MEMORANDUM

Date: 1st December 2025
To: APSC 100 Instructors, APSC 100 Students
From: Team K7
Subject: The Roley – An Adaptive Tube Squeezing Device

Introduction

We have designed an accessible, easy-to-use toothpaste dispensing device to address the needs of individuals with limited hand dexterity, such as Ken Fraser, who sustained a C5–C6 spinal injury in a 1979 diving accident. Users with similar disabilities need a device that requires minimal grip strength, reduces fine-motor movements, and keeps the tube and surrounding area clean. The goal is to create a practical, intuitive device that promotes independence, supports consistent daily routines, and enables self-sufficiency. Our design process is outlined below, detailing the needs of the stakeholders, the concepts generated, and the evaluation process. We recommend a simple, low-effort squeezing mechanism that balances usability, durability, and manufacturability as the most feasible solution for further development and implementation.

Design Needs and Target Design Specifications

A stakeholder assessment was first conducted to clearly define the problem and establish design goals. Individuals with limited hand mobility, such as people with partial paralysis, reduced dexterity, or impaired grip strength, are the primary stakeholders. Additionally, caregivers, occupational therapists, and family members play an important role in supporting daily living activities and were therefore included in the analysis. *See Appendix A for full details on the needs analysis.*

The needs assessment focused on users who struggle with squeezing standard toothpaste tubes due to limited grip strength or finger mobility. From this analysis, four key requirements were identified: the device must allow toothpaste to be dispensed with minimal pinch or grasp force; it must dispense an appropriate amount with minimal spillage; it must accommodate any standard squeeze tube; and it must be affordable and easy to manufacture. Beyond these requirements, the objective is to design a device that is safe, durable, easy to use with one hand, and keeps the tube and surrounding area clean. These objectives translated into evaluative criteria summarized in *Appendix A*, with the most important being ease of use and reliability.

Concepts Generated

After initial brainstorming sessions, preliminary sketches and physical models were developed to address the highlighted needs. Six concepts were developed; descriptions and original sketches each can be found in *Appendix B*.

Concept Evaluation

Out of the six concepts generated, the "Block Stamper" did not meet requirements and was quickly discarded. With only five concepts to evaluate, ranking was skipped and concepts immediately advanced to scoring. The evaluation criteria included ease of use (40%), consistency (25%), mess prevention (15%), cost (10%), versatility across different tube formats (5%), and the ability to remove the cap (5%). Using a weighted decision matrix, the "Super Squisher" received the highest score of 6.85; it demonstrated the strongest alignment with stakeholder needs, particularly in ease of use, the most heavily weighted criterion for our design. *See Appendix C for the full WDM.*

Iteration and Final Design

We further refined the Super Squisher by incorporating a cylindrical press that allows Ken to dispense toothpaste by rolling it across the tube, eliminating the need for wrist flexion or significant force (*see Appendix D for stress analysis*). Reflecting this added functionality, we renamed the device the "Roley." The Roley is designed to be manufactured in PLA for simple, low-cost production. The finalized design is detailed in *Appendix E.*

Conclusion and Recommendations

Our analysis identifies the Roley as the preferred solution for individuals with limited hand mobility or grip strength. Its cylindrical press allows users to dispense toothpaste gradually, providing maximum control, while the slanted design holds the tube securely and aids rolling. A curved rest stabilizes the cap, and an integrated cap remover leverages wrist extension for easier opening. Made of durable, affordable plastic, the Roley combines functionality, ease of use, and long-term reliability. We recommend the Roley as an effective solution to support independent oral care for users with reduced hand dexterity like Ken Fraser.

No GenAI tools were used in the preparation of this memo or any of its contents.

Appendix A: Needs Analysis

Our initial needs analysis is included in Table 1 below. Stakeholders are ranked in decreasing order of influence, and needs are ranked in decreasing order of importance for each stakeholder.

