Team Nugget's Hands-Free Door Opener

Phase 1 Progress Report

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Team Nugget

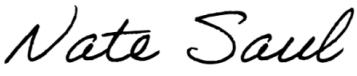
ME 26300-129

LC: Seunghwan Jo

LA: Nathan Wang

Team Members:

Nate Saul



02/11/2022

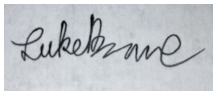
Samuel Graham

02/11/2022

Dingming Lu

02/11/2022

Luke Bame



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Executive Summary

The objective of this report is to provide information regarding the problem Team Nugget has planned to solve along with the research correlating to the problem. Team Nugget was prompted to provide an improvement to a product that applies to everyday life. Team Nugget chose to improve upon hands-free door opening devices, more specifically the StepNPull, due to the lack of options within the market and the problems the current products have.

To gather data on what customers desired, a survey was conducted which garnered over one hundred responses, which focused on learning about the inadequacies of the StepNPull, our primary competitor. In addition to the survey, patents and the market overall was researched to determine what ideas have been previously attempted and whether the market is open to Team Nugget's potential solution. From the conducted research, it was determined that customers are generally dissatisfied with the StepNPull, the patent space for the solution is open, and the market is projected to grow over the coming years. In addition to this research, benchmarks were selected to see how the current market addresses the issues faced by consumers. To visualize our end users and ensure that our product design is ergonomic, four personas were created and fleshed out. Finally, a plan for the future phases of design and prototyping was constructed to keep the team on pace and illustrate how Team Nugget will move forward in the weeks to come.

From the survey, patent and market research, and personas, Team Nugget generated the primary customer requirements for a hands-free door opener; these requirements being easy to operate, durable, low effort, safe, and quick. From the benchmarking process, it was determined that while some of our competitors fully satisfy customers on three or even four of the customer requirements, they completely fail or perform middlingly on the remaining requirements. Team Nugget wishes to provide a product that can maximize those five requirements while maintaining the core hands-free aspect. Considering the market, our competitors, along with our predicted price of $85 per unit, Team Nugget projects 30,000 unit sales, assuming 20% of the unit sales of our top competitor StepNPull.

The research conducted by Team Nugget has shown that the market is in a place where a convenient hands-free door opener would see success. The current solutions that address this issue only do so partially, leaving space for Team Nugget to innovate on the current market. Team Nugget is working towards creating a hands-free door opening device that is easy to operate, durable, low effort, safe, and quick. Team Nugget requests that additional funding be granted in order to produce our desired product.

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I. Introduction

The Purpose of this report is to address the problem of a non-user friendly way to open doors. In universities, hospitals, warehouses, and almost any business there are doors that can be hard to open for someone carrying supplies, that are unsanitary in the current pandemic, and that can be difficult to open for people with disabilities. Despite many attempts at tackling this problem, many of the products do not fit the needs of everyone, just the needs of a select few. Some of these attempts include the StepNPull foot hold, FortStrong door closer, automatic door and hardware, and a foot operated door opener.

The motivation from this project comes from personal experience with opening doors. Throughout the university, doors have foot openers that take a large amount of force in order to open them. Also, some of the doors are in awkward places which renders the foot opener useless. Along with the foot opener, the automatic door openers take a long time to open the door, which is inefficient. All products today that try to tackle this problem have some part of them that does not satisfy customer needs.

The beginning of this report will provide details on all of our research. This includes research on customers, markets, and other patents that try to tackle our problem. After this, the report will focus on the house of quality (HOQ). The HOQ will provide details concerning the customer requirements, engineering specifications, and some of the current solutions to the problem. This part of the report will also focus on how the current solutions are failing to meet some of the customer requirements. Additionally, Team Nugget will explain more in depth our problem definition and our values and goals for the project. Finally, how we will take humans into account, the future project scheduling, and the recommendations for the project will be provided.

