Team 147

Device for Experimental Design Course

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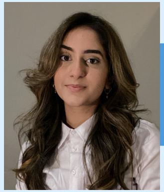
MAIN CLAIM



Nasoe Talash

Our final design will be the most successful design in the Six Sigma industry.

Context

SIX SIGMA for Engineers

Nasoe Talash

Six Sigma for Engineers is a professional skill development course taught in the summer at the University of Toronto

Beginner's green belt: emphasizes the application of **DMAIC** (Define, Measure, Analyze, Improve and Control) methodology to control organizational processes and solve problems in the real world.

Black belt: focuses on improving leadership by managing process improvement and transformational change across an organization.

Figure 1: DMAIC methodology

Problem Background

Problem Background

Zeina Shaltout

Client : Guerino Sacripante (UofT lecturer teaching the Six Sigma experimental design course)

Currently, the default catapult design consists of 3 variables; lever angle, stopper position, pin position (Figure 1)

A design consisting of only 2 variables which outputs the transfer function: $Y(x) = K + aX1 + bX2 + cX1*X2$.

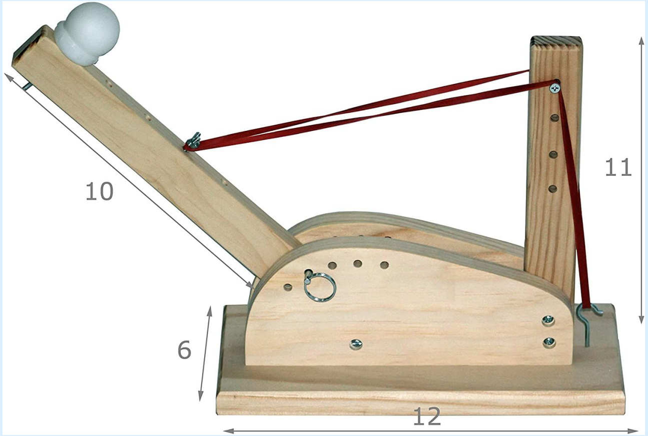


Figure 2: The Catapult is a device used in the Six Sigma for Engineers course

Full Strike

Zeina Shaltout

Figure 3: Full Strike Prototype

Video 1: Demonstration of Ball rolling down Full Strike

Full Strike Satisfies Objectives and Constraints

Full Strike Satisfies Objectives and Constraints

Harsheta Sharma

Table-6-Design objectives, objective goals and metrics

Objective	Objective Goals	Metric
Physical Integrity	Can take apart and put together for iteration	Design is sturdy at every combination of settings - Consistent results within the error tolerance [40]
Efficient use of time	Each iteration is completed in a sufficient amount of time	Easily readable variables: angles, length, mass etc.
Objective	**Objective Goals**	**Metric**
Allow for detailed analysis	The learning outcome of the design relates to the objective of the course [1]	Variables will have multiple settings for the adjustment - One set variable (3 adjustments) - One continuous variable
Student Experience	The student is satisfied with their learning experience	Student Success Surveys

Figure 4: Our objectives table from the Conceptual design specification

How does Full Strike satisfy these objectives?

- ➢ Ramp adjustment allows for multiple rounds of iteration.
- ➢ Includes accessibility features, minimizing the time to record results.
- ➢ Multiple adjustment settings allowing the students to analyze the different combinations.