Table 1. Needs Analysis

Stakeholder	**Source**	**Needs**
Ken Fraser (primary user)	Week 9 stakeholder ranking, user profile	● Able to dispense toothpaste without pinch or strong gripping ● Device must be easy to use with severely limited mobility ● Toothpaste must be squeezed cleanly with minimal mess ● Cap must be removable and replaceable with low fine-motor demand ● Device must stay stable during use
Emma (occupational therapist)	Week 9 stakeholder list	● Device must reduce fine motor load and grip requirements ● Safe and ergonomic to operate with one hand ● Supports independence in daily activities ● Must be durable and hygienic
People with similar disabilities	Week 9 stakeholder list	● Reliable operation without needing two hands ● Low risk of slipping, spillage, or accidental movement ● Compatible with common tube sizes ● Affordable and easy to obtain

Table 2. Design Requirements

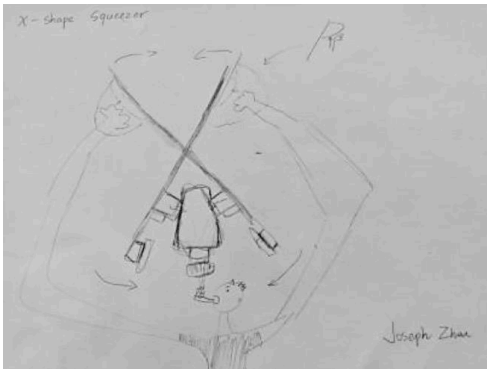
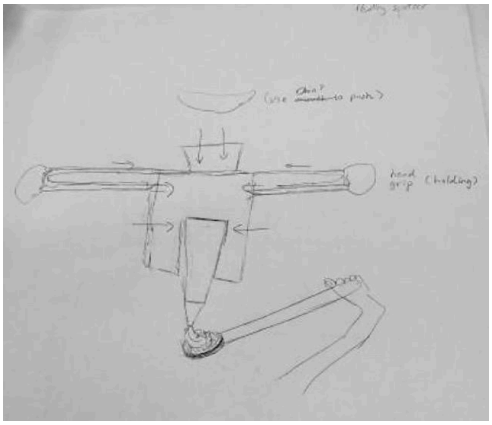
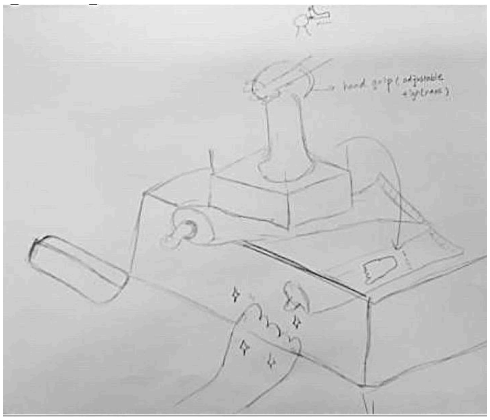
Design requirement	**Justification for requirement**	**Concepts that do not meet the requirement**
Easy to dispense from tube without strong grip / pinch	Ken cannot grip / pinch so he has to be able to use the device without doing so	Block stamper
Minimal mess created	It would be inconvenient to make a mess every time he wants to brush his teeth	Block stamper
Dispenses proper amount of substance	To not waste product and avoid not having enough on the brush either	
Works for any standard squeeze tube	Makes device more broad in terms of usage so you don't need one for every single tube you own	
Affordable and easy to manufacture	Lower cost will make it more available to help more people	

Table 3. Evaluation Criteria

Criteria	**Measurement**
Ease of use	Amount of force (N) needed to dispense (0 = requires strong effort (greater than 50N)
Spillage	No spillage = 10, frequent spillage of greater than 1 mL = 0
Consistency	Within 10% error for accuracy of desired amount dispensed = 10; greater than 50% error = 0
Versatility amongst tubes	Compatible with 90+% of tubes of standard size = 10; compatible with less than 20% of tubes = 0
Cost	Cost less than $5.00 to produce = 10; greater than $30.00 to produce = 0
Removes cap	Removes cap = 10, is unable to remove cap = 0

Appendix B: Initial Concepts

Table 4. Initial Sketches.

Name of Sketch	**Main Idea of Concept**	**Photo**
X-shaped Squeezer (Teammate 1 of 6)	Uses two crossed sticks connected with each other in the middle like an X (like scissors); users can use two hands to add a small compressive force on both sides to accurately squeeze some toothpaste.	
Floating Squeezer (Teammate 2 of 6)	Uses a U-shaped block with pins to enclose and squeeze toothpaste. With the toothpaste vertically falling onto the toothbrush.	
Block Stamper (Teammate 3 of 6)	Simplicity is key. This idea features a simple block with a handle that Ken can wrap his fingers around and press on the toothpaste.	

