A Case Study to Investigate how Beta Product Marketing can Test the Validity of a Product's Market Potential

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MASTER THESIS

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A Product Development Process of a Caulking Gun with the Goal of Discerning the Worth of Beta Product Marketing

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Abstract

Many entrepreneurs and start-ups come to the point when they have finished the development of a product but then moves to the phase which is crucial for a products success, the marketing effort. Large investment costs combined with the uncertainty of the developed product's market value is the reason for many products failure. Thus, many new products never reach the market because of the lack of certainty concerning the products market potential.

This thesis aims on spreading some light on the market value of a product by using a new method, described by the thesis as "Beta Product Marketing". This method builds on the principle of developing a so called beta product. A beta product is a prototype that is introduced into the market as if it was the finished product. By analyzing the responses from these sales, one can, according to the thesis, better determine the market potential of one's product and thereby get important insights before taking large investment risks.

The thesis consisting of two main parts, one being the development of a product and the latter treating the field of exploring the market.

This thesis resulted in a prototype that could be introduced as if it was the finished product. The Beta Product Marketing resulted in a small study comparing the method to a standard way of predicting the market attractiveness. It was stated that the method seemed to predict the market quite well but that the research needs more data to be verified.

Keywords: Beta Product Marketing, market validity, entrepreneurial marketing, prototype, test sales

Sammanfattning

Många entreprenörer och startup kommer till en punkt när de har slutfört utvecklingen av en produkt men flyttar sedan till den fas som är avgörande för en produkts framgång, marknadsföringsbiten. Stora investeringskostnader i kombination med osäkerheten om den utvecklade produktens marknadsvärde är orsaken till många produkters misslyckanden. Detta leder till att många nya produkter aldrig når marknaden på grund av bristen på säkerhet över produktens marknadspotential.

Examensarbetet syftar till att öka kunskapen och säkerheten kring en produkts marknadsvärde genom att använda en ny metod som beskrivs av examensarbetet som "Beta Product Marketing". Denna metod bygger på principen att utveckla en så kallad beta-produkt. En beta-produkt är en prototyp som introduceras på marknaden, som om det var den färdiga produkten. Genom att analysera svaren från dessa försäljningar kan man enligt examensarbetet bättre avgöra marknadspotentialen för en produkt och därigenom få viktiga kunskaper innan man tar stora investeringsrisker.

Examensarbetet består av två huvuddelar, en är utveckling av en produkt och den senare behandlar området för att utforska marknaden. Examensarbetet resulterade i en prototyp som kunde introduceras, som om det var den färdiga produkten. Beta produktmarknadsföring resulterade i en liten studie som jämförde metoden till ett vanligt sätt att förutsäga marknadens behov. Enligt examensarbetet verkade metoden förutsäga marknaden bra men studien behöver mer data som kan verifiera undersökningen.

Nyckelord: Beta Produkt Marknadsföring, marknadspotential, entreprenöriell marknadsföring, prototyp, test försäljning

Acknowledgments

This thesis is the fruit of an upbringing in an environment where truth is always the goal. Where the question "why?" is always asked to understand the essence of things. That is also why I have spent five years doing university studies, to broaden my knowledge of the essence of things. That is why I owe a great gratitude towards my parents who have been this oasis where good is always strived for.

I would like to thank my family, friends and my fiancé for their support.

I want to give great thanks to my supervisor, Damien Motte, who has always been there to answer any of my questions. His great interest in the area of innovation is contagious and it has helped me to broaden my perspective. Damien Motte has also been essential for the structure of my work, by carefully reading my thesis and giving me valuable insights.

I would also want to thank Associate Professor Devrim Göktepe-Hultén from the Department of Business Administration who have provided me with valuable tips concerning the structure and marketing part of my thesis.

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This thesis was performed in the Division of Product Development at the Department of Design Sciences LTH. I would like to thank all employees who have given me feedback and participated in my survey. Also, I would like to thank all other master students who have been in the same office, making it more fun to come to work every morning.

The reason man studies nature is because it is meaningful and beautiful. Thank You for this depth that leads to Truth

Lund, May 2018

Fadi Hanna

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1 Introduction

This master thesis will develop on existing concepts of testing a product's market potential. The master thesis will be done as a case study on a product which have reached the end on its development process. The thesis intends to give insights to the product development process so that it can be determined if the product in question has market potential.

1.1 Background

1.1.1 General background

This master thesis builds on a continuation of work done in the course MMK101 [1] with the intention of evaluating the interest of the product developed in the course.

MMK101 [1] is a course of 30 credits with the purpose of developing a product prototype and integrating the product development process in the development and producing a report that documents the process.

In the course "product development project" MMK101 a product development process on a caulking gun was conducted and an early staged prototype was presented. Along the process an investigation of needs was conducted in traditional product development manner, more specifically according to Ulrich and Eppinger [2].

