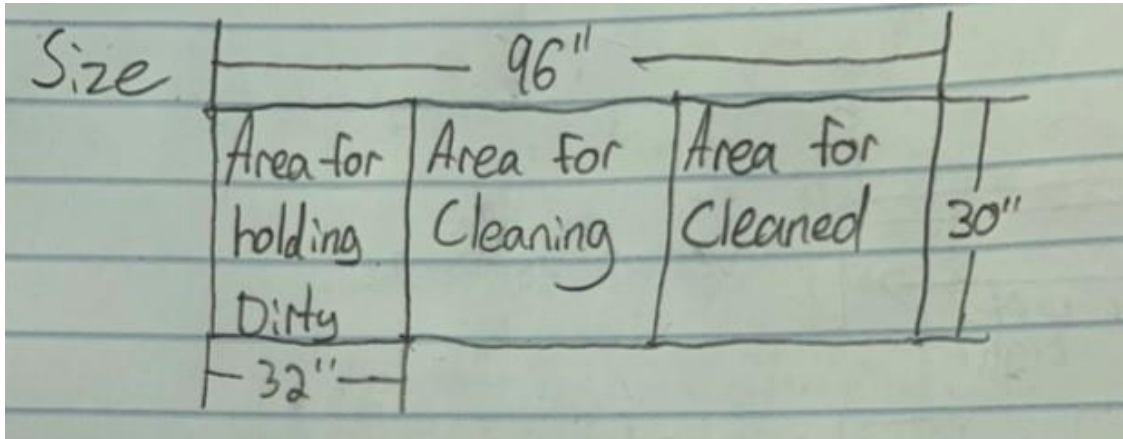
2.2.3 Two wheels on the side



The brush will move to each hole in the raft through the use of multiple motors that move the brush on an x,y,z plane(similar to how the extruding system is moved around on a 3d printer). By allowing the brush to move we eliminate the need to have 1 brush per hole which would be costly when the brushes wear out and need to be replaced. However, this will affect the time it takes for each board to be cleaned (time increases with a one brush system). The 2 pressure washes will be fixed to the top and bottom of the machine and they will be rotating as they spray water. Moving between each of the four main parts of this system will be done using and automated wheel rolling system allowing the rafts to clean with minimal supervision/user intervention. A downside to all this automation is that there are more parts likely to break down/require fixing and a specialist might need to be sent to the location which is not ideal.

