GNG 1103 – Project Deliverable C

Group A09

After interpreting client needs and formulating a problem statement, our design team has developed design criteria and metrics to measure how well potential solutions meet the client's needs, performed technical benchmarking of existing products using our design criteria, and chosen target specifications for potential solutions. Throughout this process, some client needs were revised, and additional needs were defined.

Revisions to Client Needs

Due to the complexity associated with the need of cost effectiveness, our team has chosen to address only purchase price within the scope of this deliverable. Similarly, the need of food safety has been very simply addressed.

To better define cleaning ability, our team has added the additional needs of the solution cleaning rafts quickly, and the solution having the capacity to clean multiple rafts at once. The client directly stated that a solution would ideally clean multiple rafts and that there is roughly three days to clean one quarter of the 82 rafts used in the system, so our team feels that these additional needs are appropriate.

Design Criteria and Metrics

Our design team has defined the following design criteria and metrics, shown in table 1, by which to evaluate potential solutions. Since the scope of this deliverable did not entail acquisition and testing of physical solutions, our team developed both metrics that could be used with solutions available for testing and metrics that could be practically measured without solutions available. Moving forward, our team will use the metrics developed for actual testing to evaluate prototypes.

Table 1: Characteristics, metrics, and measurement processes.

		Metric		**Measurement Process**	
Priority	**Characteristic**	**With solutions**	**Without solutions**	**With solutions**	**Without solutions**
Primary needs	Cleaning ability	Percentage of dirty test area clean after one cleaning cycle	Yes or no whether one cleaning cycle is effective	Perform test cleaning with dirty object	Read online reviews of cleaning effectiveness
	Time on task	Time required to operate device for one cleaning cycle in minutes		Perform test cleaning and time operation	Estimate based on product instructions and online reviews

	Simplicity	Number of steps to operate device		Perform test cleaning	Read product instructions and online reviews
	Food safety	Yes or no whether device leaves residue on objects cleaned		Perform test cleaning and examine object	Read product instructions, warnings, and online reviews
Secondary needs	Cleaning capacity	Volume of cleaning area in cubic cm		Measure cleaning area	Read product specifications
	Non-destructivity	Difference in weight of objects before and after cleaning in mg	Yes or no whether device damages objects cleaned	Weigh object before and after cleaning	Read product instructions and online reviews
	Compactness	Volume of device in cubic cm		Measure device	Read product specifications
	Durability	Number of high stress or moving parts		Identify high stress parts, disassemble if necessary	Identify high stress parts from product specifications and online reviews
	Maintainability	Number of parts		Count, disassemble if necessary	Estimate using product specifications
	Cost	Aggregate cost of materials in dollars	Purchase price in dollars	Find typical cost of major materials used and calculate	Find device available for online purchase
Tertiary needs	Water use	Water used per cleaning cycle in mL		Perform test cleaning and measure	Read product specifications
	Cleaning speed	Time required for one cleaning cycle in minutes		Perform test cleaning and time	Estimate from product specifications and online reviews
	Waste Production	Weight of waste product produced per cleaning cycle in mg	Yes or no whether device produces waste products	Perform test cleaning and measure	Estimate from product specifications and online reviews
	Cleanliness	Area around device likely to get dirty in square centimeters	Yes or no whether device is likely to get surroundings dirty	Perform test cleaning and measure	Read product specifications and online reviews

Technical Benchmarking

Our team has evaluated the following products, as shown in table 2, with respect to the previously described characteristics and metrics. Most of these products only address a subset of the client's needs, thus any metrics not relevant to a particular product are noted as not applicable.

Table 2: Technical benchmarking.

		Product				
Characteristic	**Metric**	**Noble Warewashing I-E Single Rack Low Temperature Door-Type Dish Machine - 115V**	**Aquarias Algeacide**	**Lalapool Swimming Pool Wall & Tile Brush**	**Crest P2600 Powersonic Benchtop Ultrasonic cleaner**	**T-120 Trident Touch-Free Car Wash System**
Cleaning ability	Y/N one cleaning effective	Y	Y	Y	Y	Y
Time on task	Min to operate for one cleaning	1.5	5	Varies	1	N/A
Simplicity	Number of steps to operate	1	2	1	3	N/A
Food safety	Y/N leaves residue on object	N	N/A, but deadly if ingested	N/A	N	Y
Cleaning capacity	Cleaning area volume cm^3	$4.46x10^5$	Varies	N/A	$26x10^3$	N/A
Non-destructivity	Y/N objects damaged	N	N	N	N	Y
Compactness	Device volume cm^3	$1x10^6$	1000	2500	63000	$5x10^8$
Durability	Number of high stress or moving parts	Many	N/A	N/A	0	Many
Maintainability	Number of parts	Many	N/A	4	Many	Many
Cost	Purchase price in dollars	3530	30	25	3200	$5x10^5$ +
Water use	Water used in one cleaning in mL	$5.68x10^3$	N/A	N/A	$29x10^3$, can be re-used	$310x10^3$
Cleaning speed	Min for one cleaning	1.5	720	Varies	10-20	Varies, 0.75 avg.
Waste Production	Y/N produces waste	Y (Waste water)	N	Y (Bristles)	N	Y (Waste water)
Cleanliness	Y/N gets surroundings dirty	N	N	Y	N	N

Target Specifications

Based off of the technical benchmarking, our team has established the following target specifications and constraints, shown in table 3. These target values are in relation to the metrics developed for use with actual testing, as this is what will be used moving forward.

Table 3: Target specifications.

Characteristic	Metric	Criteria	Constraint	Target
Cleaning ability	Percentage of dirty test area clean after one cleaning cycle	Higher	≥	80
Time on task	Time required to operate device for one cleaning cycle in minutes	Lower	≤	10
Simplicity	Number of steps to operate device	Lower	≤	3
Food safety	Yes or no whether device leaves residue on objects cleaned	N/A	=	N
Cleaning capacity	Volume of cleaning area in cubic cm	Higher	≥	$38x10^3$ (2 rafts at once)
Non-destructivity	Difference in weight of objects before and after cleaning in mg	Lower	≤	$1x10^5$
Compactness	Volume of device in cubic cm	Lower	≤	$20x10^6$ (Maximum space available)
Durability	Number of high stress or moving parts	Lower	≤	10
Maintainability	Number of parts	Lower	≤	100
Cost	Aggregate cost of materials in dollars	Lower	≤	1000
Water use	Water used per cleaning cycle in mL	Lower	≤	$6x10^3$
Cleaning speed	Time required for one cleaning cycle in minutes	Lower	≤	360
Waste Production	Weight of waste product produced per cleaning cycle in mg	Lower	≤	$6x10^3$
Cleanliness	Area around device likely to get dirty in square centimeters	Lower	≤	100

Client Impact on Design Criteria

Our team has taken the client's need into careful account while developing our design criteria and target specifications. The most important criteria will be cleaning ability and time on task, as this what the client has directly asked for -a device to effectively clean rafts while reducing labour. Those key criteria will be used as a minimum requirement for potential solutions, and the other criteria will be used to evaluate the merit of each solution.