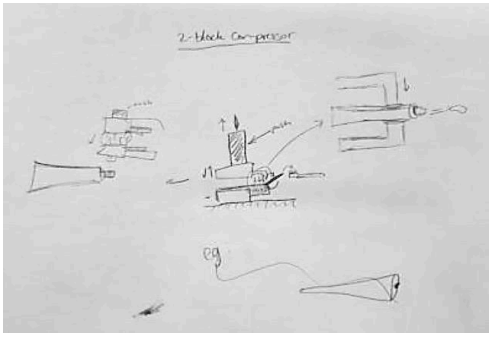
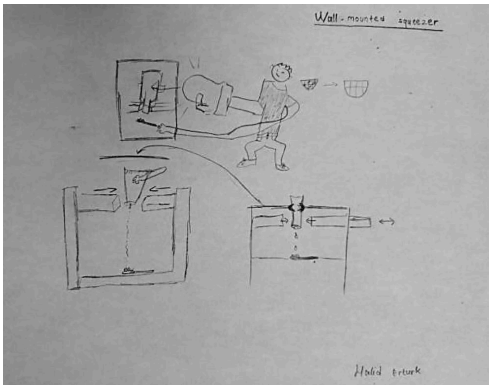
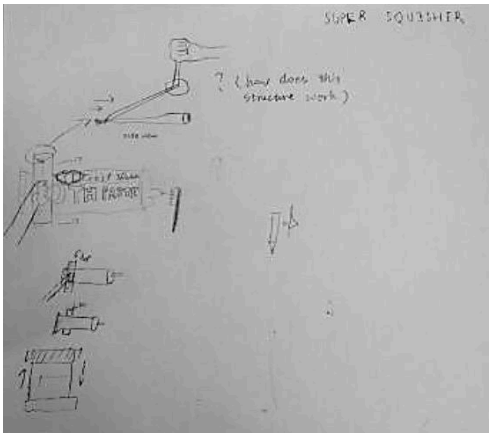
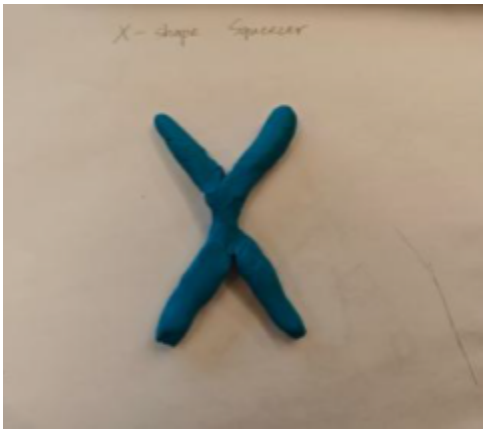
2-block compressor (Teammate 4 of 6)	Use two attached blocks and a large rotator to close the blocks to the size of the tube, then an extruded handle/pusher on top will squeeze it out.	
Wall mounted squeezer (Teammate 5 of 6)	Placing the toothbrush and toothpaste in their designated spots (shelf and clips), then applying force on both sides to get the paste.	
Super Squisher (Teammate 6 of 6)	Using the Super Squisher as a squeegee and using one fist to push it along the tube easily, getting toothpaste from all edges of the tube.	

Table 5. Initial Prototypes

Concept	**Description**	**Photo**
X-shaped Squeezer (Teammate 1 of 6)	Uses two crossed sticks connected with each other in the middle like an X (imagine scissors); the user can use two hands to add a small compressive force on both sides to accurately squeeze some toothpaste.	
Floating Squeezer (Teammate 2 of 6)	Uses a U-shaped block with pins to enclose and squeeze toothpaste. With the toothpaste vertically falling onto the toothbrush.	
Block Stamper (Teammate 3 of 6)	This idea features a simple block with a handle that Ken can wrap his fingers around and press on the toothpaste.	