II. Customer Survey and Market Research Results

1. Customer Survey Results

We set up seven questions in a survey, including their extent of experience with using the step and pull, why they didn't use step and pull, their thoughts about germs, ease of use of a door, and their expectations. One hundred and six people took the survey in three days, and here is the result.

When asking about their level of care of the spread of germs, only 11.3% of them really care about the germs (rate of 9 and 10), 7.5% of them don't care at all, and the number of people in each rest of the rate level (from 2 to 8) are very close. That is, the median is 11.3%, and the mean from the rate of 2 to 8 is 11.6%.

51.4% of them really care about the ease of use of a door, and the rest are approximately evenly distributed from 1 to 7. The top two factors that the customers care about are effort required to open a door and time required to operate a door. Not many people care about the space filled by the product (26.3%).

There is a product, then there is a price. 92.5% of them are willing to pay it if the price is less than $20, including 62.6% for less than $10, and 29.9% for between $10 and $20. The rest group of people, 7.5% of them, will accept the price greater than 20$.

2. Market Research Results

a. Market

In addition to data from the survey, Team Nugget also performed a simple analysis of the current market. According to the Americans with Disabilities Act National Network, at least 60% of entrances to a public building must be handicap accessible, with the same article stating "People with disabilities are the largest and fastest-growing minority in the U.S." This combined with the fact that according to the American Institute of Architects "spending on nonresidential building construction [is expected] to increase by 5.4 percent in 2022" and expected to rise from there. Additionally Team Nugget found that our most direct competitor, StepNPull, saw massive increases in sales from 2019-2020. From this market analysis, Team Nugget has determined that not only is there a market for handicap friendly door openers but that market is expanding in proportion with huge markets such as handicap friendly products and construction.

b. Product and Patents

(1). Step N Pull: Step N Pull is a piece of aluminum that is attached to the bottom of a door away from the rotating axis. It has a sawtooth design on the hook to provide enough grip to open the door by foot. This little awkward-to-use aluminum piece that takes maximum effort to open costs $30. Its patent was granted in 2015 and is still active (US9115530B2).

(2). Automatic Door and Hardware: It requires people to push a button to activate the system and open the door. This wheelchair-friendly door costs $300 to $600. It's slow to open, and its angular velocity can not be changed.

(3). Foot-operated door opener: this relatively small product is complicated to build. People will step on a pedal to unlock the trigger and open the door. This product was invented by Robert Stuart, and its currently expired patent was granted on September 18th, 2007 (US7270352B1).

(4). Foot operated door opener: This simple and install-friendly product has a similar name to the previous one. It should be installed very close to the axis of rotation, so people won't step and push for a long distance to open it. A close-to-axis design requires a large force to open. It was invented by Garritt Darling, and its currently expired patent was granted on March 26th, 2002 (US6360488B1).

(5). FortStrong: this product can close the door very slowly by itself and make people feel harder to open because of the internal resistance. This expensive device only does the door closing job and costs about $150.

III. House of Quality

From Team Nugget's research into the market, consumers, and currently available products, a house of quality was constructed to qualitatively and quantitatively measure what customers desire in a hands free door opener. From the research, Team Nugget has found that customers most value an easy to operate, durable, low effort, safe, and quick hands-free door opener.

Using the determined customer requirements, engineering specifications were selected and weighed against each requirement. Ease of operation is measured with both the force required to open the door, measured in newtons, as well as the time to open the door, measured in seconds. Durability is measured by the strength of materials used to construct the product, measured in ksi, as well as the longevity of the product, measured in years. Low effort is

measured in the force required to open the door, measured in newtons. Safety is measured by the number of components within the product that could potentially pinch any end users. Finally how fast the door opens is measured in seconds required for someone to pass through the door.