Serves Requirements of Constraints

Harsheta Sharma

Table-7-Design constraints, metrics and limits

Constraint	Metrics	Limit	Justification
Shall not deteriorate over time	Service life in years	Made of plastic or Wood [5]	Wood is strong and stiff as well as lightweight allowing for long time use [19]
Must be affordable	Cost in $CAD	Under $70 (CAD) to create [5]	Considering the prices of wood and manufacturing the client has requested a specific budget
Must be easily operational	Number of Variables	Include two variables [4]	Minimizing the number of variables makes the problem-solving process simpler for beginners to analyze in detail

Figure 5: The first part of constraints table from Conceptual Design Specification

Constraint	Metrics	Limit	Justification
Must be used indoors	Range of design operations in metres	Design cannot project things beyond the height of 4m and length of 12m	The design will be operated at UofT, St George campus in a standard classroom (approximately 4m x 12m x 9m). The range at which the design operates must stay within the operating environment
Must be safe for the user	Compliance of safety regulations of learning devices	Must obey *the Higher Education Quality Council of Ontario* [18]	To implement the design in a learning environment, it must be safe for the students to use
Must be transportable	Measure in kg and cm	Weigh less than 10 kg Length, width, and height of the design should be a maximum of 50 cm each [13] (Appendix-F)	The design will be moved from room to room, therefore the students must not face any difficulty doing so.

Figure 6: The second part of constraints table from Conceptual Design Specification

Alternative Design Selection

Alternative Design Selection

Crystal Sze

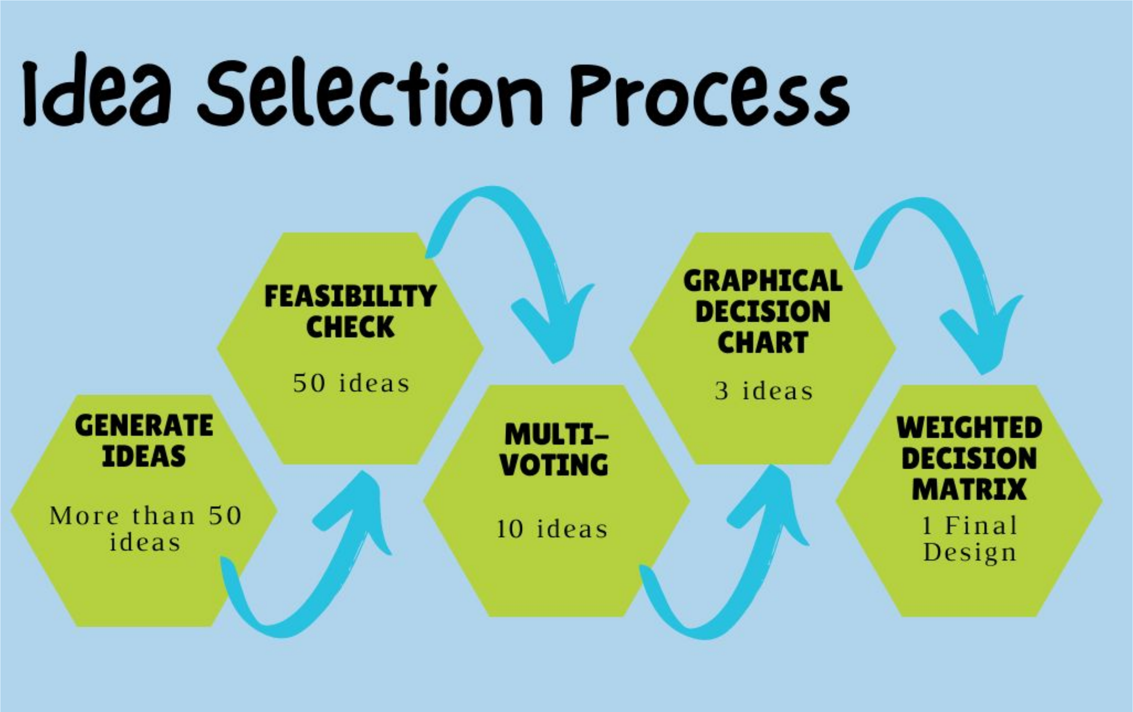


Figure 7: Idea Selection Process

Advantages:

- A strong comparison amongst the ideas to pick out which one will operate the best
- Ensure the ideas are precise