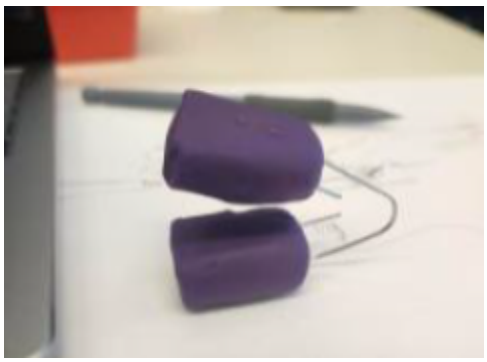
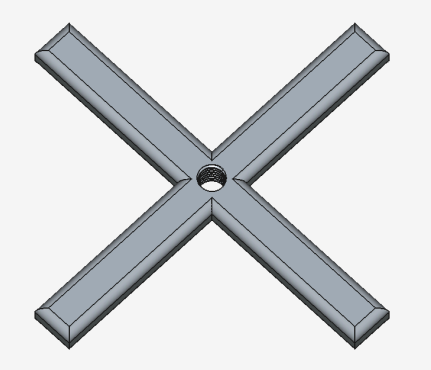
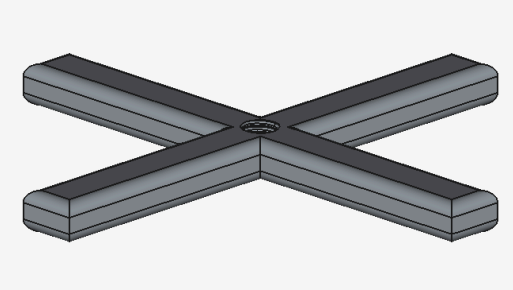
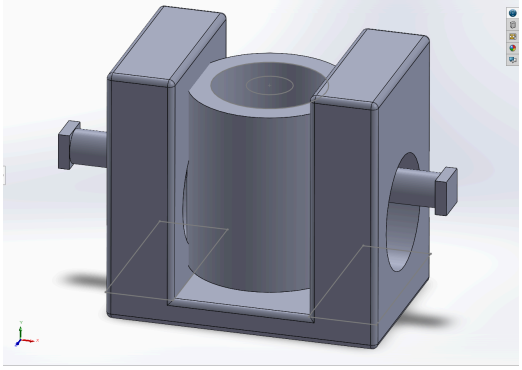
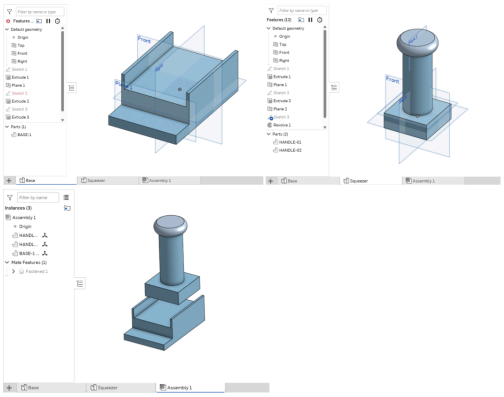
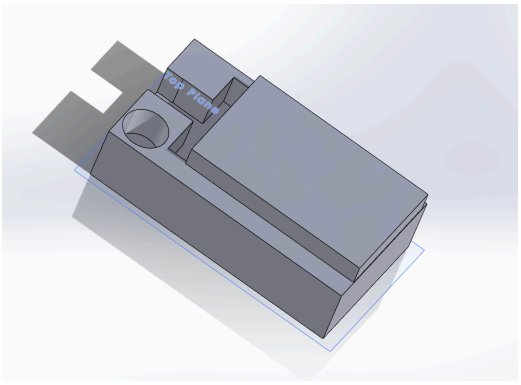
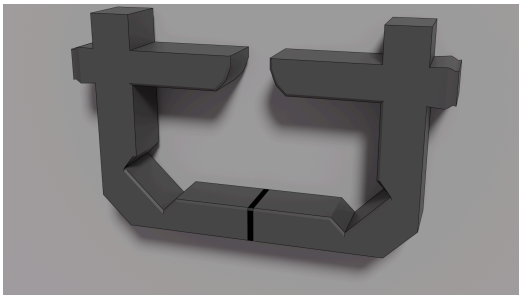
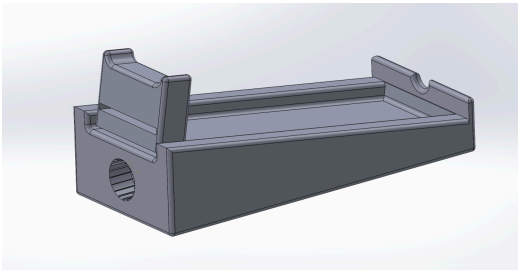
2-block compressor (Teammate 4 of 6)	Use two attached blocks and a large rotator to close the blocks to the size of the tube, then an extruded handle/pusher on top will squeeze it out.	
Wall mounted squeezer (Teammate 5 of 6)	Place the toothbrush and toothpaste in their designated spots (shelf and clips), then apply force on both sides to get the paste.	
Super Squisher (Teammate 6 of 6)	Take the squisher and use it as a squeegee to push up the toothpaste and using it up to the end.	