Team Nugget's House of Quality additionally analyzed three products within Team Nugget's target market to find how they met the highest weighted customer requirements. The results of this analysis found that the products under analysis usually met at least three requirements but would completely fail to meet the other requirements or would perform average to below average across the board. For example, Automatic Door and Hardware's door openers perform exceptionally well on effort required to open the door, ease of operation, and safety, however, the time required by the door is comparatively very high. These failures seen in the benchmarks demonstrates that there is room to improve on these products and potential in the market. Team Nugget's target product price is $80-$90, a standard price for products that offer less functionality than our proposed product. Additionally the product should be able to allow a door to be opened in 2 seconds while requiring a maximum of 67 Newtons to open. The product should also be functional for a minimum of 10 years and incorporate no more than 3 pinching parts.

Resulting from Team Nugget's House of Quality, the dominant customer requirements were identified as points for the product to be designed around. The final product should allow a door to be opened with little force, and require little time to open while being ergonomic, durable, and safe. Most critically the product will function while not being operated with a user's hands. The aforementioned engineering specifications, along with several others will be considered and utilized to guarantee that the final product fully fulfills these needs. Team Nugget's House of Quality demonstrated that there is significant room for improvement on hands-free door opening devices.

IV. Problem Definition

From Team Nugget's research, the key customer requirements for the product to fulfill are that it must be easy to operate, durable, low effort, safe, and quick hands-free door opener. Team Nugget has found that the market for doors and specifically hands-free operated doors is expanding and believes that it can reach up to 20% of our most relevant competitors' sales, or 30,000 first year units. Team Nugget has established engineering specifications in accordance with the customer requirements. Team Nugget plans to address these requirements by creating

a product that has a functional lifespan of minimum 10 years, requires 67 or less newtons of force to open, and takes 2 or less seconds to open, while being completely hands free.

Now, our problem definition has come. Our current goal is to improve the current method of opening doors without needing to use someone's hands. The potential customer includes hospitals, warehouses, universities, and handicapped people. In a hospital and a university, it should prevent the spread of germs. Also, the customers should be able to open the door while holding a lot of stuff in their hands. For warehouse and handicapped people, people should be able to open the door easily without someone's help. In these cases, the door should not require more than 76 Newtons to open, which is equivalent to the force of lifting two wooden chairs. It should take 2 seconds or less to open, which will avoid wasting time especially in an emergency. It should maintain its functionality for at least for 10 years, and should not incorporate more than 3 pinching parts because more components and more moving parts are more likely to be broken.

V. Human-Centered Design Considerations

Since we are not using hands to open a door, using feet is a promising choice. To transfer the motion from the feet down below and not affecting the path, the trigger should be close to the door and wall, transfer the motion to the top with hydraulic mechanism or lever, meanwhile not affecting the door to open. It should not be awkward to use and willing to be used if people see it.

VI. Project Plan

As team Nugget enters phase 2 of the design process, specific design and modeling concepts will be explored in greater detail. With the problem definition and plan of attack being established in phase 1, the team is poised to make engineering specification driven design decisions which fully address customer requirements. Key activities in phase 2 include: concept generation and selection, benchmark comparison, design documentation, BOM and financial analysis, and of course early stage prototyping.

After phase 2, Team Nugget will begin phase 3 of the design process. This phase will be marked by the physical development of a prototype/product. The prototype will be subject to a myriad of analyses with the intent of measuring market viability. At the conclusion of phase 3,

Team Nugget will present the final product as well as the culmination of data collected along the way. It will be the team's goal to prove the final product’s ability to address an everyday issue with a well-tested mechanical solution.

VII. Conclusion and Recommendation

Over the past few weeks, Team Nugget has been working toward a clearer idea of the issues presented with a hands free door opening device. In addition to problem understanding, there have been several modes of solution scoping, either through market research, customer research, and even direct research with existing door appliances in and around campus. All this data collection has allowed the team to construct a complete understanding of what our product must be able to achieve given the customer requirements which were translated into engineering specifications.

As part of the customer research, a survey was conducted in order to better understand the interests and desires of an average user. The survey included questions about key aspects of the product such as ease of use, time required to use, longevity, and safety. Questions pertaining to product price and overall customer demand were also included in the survey. The resulting data allowed us to conclude that an easy to use hands free door opening device does have market viability.