Graphical Decision Chart

Crystal Sze

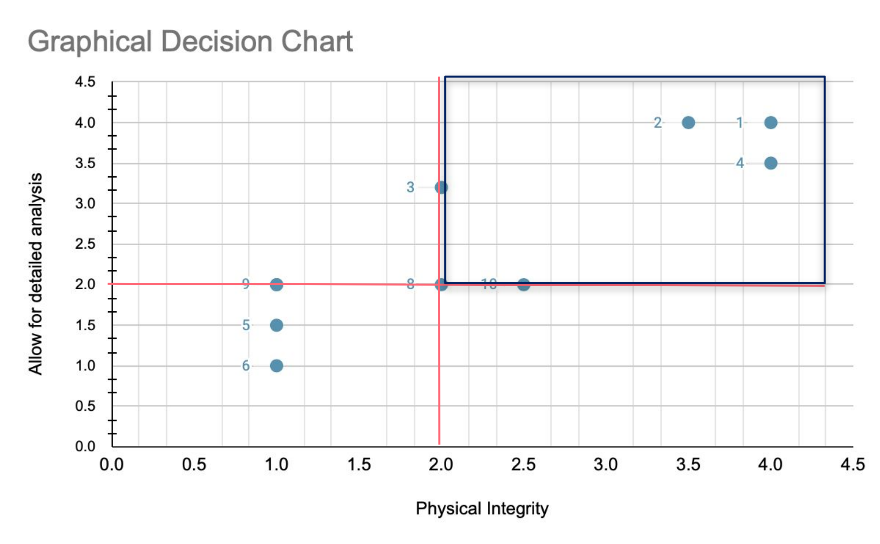


Figure 8: Graphical decision chart

How does it work:

➢ By using a scoring system to rank the designs respect to two main objectives

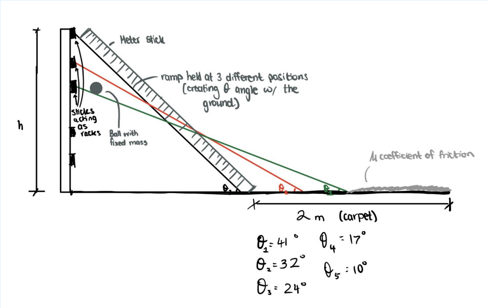
Two Objectives:

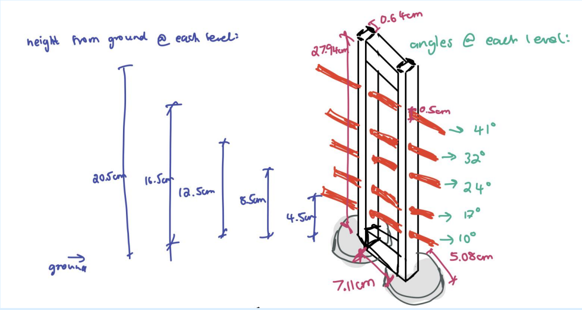
➢ Allow for detailed analysis
➢ Physical Integrity

Three Alternative designs

Crystal Sze

Figure 9: First (Final) Design:





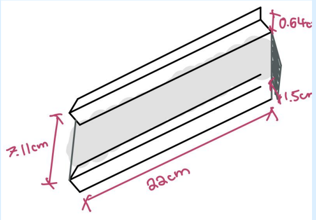


Figure 10: Second Design:

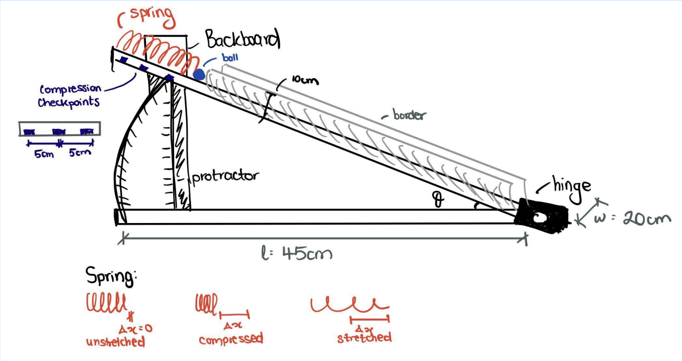
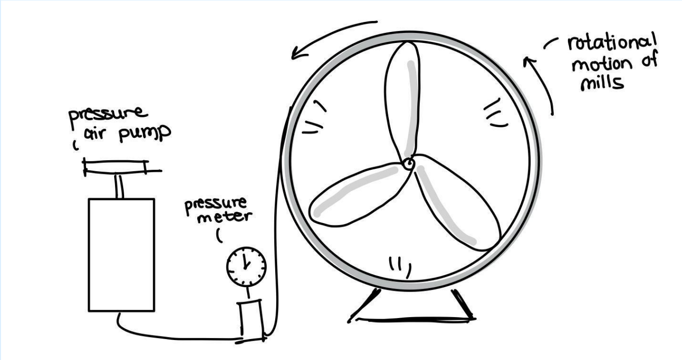


Figure 11: Third Design:



How Was The Final Design Chosen?

Crystal Sze

Objective	*Rank*	*Percentage Weighting*
Physical Integrity	*2*	*30%*
Efficient Use of Time	*3*	*20%*
Allow for detailed analysis	*1*	*40%*
Student Experience	*4*	*10%*

Table 1: Percentage weighting of objectives

Objective	*Alternate Design 1: Full Strike*	*Alternate Design 2: Quick Start!*	*Alternate Design 3:Blown Away*
Physical Integrity	*0.3x0.7=21%*	*0.3x0.5=15%*	*0.3x0.4=12%*
Efficient Use of Time	*0.2x0.75=15%*	*0.2x0.5=10%*	*0.2x0.4=8%*
Allow for detailed analysis	*0.4x0.8=32%*	*0.4x0.8=32%*	*0.4x0.8=32%*
Student Experience	*0.1x0.7=7%*	*0.1x0.7=7%*	*0.1x0.5=5%*
Totals:	*75%*	*64%*	*57%*

Table 2: Weighted Decision Matrix

Weighted Decision Matrix:

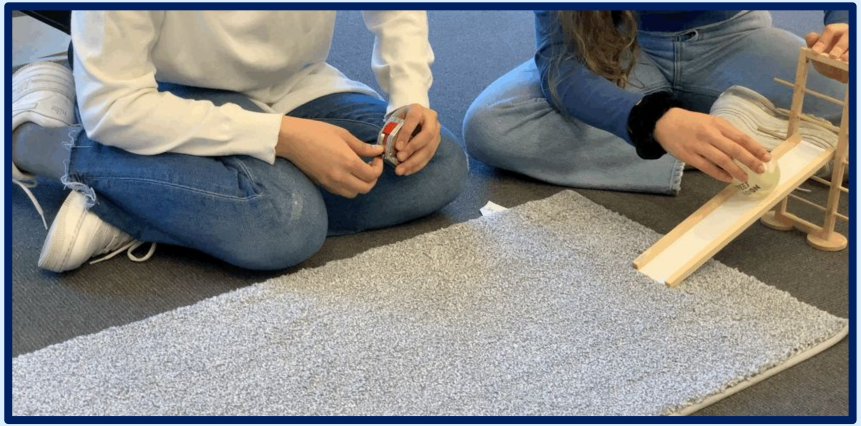
- ➢ Weighting the objectives and giving out scores to the objectives respect to the design

Result:

- ➢ The full strike obtained the highest rating of 75% effective
- ➢ 11% & 18% more effective

Fulfills Measures of Success

Measure Of Success



Video 2: Team 147 conducting measurement tests

Experiment #	Height	Ball Placement	Distance - CM				
			1	2	3	4	5
1	High - 16.5 CM	High - 30 CM	119.8	117.4	116.4	120.5	118
2	High - 16.5 CM	Low – 10 CM	36.1	39.2	42	38.1	40.9
3	Low - 8.5 CM	High - 30 CM	65	72.3	71.8	71.1	74.9
4	Low - 8.5 CM	Low – 10 CM	26.2	25.3	27.9	26.4	29
5	Mid - 12.5 CM	Mid – 20 CM	63.3	68.2	63.7	69.6	64.6

Figure 12: Data from our tests

Mohid Tahir

25 Tests were Conducted:

- 5 different variable combinations that were tested 5 times each.
- The results were recorded in a table (Figure 2)

Data was Plugged into MiniTab

- Provided a transfer function which shows us the required settings to achieve a given distance.