Finding the needs of the product is a topic well covered in product development literature but to be able to assess if these needs are sufficiently important, to the sense that they will result in a sale is a crucial question that needs to be further looked upon.

In the end of the product development project in the course MMK101 it couldn't be determined if the product would be a success on the market. To really cover this question, one needs to go beyond the subjectivity that follows a simple statement such as "This product would be interesting for me". The problem with these statements are that the person in question needs to imagine herself being in a situation that she is not in. This includes that the person in question needs to presuppose his potential attitude which creates a dissonance between a real need and a presupposed need. This last statement will be the base of the method used in this thesis, to clarify what the actual needs are and not having to consider the fictive needs that the potential customer says he has but really do not have. This is also the base of error a company has when doing predictions of how many products it will sell during a certain period. The thesis will investigate a method that treats this uncertainty of fictive needs.

1.1.2 Related literature

This thesis will help understand this dissonance so that one can reduce it and by this also reducing the risk of failure.

The obvious way to represent the need in a correct way is to try to make a real sale and see if the person in question will pay the demanded price. This will remove the speculative part of the question and give support for the product’s market attractiveness.

This master thesis aims to investigate the concept of producing a product in small scale with low investment costs and to analyze the response from its sale. This sale will according to the hypothesis of the thesis lay a better ground to decide for potential future investments. The approach that in this thesis is called “Beta Product Marketing” will according to the hypothesis also contribute to the developing of a product that better fits the needs of the customer and that the total developing time and potentially costs will reduce.

There are already existing methods of pre-launching products on the market such as expeditionary marketing [3], test-marketing [4] and in Strategic Management of Innovation [5]. The methods presented in test-marketing [4]focuses on adding confidence in an already done product development process so that management dears to take a final decision. While expeditionary marketing [3] focuses on changing the traditional mentality of well established companies so that they dear aiming on new markets without the traditional marketing research (see [6] for more details). In Strategic Management of Innovation [5] it is pre-supposed that the product is completely finished before testing the product in the market. In [5] the product is launched at a small scale and its sale is thoroughly monitored; product changes are then performed before going into mass-production.

Compared to three approaches, the Beta Product Marketing goes one step further to decrease cost and get earlier feedback. The product is a beta-version, not finished but sufficient for leading customers to judge the products worth. One could say that this thesis principle method could be regarded as entrepreneurial marketing [7] while combining the thinking of test- and expeditionary marketing. The hopes are that this thesis will enlighten the sphere of cooperation between engineering and market so that the lead time, cost and customer fulfillment of the product can improve.

1.1.3 Former work conducted in MMK101

As the product development part of this thesis builds on the work done of a project made in the course MMK101, a presentation of the work done will be given so that the reader can capture the context of the project.

Mechanical powered caulking gun (39SEK Biltema)

Pneumatic powered caulking gun (2560SEK Würth)

Battery powered caulking gun (1863SEK Proffsmagasinet)

Figure 1.1 Different kinds of caulking guns with price

From the work [8] we read that there is a market gap between the existing caulking guns on the market. There are the simple 10 USD caulking guns which are manually driven by hand force and then there are at the other end the electrical driven caulking guns with cost going up to 1000 USD a piece. From both market scan and interviews made, the following target group was identified " "A caulking gun for the user that uses it quite often but sees no need of buying a battery driven of an economic perspective or of a practical perspective of limited space in the tool storage."

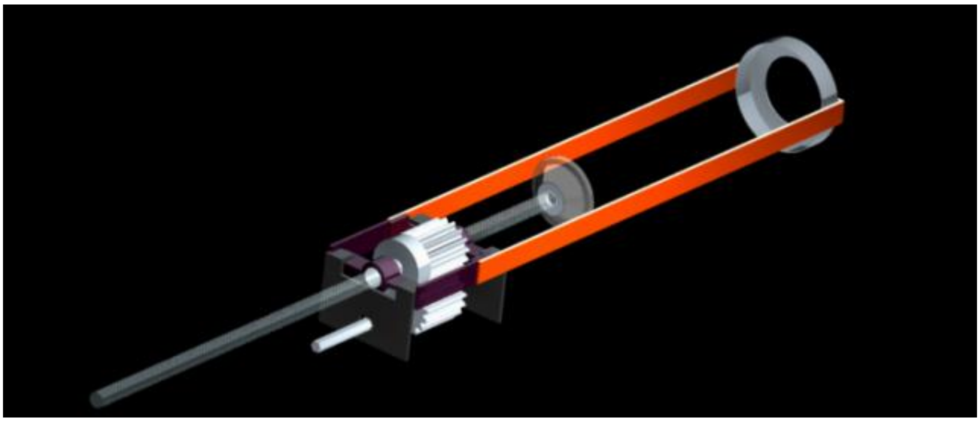


Figure 1.2 Illustration of the concept solution from MMK101

The needs for a caulking gun that can be an add-on to an ordinary electrical drill that was identified where powerful, lightweight, balanced, even flow, high speed and price competitive. From these needs a caulking gun was designed and technical drawings was presented of the solution. The separate principal functions where demonstrated with a prototype, but no working prototype was constructed.