In researching the market for similar products, Team Nugget was able to establish that there is certainly a market gap when it comes to the device specifications the team had in mind. Current foot operated door opening devices all lack one or more major specifications which Team Nugget plans to exploit with their new device.

In the House of quality matrix, The team gained a better understanding of what product features should be focused on more heavily. The HOQ also allowed for direct comparisons among the leading competitor products. Through the house of quality, Team Nugget gained perspective on both product requirements and the market itself.

As stated in the project plan section, Team Nugget is entering the second phase of the design process. The ultimate goal of phase 2 will be to have a fully fleshed out design to present and then in phase 3 the actual physical creation of a prototype will be implemented. In order to be in good standing for phase 3, it will be crucial that the team is able to nail down key design aspects that address the customer requirements.

VIII. Appendix

PROJECT TITLE	Phase 2	TEAM NAME	Team Nugget
GROUP MEMBERS:	Graham,Saul,Barne,Lu	DATE	2/11/22

TASK TITLE	START DATE	DUE DATE	DURATION
Functional Decomposition	2/16/22	2/23/22	8
Generate Concepts	2/16/22	2/23/22	8
Select Concepts	2/18/22	2/23/22	6
Compare to Benchmarks and Patents	2/18/22	2/23/22	6
Create Design Documentation	2/18/22	2/23/22	6
Openended Description	2/23/22	2/25/22	2
Bill of Materials	2/23/22	2/28/22	5
Financial Analysis	2/25/22	3/2/22	7
Update Project Plan	2/16/22	3/9/22	23
Preapre Report	2/25/22	3/11/22	16
Progress Report 2	3/18/22	3/18/22	0
Phase 2 Prototype	3/8/22	3/18/22	10
Product Design and Modeling (Begin)	3/16/22	3/20/22	4
Phase 2 Review	3/18/22	3/20/22	2

PHASE ONE

WEEK 1							Week 2							Week 3							Week 4							Week 5						
M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Figure 1: Phase 2 Gantt chart

PROJECT TITLE	Phase 3	TEAM NAME	Team Nugget
GROUP MEMBERS:	Graham,Saul,Barne,Lu	DATE	2/11/22

TASK TITLE	START DATE	DUE DATE	DURATION
Completion of Modeling and Product Design	3/21/22	4/1/22	10
Operational Description	3/21/22	4/1/22	10
Part Drawings	3/21/22	4/1/22	10
Assembly Drawings	3/21/22	4/1/22	10
Update Bill of Materials	4/1/22	4/3/22	3
Justify Final Design	4/4/22	4/8/22	4
Performance Analysis	4/9/22	4/13/22	4
Assembly Analysis	4/5/22	4/8/22	3
Economic Analysis	4/4/22	4/7/22	3
Phase 3 Prototype	4/4/22	4/24/22	20
Preapre Final Report	4/19/22	4/24/22	5
Audience Analysis	4/19/22	4/20/22	1
Content	4/21/22	4/23/22	2