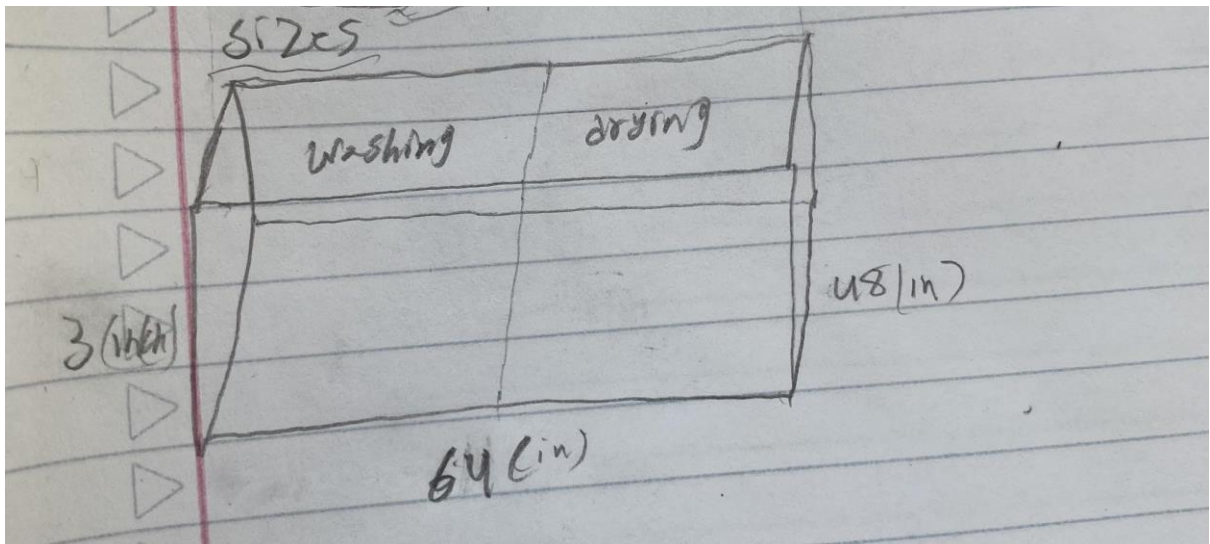
2.3 Size

2.3.1 96in X 30 in



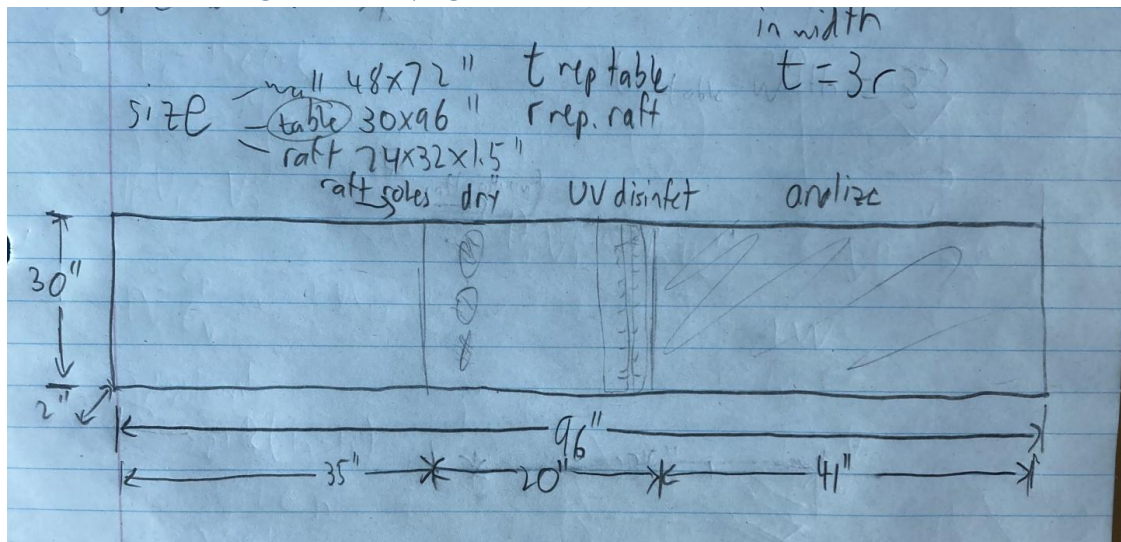
This design shows which areas the boards will be in during all the processes of being cleaned. It all fits within the size constraints in our specifications. It could be more compact but otherwise meets our needs for a table design.

2.3.2 48in X 64in X 3 in



The height of this cleaner is 3 inches, the length is 68 inches, and the width is 48 inches. Half of its size cleans rafts and the other half dries rafts. The disadvantage of its size is that it can clean 1 raft each time and dry 1 raft each time. Is not capable of cleaning lots of rafts for busy days.

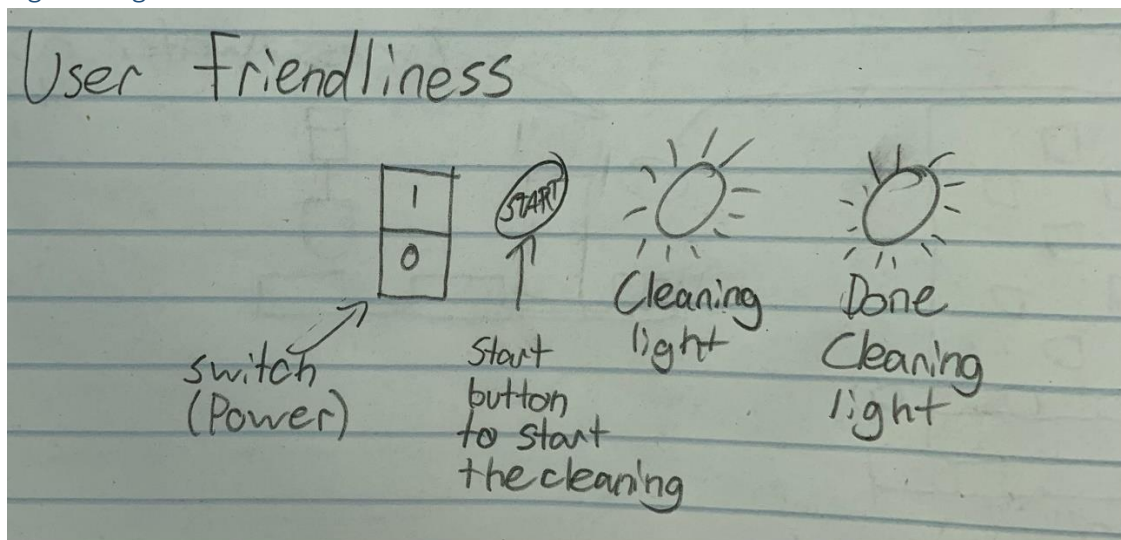
2.3.3 96in X 30in including UV and drying



