MEMORANDUM

Date: November 18, 2018
To: Peter Ostafichuk, APSC 100 Instructor
From: Harry Ooi, Emmanuela Ambah, Isabelle Andre, Munira Yassin, Brian Yu, Group G3, APSC 100
Subject: A Multifunctional Bottle Opener For Ken Fraser

Introduction

Every year, 20 to 50 million drivers sustain injuries related to significant traffic collisions, with over 5 million retaining a disability for life. Certain activities we take for granted are a challenge in the daily lives of those retaining a disability. Ken Fraser, an executive director of the Vancouver resource society and the main focus of this module, was involved in a car accident in 1979, instantly breaking his neck. This accident left him paralysed from the armpits down, as well as with very limited hand and finger functions. Actions requiring finger coordination such as opening a bottle or a pop can become tedious tasks without assistance or the use of tools. This memo summarizes a project to design an adjustable and reusable tool, to help Ken Fraser and other individuals with similar limitations to open a bottle cap and other kinds of drinks. A summary of the stakeholders' needs, namely Ken Fraser and his occupational therapist Emma Smith, are included, as well as a review of the concepts generated, and the process by which a final design was chosen.

Design Needs and Objectives

We consulted our main stakeholders, Ken Fraser and his occupational therapist, Emma Smith to get a clear idea about what we needed to consider when generating our concepts for the bottle opener. After communicating their needs to us, we created a table of specific requirements (see Table 1 in Appendix B) that our bottle opener must have. Ken Fraser, has a limited range of movements; the range of motion of his arms are restricted to below shoulder level both forward and sideways. His elbows may only bend or straighten halfway, and his fingers are stiffly curled in.

Our requirements take into account Ken Fraser's mobility and places emphasis on concepts that are comfortable, simple to use, durable and efficient. The bottle opener must be adjustable in order for it to be able to open a wide variety of bottles, including screw-top plastic bottles, glass bottles, and aluminum cans. Furthermore, the bottle opener should be able to withstand a large amount of pressure, require the least amount of force to operate, be compact and be lightweight. The stakeholders' needs can be used as evaluation criteria to score the designs and prototypes created (see Table 2 in Appendix B).

Concepts

To generate concepts, we created 6 C-sketches each edited by 3 team members. We then modelled our preliminary designs with modelling compound and basic adhesive materials. Six CAD designs were created to represent the prototypes developed in earlier stages. These sketches and model representations are included in Appendix A.

While reviewing our concepts, we noted that every design was centered around a wrist-based device. Furthermore, our concepts showed a lack of clarity around the style and size of bottle cap to open: Iterating back to the "study-clarify" stage, we realized a multi-use device could prove useful to the problem, and moved forward to include this factor in our evaluation of the reiterated designs.

Concept Evaluation

To decide what design to move forward with, six prototypes were classified through a Weighted Decision Matrix (WDM) [Appendix C, Table 3] to determine the most robust solution. All factors within the evaluation criteria were based on the needs of Ken Fraser. Due to his busy work schedule, it is unreasonable for him to spend extended periods of time attempting to open a bottle. Secondly, he must be able to easily wear and remove the device with his mouth or wrist. Lastly, the tool must be versatile, which in this case, would be determined by the number of different bottle cap sizes he could open with the tool. The proposed solutions were therefore evaluated based on ease of wear, stability of tool, volume of material needed, time needed to complete task, and adaptability, as demonstrated in [Appendix A, Table 2], with the most weight placed on versatility, ease of use and task completion time. The concepts were scored relative to one another, and the weights were altered to ensure that the most robust decision was chosen. Although a few designs were closely scored, the "Multitool Bracelet X1500 Terminator" [Appendix A, Figure 1] appeared to be the best option. A bracelet design for easy wear with hinges to allow for easy rotation, was concluded to be the most efficient way to complete the task. Furthermore, our chosen design allows for various "clip-ons" that can perform other tasks such as opening pop cans, amongst other things.

Conclusion and Recommendations

After taking the needs of Ken into great consideration, tackling the challenge of opening a bottle without the needed dexterity of finger movement was concluded to be a task for our team to complete. Upon completion of generating concepts, a weighted decision matrix was created to quantitatively determine the best option. The main criteria contributing to the selection of the appropriate device, was the ease of use and the versatility. A variety of criteria with varying weights were used to score our potential solutions. The device most suited to Ken's needs is the "Multitool Bracelet X1500 Terminator". This device can be printed using 3D printing technology, and could even be adapted to various other uses as needed in the future.