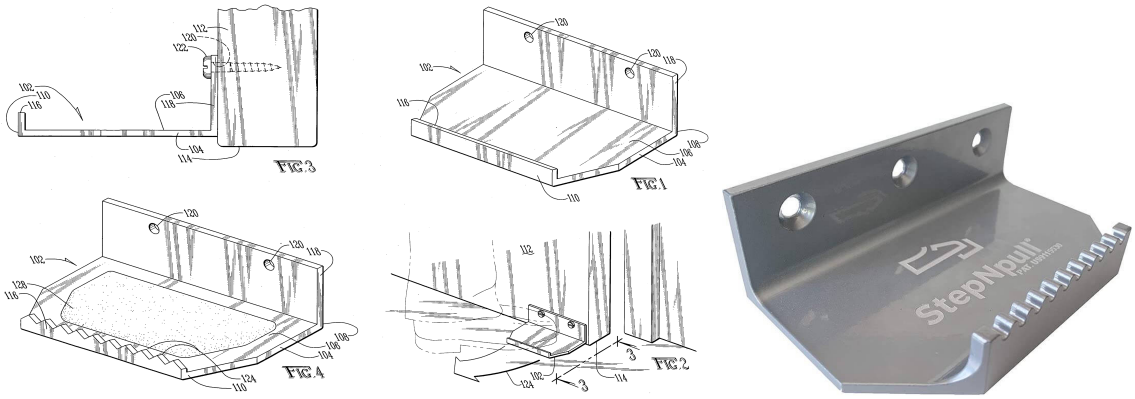
PHASE ONE

WEEK 1							Week 2							Week 3							Week 4							Week 5						
M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN	M	T	W	R	F	S	SUN
21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Figure 2: Phase 3 Gantt chart

HOUSE OF QUALITY	Who (Customers)				How (ES)									Now (Benchmarks)			Ratings Legends:
What (Customer Requirements)	Warehouses	Handicapped People	Hostpital	Universities	Weight averages	Force of operation (Newton) ↓	Strength of material (ksi) ↑	Longevity (years) ↑	Unit Cost ($) ↓	Size of Unit (in^3) ↓	Use of Standardized Parts (#) ↓	Sound Produced (Decibles(dB)) ↓	Time to open door (Seconds) ↓	Number of Pinching Parts (#) ↓	Automatic Door and Hardware	StepNPull	FortStrong	Now vs What:
Effort to open the door	10%	15%	11%	7%	10.75%	9	1	1	0	0	0	0	3	0	5	1	3	1 = does not meet requirement
Ease of operating the door	17%	12%	13%	10%	13.00%	9	0	3	0	1	0	1	3	0	5	1	3	2 = meets requirement slightly
Time required to operate door	10%	9%	5%	5%	7.25%	0	0	0	3	0	0	0	9	0	2	3	4	3 = meets requirement somewhat
Space filled by unit	3%	5%	5%	5%	4.50%	0	1	0	1	9	3	0	0	1	5	5	5	4 = meets requirement mostly
Ease of installation	8%	5%	8%	10%	7.75%	0	0	3	3	3	9	0	0	1	2	5	4	5 = meets requirement completely
Low Cost	10%	5%	8%	14%	9.25%	3	3	3	9	1	1	0	0	0	1	4	2	
Durability	15%	11%	12%	14%	13.00%	1	9	9	3	0	1	3	0	0	4	5	4	How vs What:
Aesthetically pleasing	0%	5%	5%	5%	3.75%	0	1	0	3	1	1	9	0	1	3	3	3	blank (=0), 1, 3, 9
Ease of repair	11%	7%	7%	6%	7.75%	1	1	3	1	1	9	0	0	0	2	5	3	
Safe to operate	10%	10%	13%	10%	10.75%	3	9	0	0	1	0	0	3	9	5	4	4	Who vs What:
Retro-Compatibility	3%	5%	8%	8%	6.00%	0	0	1	1	3	3	0	0	0	4	5	4	weights summing to 100
Quiet	0%	5%	5%	5%	3.75%	1	1	0	3	0	0	9	1	1	4	5	4	
Purely Mechanical	0%	3%	0%	1%	1.00%	0	0	1	3	3	3	1	1	1	1	5	5	
Customizability of door operation time	3%	3%	0%	0%	1.50%	0	1	0	1	1	9	0	9	0	4	3	3	
Total	100%	100%	100%	100%	100.00%	27	27	24	31	24	39	23	29	14	47	54	51	
Automatic Door and Hardware						67	~30	N/A	$1,600	269	~3	N/A	6	3				
StepNPull						67	~40	N/A	$30	30	0	N/A	3	0				
FortStrong						67	~30	N/A	$130	372	~3	N/A	2	3				<= these are values for ES in proper units
Target (Delighted)						22	45	15	$10	100	6	10	1.5	0				
Threshold (Disgusted)						132	25	3	$1,600	500	0	70	10	6				