Process of Testing the Device

Mohid Tahir

Mini tab software

*Measured from ramp (added ball placement distance to data)

Transfer Equation

Distance = 12.13 - 0.693 Height + 1.216 Ramp Place + 0.2208 Height*Ramp Place

Figure 14: The Transfer Equation provided by the MiniTab software, the same software that will be used in Six Sigma for Engineers

Figure 13: Team 147 conducting tests for our prototype.

Guerino Sacripante
Mon 4/11/2022 11:09 PM
To: Mohid Tahir

Measure of Success and tran...
42 KB

attached is the transfer function on 2nd page.

You are done with measure of success

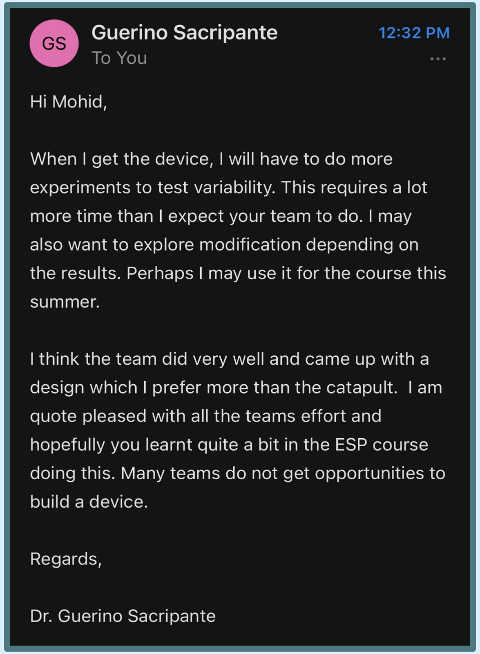
Figure 15: Email Communication with our client, Dr. Guerino Sacripante confirming that we have successfully completed our **Measure of Success**

Client Implementation

Client Implementation

Zeina Shaltout

- ➢ Client desires to manufacture more devices, and implement them in his future Six Sigma classes after more detailed testing
- ➢ Pleased with the team's efforts
- ➢ Allows for a new and improved approach to optimization in the six sigma industry.
- ➢ Device has potential to expand in the six sigma industry and be used in courses beyond UofT



GS Guerino Sacripante 12:32 PM
To You

Hi Mohid,

When I get the device, I will have to do more experiments to test variability. This requires a lot more time than I expect your team to do. I may also want to explore modification depending on the results. Perhaps I may use it for the course this summer.

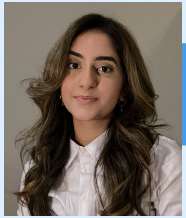
I think the team did very well and came up with a design which I prefer more than the catapult. I am quote pleased with all the teams effort and hopefully you learnt quite a bit in the ESP course doing this. Many teams do not get opportunities to build a device.

Regards,

Dr. Guerino Sacripante

Figure 16: Client responding to Team 147's request for overall feedback on the project

Conclusion



Nasoe Talash

- ➢ Our device meets all objectives and constraints
- ➢ it was chosen using analytical and contrasting idea generation methods
- ➢ It completed a successful measures of success
- ➢ it was personally approved by our client himself meeting all of his needs, ready to be implemented

Which all proves that this is the best design for this problem and can hopefully aid students in the Six Sigma course for years to come.

Figure 16: Climbing to success clipart

Thank You!

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