Appendix A: Sketches and Prototypes

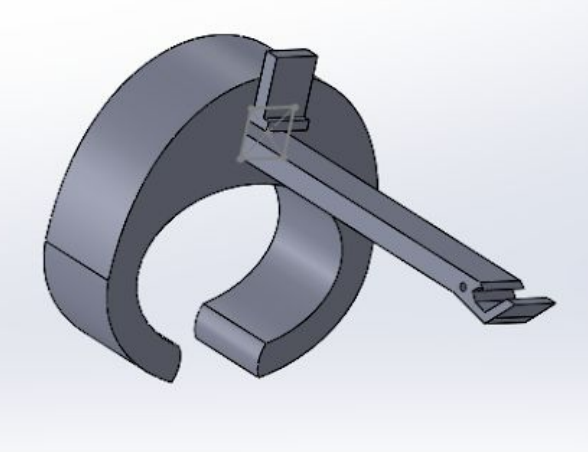

Figure 1: Multitool Bracelet X1500 Terminator

Figure 2: Notch Watch Bottle Opener

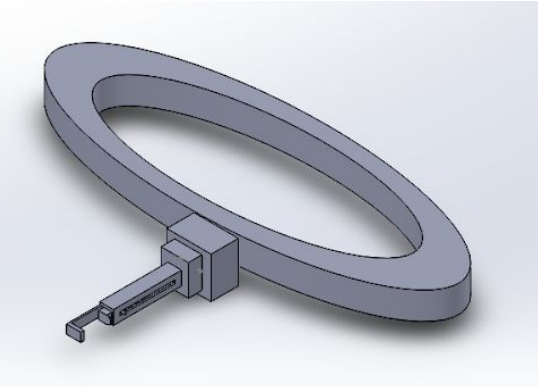

Figure 3: Open Sesame

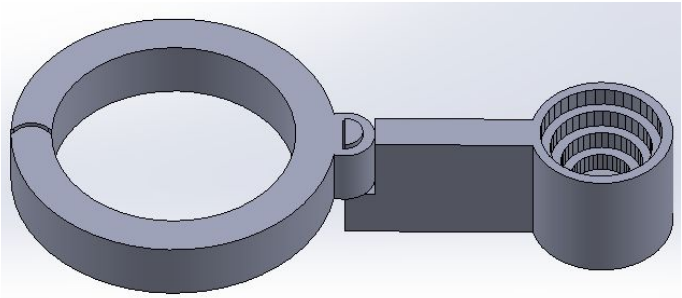

Figure 4: Doraemon Wrist

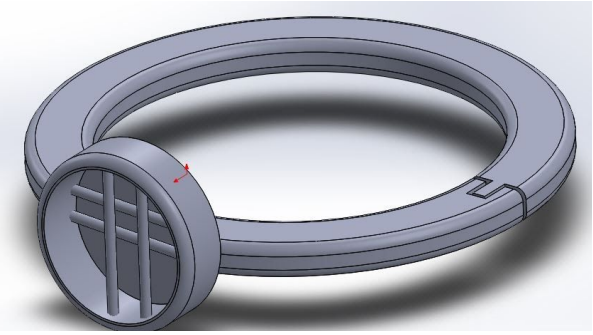

Figure 5: Open!

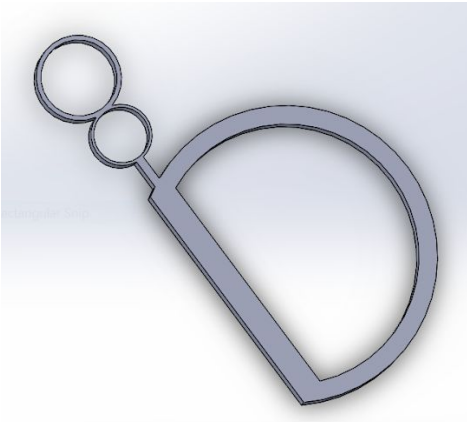

Figure 5: The Complicated Thanos

Appendix B: Requirements and Evaluation Criteria

Requirements

Design requirements	Reason	Concepts not meeting requirement
Ease of use	Must be able to be used by someone with limited mobility	
Supplies enough force to remove bottle cap	Low user exertion/fatigue	
Device is stable	Device must not break under pressure	
Quick operation	Must be able to use tool efficiently and quickly	
Need to be able to open a variety of bottle size	Tool must open a variety of bottles sizes and types	Open sesame, Open!

Table 1: Tool Design Requirements

Evaluation Criteria and Weight

Design evaluation criteria	Reason	Metric	Score of 0	Score of 10	Weight
Ease of wear	Should be time efficient and easy to get ready for use	Time (sec)	30 sec	10 sec	25%
Stability of bracelet and tool	Tool must be stable enough to be used	Scale 0-10	Consistent wobbling	Control of device	15%
Volume of material needed	Should be cost efficient	Cm^3	15cm^3	5cm^3	10%
Time needed to complete task	Must be time efficient, facilitate opening of bottles	Time (sec)	45 sec	15 sec	25%
Types of caps to open (every 2mm variance = new type)	Should open as many types of bottles/cans as possible	# of Types	0	10+	25%

Table 2: Tool Evaluation Criteria and Weight

Appendix C: Weighted Decision Matrix

Weighted Evaluation Criteria

Criteria	Weight	Multitool Bracelet X1500 Terminator		Notch Watch		Open Sesame		Doraemon Wrist		Open!		The Complicated Thanos	
Ease of wear (sec)	10%	9	2.25	7	1.75	5	1.25	6	1.5	5	1.25	8	2
Stability of bracelet and tool	20%	8	1.2	10	1.5	7	1.05	7	1.05	6	0.9	6	0.9
Volume of material needed (cm^3)	25%	6	0.6	7	0.7	9	0.9	7	0.7	8	0.8	9	0.9
Time needed to complete task (sec)	15%	7	1.75	7	1.75	7	1.75	7	1.75	7	1.75	7	1.75
Types of caps to open (every 2mm variance = new type)	20%	10	2.5	6	1.5	4	1	10	2.5	4	1	6	1.5
Ease of wear (sec)	10%	9	2.25	7	1.75	5	1.25	6	1.5	5	1.25	8	2
Total	100%		**8.3**		**7.2**		**5.95**		**7.5**		**5.7**		**7.05**
Rank	/6		**1**		**3**		**6**		**2**		**7**		**5**

Table 3: Weighted Decision Matrix