Table 6. CAD models.

Concept	Description	Photo
X-shaped Squeezer (Teammate 1 of 6)	Users can use two hands to add a small compressive force on both sides to accurately squeeze some toothpaste. Insert the toothpaste in the middle to remove the cap easily and just leave the cap in the middle to add it back on later.	 
Floating Squeezer (Teammate 2 of 6)	Insert the toothpaste into the cylinder and press the pins on the sides to extract the toothpaste.	

Block Stamper (Teammate 3 of 6)	The tube rests on a block, a stamp is used to push contents out of the tube.	
2-block compressor (Teammate 4 of 6)	Block on top squishes toothpaste in a rectangular holding section to squeeze contents out.	
Wall mounted squeezer (Teammate 5 of 6)	Insert the toothpaste into the regular position and by using the blocks on both sides, squeeze the toothpaste out.	
Super Squisher (Teammate 6 of 6)	Place toothpaste on the ramp and use gravity + sliding motion with the hand to squeeze out the toothpaste from the bottom.	

Appendix C: Weighted Decision Matrix

The full weighted decision matrix is shown below in Table 7, summarizing the evaluation of the six toothpaste squeezer concepts generated by K7. See “Design Need and Target Design Specifications” and “Concept Evaluation” for a description of the evaluation criteria and how the weights were determined.

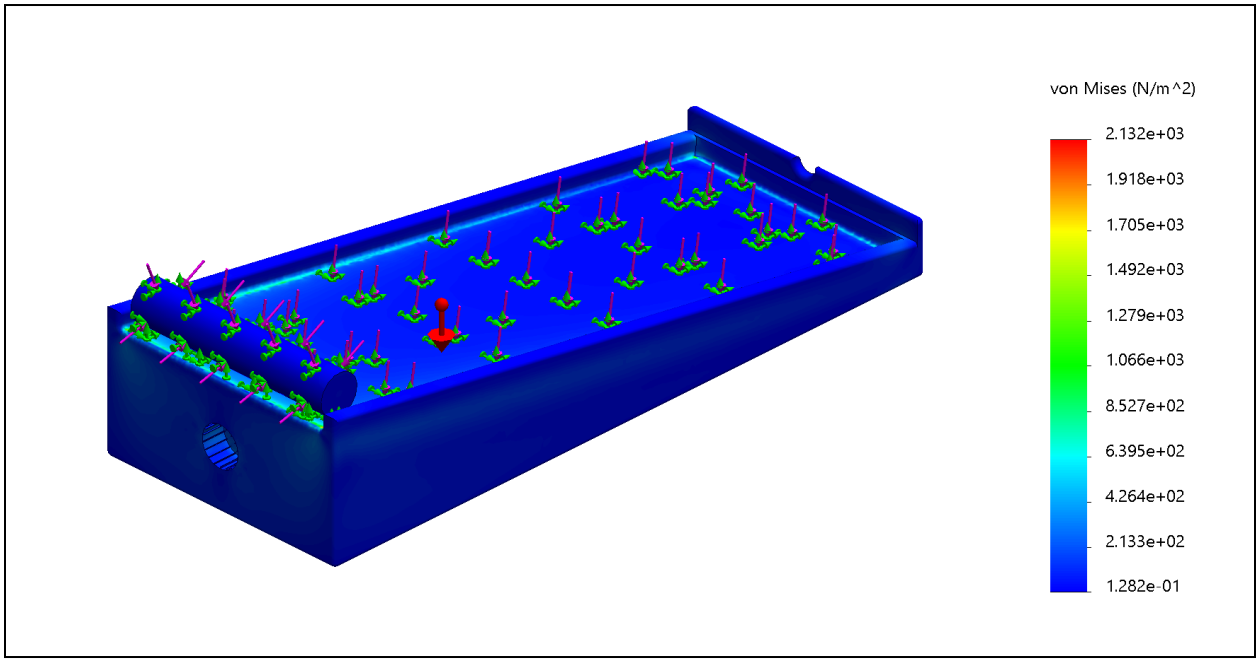
The criteria used is listed on the first column, followed by their weight in the second column. Columns 3-7 list the five ideas that reached the scoring stage, and each column gives the raw score (0-10) on the left as well as their corresponding weighted contribution on the right.