This cleaning system fits on the table. Its expected size is 30x55 inches and the table is 30x96 inches. This leaves 41 inches of space to take the board from the machine/analyze it.

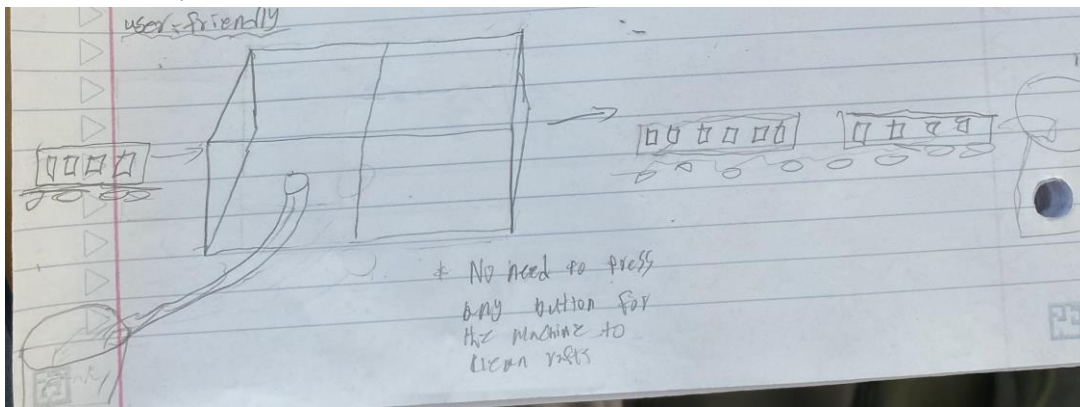
2.4 User Friendliness

2.4.1 Light Design



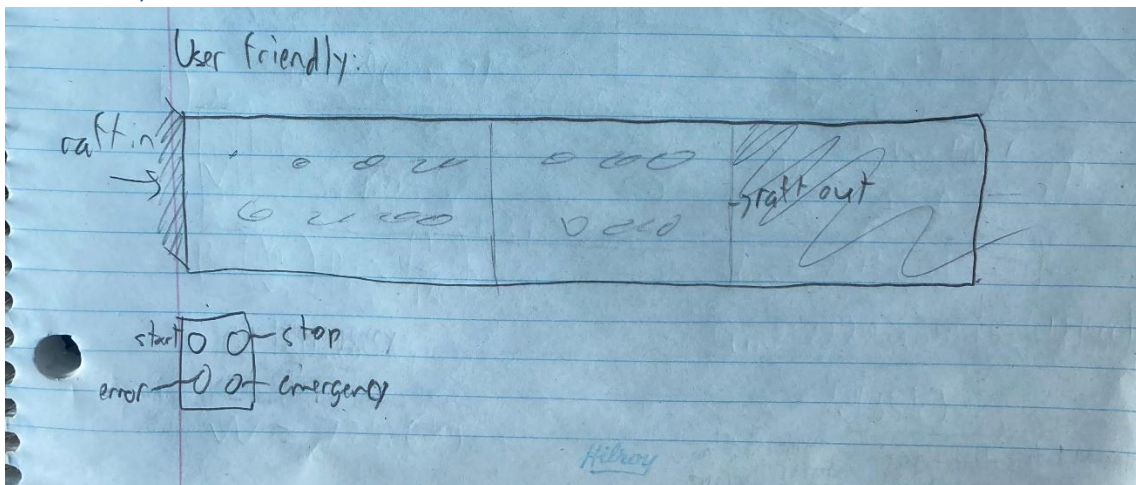
This design has a switch that turns the whole machine on, a button to start the machine, and a light which demonstrates when the machine is cleaning, and a light for when the machine is done cleaning. Based off our design specifications we need something that's very simple to understand, there's not much set-up or complicated parts to this design. Only one button to turn it on, and lights to show the farmer if the machine is still being cleaned or not. A downside to this design is that using lights will use more power, which decreases the power we have left to use on the motors.