Figure 3: House of quality



Figures 4-6 (left to right): Step N pull, patent No. US9115530B2

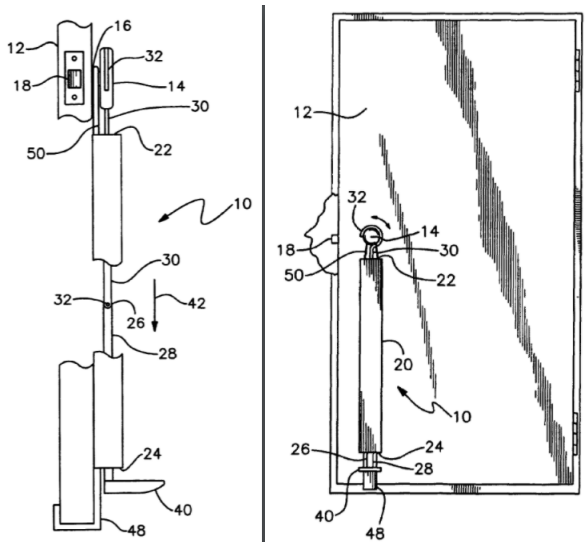


Figure 7-8: foot operated door opener (1), patent No. US7270352B1

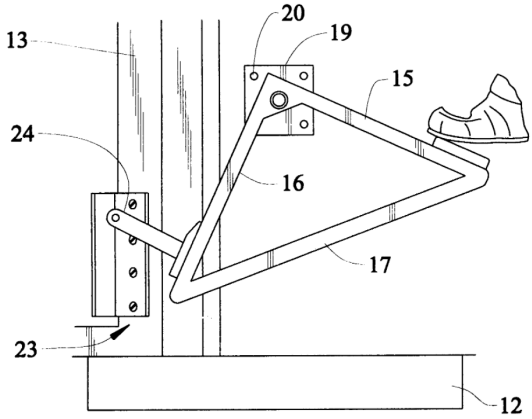


Figure 9: Foot operated food opener (2), patent No. US6360488B1

Mr. Deere is a 40-year-old warehouse worker for his company in West Lafayette, IN. He handles many boxes a day for shipping purposes, and has to open different doors throughout the day in order to get the boxes ready. Since these boxes are heavy, it requires John to use both hands to carry them. Because of this, in order to open doors he must set down the box, then open the door, then pick up the box and move through the door. This is very inefficient, and causes some delays throughout the work day for John and his crew.

Figure 10: persona 1: John Deere

Prof. Friday is a university instructor in the department of mechanical engineering. He always brings some fun stuff with his textbooks to demonstrate the theories for his students. However, his stuff on his two hands doesn't allow him to open the door easily. In order to open the door, he has to crouch, push the handle, and pull the door in a very awkward way. Additionally, the door can be very heavy, which makes the movement even harder.

Figure 1e1: persona 2: Prof. Friday

Dr. Sofia Jones is a neurologist in Fort Wayne, IN, and works 5 days a week in the hospital. Each day, hundreds of workers, patients, and visitors touch the different door handles in the hospital. During the COVID-19 outbreak, door handles were helping to transmit the virus. The doctors wore gloves, but the patients and visitors in the hospital did not. Because of this, infection rates grew in hospitals.

Figure 12: Persona 3: Dr. Sofia Jones

Achilles is a 10-year-old who was in an accident when he was younger. In this accident, he became paralyzed from the waist down, and requires the assistance of a wheelchair to move around. Most doors have a handicap button in order to help those with disabilities, however almost all bathroom doors do not. For Achilles it is difficult to open the bathroom doors, especially if the handle is too high for him to reach. In order to open the door, he must wait for someone else to use the restroom.

Figure 13: Persona 4: Achilles Johnson

IX. References

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