Table 7. Weighted Decision Matrix

Criterion	**Weight**	**Tube Squeezer Concepts**									
		Super Squisher		**X-shape Squeezer**		**Floating Squeezer**		**Wall Mounted Squeezer**		**2-block Compressor**	
Ease of Use	40%	8	3.2	6	2.4	6	2.4	8	3.2	5	2.0
Spillage	15%	8	1.2	6	0.9	7.5	1.13	5	0.75	6	0.9
Consistency	25%	6	1.5	8	2.0	5	1.25	8	2.0	6	1.5
Versatility / Compatibility	5%	9	0.45	5	0.25	6	0.3	5	0.25	7	0.35
Cost (to produce)	10%	6	0.45	8	0.45	3	0.3	0.2	0.2	6	0.6
Removes Cap	5%	10	0.5	9	0.45	0	0	0	0	10	0.5
Total Weighted Score	100%		6.85		6.45		5.38		6.40		5.85
Rank (1 = best)		1		2		5		3		4	

Appendix D: Stress Analysis

Figure 1. Stress Analysis of the Roley



Appendix E: Final Product

Figure 2. Final CAD Model

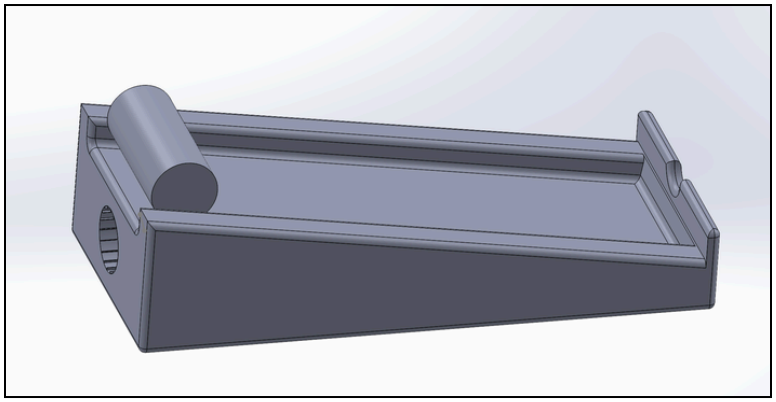


Figure 3. Final CAD Model - Front View with Cap Remover

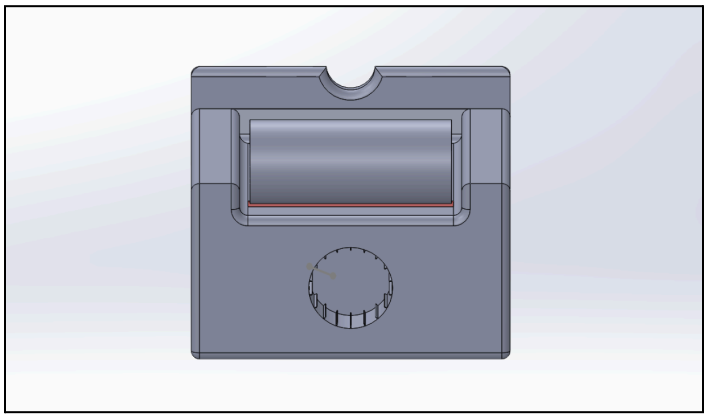


Figure 4. Cylinder with Stopper Close-up