2.4.2 Two Button System



One button is used for turning on the machine while the other one is used for turning off the machine. The less button it has the more is easy to use and the farmer won't get focused since there are only two buttons. The machine does the most work on its own which is why it only has two buttons. With this system, there will be fewer accidents and it will be more simple since there won't be any occupation where the farmer press a button accidentally that could cause some trouble. The farmer won't need to remember lots of buttons or needs to do some work for the machine to start cleaning the rafts.

2.4.3 4 Button system with colour and sounds



Really simple to use and requires barley any training. User puts raft in the entry slot, closes the door and hits the start button. The machine does the rest and leaves the board on the other side on the table after cleaning process is complete. There are also indicators with colors and sound that tells user when a new raft is ready to put in as well as indicators that lets user know is something goes wrong where the problem occurred. This will allow him to easily debug the problem without calling a repairman.

3 Three Possible Solution

3.1 Solution 1

Cleaning	Cleaning With a Spinning Brush That Moves Across One Line and Vertically	Cleaning With a Boot Brush Style	Cleaning With One Brush that moves Across X,Y,Z	Separated Cleaning
Automation	Conveyor Belt Style with a Piece that Pushes the Boards	In/Out belt	Automated Wheel Rolling System	
Size	96in X 30 in	48in X 64in X 3 in	96in X 30in including UV and drying	
User Friendliness	Light Design	Two Button System	4 Button system with colour and sounds	

This solution uses the vertical line cleaning system, which not only fits our specification of cleaning the algae off the boards but using this concept we can make the cleaning system much smaller than the constraints. The conveyor system that uses the piece to push the boards will be useful for bringing the boards through the line of cleaning without having to rely on friction. The solution also includes the UV light at one section and a drying section because the vertical line solution doesn't clean both sides of the board equally, so hopefully the UV light will kill any algae that was missed. The 4-button system will properly let the user know how to start and stop the device at any time they want. The colors and sounds will be helpful at letting the user know exactly when there's an error or not. A drawback to this device is the water efficiency isn't great because there's constantly water being sprayed onto the board without recycling it. The motors running the conveyor belt and drill may need more power than we have access to which may become a problem, but we won't know until we decide which motors to use.

3.2 Solution 2

Cleaning	Cleaning with a spinning brush that moves across one line vertically	Cleaning with a boot brush style	Cleaning with one brush and 2 rotating pressure washers	Separated cleaning
Automation	Conveyor belt style with a piece that pushes the boards	In/out belt	Small motors moves brush across x,y,z. Automated wheel rolling system.	

Size	96in X 30in	48in X 64in X 3in	96in X 30in including UV and drying	
User Friendliness	Light design & bin where the rafts drop after cleaning	Two button system	4 button system with color and sounds	

I believe this this design concept is ideal since having a brush entering each raft hole it clean spaces that are harder for a pressure washer to reach further ensuring optimal cleaning. By having the brush move in the x,z direction we eliminate the need to have 1 brush per hole which would be costly when the brushes wear out and need to be replaced. However, this will affect the time it takes for each board to be cleaned (time increases with a one brush system). An automated wheel rolling system allows raft to easily move through machine without user intervention. The size of this concept fits the requirements. I choose to not go with the UV and drying since it was not a high priority for the client. The more features we add there might be more repair cost in the future which is not ideal for the client. A colorful light system will make the machine easy to understand for the client and the bin at the end of the system will catch the clean rafts which doesn't require the client to stay at the end of the machine after each board.

3.3 Solution 3

Cleaning	Cleaning with a spinning brush that moves across one line vertically	Cleaning with a boot brush style	Cleaning with one brush that moves across x,y,z
Automation	Conveyor belt style with a piece that pushes the boards	Automatic Electric Stairway Horizontally System	Two wheels on the side
Size	96in X 30in	48in X 64in X 3in	96in X 30in including UV and drying
User friendliness	Light Design	Two-Button System	4 button system with color and sounds

Cleans the rafts from top to bottom and the brush gets to clean the raft from all angles. Has a pressure rinsing part that can remove the algae that the brush couldn't. Has a UV disinfection which makes sure that the raft is very well cleaned. Moves the rafts without dropping them and it moves

according to the time it takes for the rafts to get done in the washing and drying part. If for some reason one raft takes a longer time to be cleaned this stairway system will move slower so that the next raft doesn't get in the washing part while the other raft is in there. Once, the rafts are clean this stairway system takes the rafts and places them into a container. If for an unknown reason the raft drops off from this stairway system it will sound an alarm to make the farmer know that a raft is missing. How this stairway system will make the alarm sound is by having a weight detector that detects the weight of the raft and when the raft drops off for unknown reasons it will make a sound alarm. Gives a perfect measurement of what the sizes for the cleaning machine need to be and it includes the measurement of all the parts that clean the raft. One button is used for turning on the machine while the other one is used for turning off the machine. The less button it has the more is easy to use and the farmer won't get focused since there are only two buttons. The machine does the most work on its own which is why it only has two buttons. With this system, there will be fewer accidents and it will be more simple since there won't be any occupation where the farmer press a button accidentally that could cause some trouble. The farmer won't need to remember lots of buttons or needs to do some work for the machine to start cleaning the rafts.

4 Final Solution

Cleaning	Cleaning With a Spinning Brush That Moves Across One Line and Vertically	Cleaning With a Boot Brush Style	Cleaning With One Brush that moves Across X,Y,Z	Separated Cleaning
Automation	Conveyor Belt Style with a Piece that Pushes the Boards	In/Out belt	Automated Wheel Rolling System	
Size	96in X 30 in	48in X 64in X 3 in	96in X 30in including UV and drying	
User Friendliness	Light Design	Two Button System	4 Button system with colour and sounds	

This design concept is our best solution since having a brush entering each raft hole it clean spaces that are harder for a pressure washer to reach further ensuring optimal cleaning. Based off our benchmarking the spinning drill brushes are effective at cleaning away algae fast as well. By having the brush move in the x, z direction we eliminate the need to have 1 brush per hole which would be costly when the brushes wear out and need to be replaced. We can also make the whole system much more compact by having a smaller area to clean the board. However, this will affect the time it takes for each board to be cleaned (time increases with a one brush system). An automated wheel rolling system allows raft to easily move through machine without user intervention, it can work in a similar way to a tennis ball practicing pushing the boards through the device. The size of this concept fits the requirements. We chose to not go with the UV and drying since it was not a

high priority for the client, and it would take more power and more sources of errors. The more features we add there might be more repair cost in the future which is not ideal for the client. A colorful light system will make the machine easy to understand for the client and the bin at the end of the system will catch the clean rafts which doesn't require the client to stay at the end of the machine after each board. The switch also is easy to understand for the users of the device.

5 Conclusion

In conclusion, after weighing all the pros and cons of solutions we decided going with solution 3 since it meets all our client's needs. This system includes a rotating brush system with pressure washing to ensure optimal cleaning as well as a simple on and off switch for user friendliness and an automated wheel rolling system that move the raft throughout the machine. Compared to our other solutions our final concept contains fewer mechanical parts decreasing the likelihood of machine failure and an improved automated rolling system that does not interfere with our pressure washing system which allows the rafts to be cleaned more thoroughly. We have also significantly reduced the complexity of the buttons used to operate the machine from 4 buttons to a simple on and off switch. Overall, we believe our solution combines the best concepts from each of our four subsystems allowing us to provide the client with this ideal solution.