The output solution from the work conducted in the course MMK101 is a caulking gun that by an input shaft converts rotary motions with the help of a gear and a nut to linear motion so that a force output can be achieved on the caulk tube so that caulk is pushed out.

The presented solution is not complete and not ready to be produced, the problems of the presented solution are presented under problem description further on below.

1.1.4 Scientific foundation

In current product development literature, it is evident that a successful product needs both the technical and marketing aspects emphasized. That is why cross-company project teams are needed to simultaneously develop technical, manufacturing and marketing aspects [9, pp. 81-93]. This thesis, with the work of investigating beta-product marketing, will try to be a method that by its nature unites technical, manufacturing and marketing efforts.

According to Thomke and Reinertsen [10] the drawbacks of traditional needs clarification is mainly two factors:

- “the co-evolution of technical solutions in components that are part of a larger system”
- “Customers’ inherent difficulty in accurately specifying their needs at the outset of a design project system.”

This corresponds to the purpose of the thesis of objectifying subjective customer needs.

The authors [10] add that on average only 58% of the requirements are specified before starting the design phase. This thesis will hopefully help to increase this staggering number by introducing the product early to the market, so changes can be made in the more thoroughly conducted design phase. The hopes are thus that Beta Product Marketing will be able to better attain the requirements then the traditional testing. The accuracy of the requirements specified by the potential customer will according to this thesis be more elaborate when the potential customer is faced with a real sale effort.

Charles M. Mayo states in “Reference for Business” [11]: “The dynamics of markets, technology, and competition have brought changes to virtually every market sector and have made new product development one of the most powerful business activities.” In pace with a bigger and more dynamic demand on the product development process, the process in itself needs to progress and be reevaluated. Markets today changer faster than ever and we need the product development process to meet the demands of the market. So, this project will be conducted to investigate ***if pre-launching a product could be a way for faster evaluation of the product under development and at what phase of the product development process should such a "beta product" be introduced.***

In the same article we read the following "Various studies suggest that between 50 and 80 percent of new products fail—the greater the rate of new product development, the higher the failure rate." which highlights the second aspect of this master's thesis, ***"is pre-sales a good way of determining a product's potential future success?"*** Important to note is that pre-launching products means higher risks of failure but with less investment efforts, and a chance to improve the product to reduce the rate of failure.

Today there is information on how to predict the potential success of a product. Ulrich and Eppinger [2, p. 175] describes a forecasting model to predict the **Q**uantity of sold products during a time period:

$$Q = N * A * P$$

Where **N** is the **N**umber of potential customers, A is the fraction of these potential customers for which the product is **A**vailable and P stands for the **P**robability that the potential customer that is aware of the product purchases it. The P is calculated in the following manners:

$$P = C_{definitely} * F_{definitely} + C_{probably} * F_{probably}$$

Where P stands for **P**rofit, C stands for a **C**orrection factor and F stands for **F**raction of respondents. These variable F are received by conducting a survey with a question to see if the customer will definitely buy the product or probably. The correction factor C is usually based on company experience but lies normally between the intervals $0.10 < C_{definitaly} < 0.5$ and $0 < C_{probably} < 0.25$. This thesis will work on a new method of calculating the P, by the introduction of a beta product. The results from the thesis can then be compared with the existing method of predicting the quantity of sales.

This important aspect of the master theses is to reduce the subjective importance of the consumers so that the information becomes more reliable. Ulrich and Eppinger in their forecasting model states that many teams uses the value of 0.4 for $C_{definitely}$ and 0.2 for $C_{probably}$ [2, p. 177]. These correction factors show that it is few that go from intent to action and that these values are very uncertain. This behavior is recognized in the field of product development and this thesis will investigate to see if launching a beta-product gives more reliable information than subjective statements.

1.2 Objectives

This master thesis consists of two main parts, the first is to develop a beta-version of the product and secondly to conduct a beta-product marketing.

In the first part a continuation of the work done in a product development project will be conducted with the focus on creating a functional prototype. The prototype will be constructed in such a way that it can be produced with low-investment methods. The continuation will foremost build on the principle of constructing a workable prototype that will be remodified until essential demands are fulfilled. When all essential functions are satisfied a search for different manufacturing methods of the small-scale production will be analyzed and discussed.

The second part of the thesis will be a try to get a beta version of the product into the market so that valuable insights can be collected, mainly validation of market potential. The master thesis will contribute to deepening the knowledge in this area by a case study of introducing a unique caulking gun into the market by a beta-product. The market reactions of the sales of the beta-version will be used to make a prediction of its market attractiveness. These inputs will put the basis to take a decision if it's beneficial to invest in the product for a large-scale manufacturing or not.

If the goals of the master thesis are reached, the results of the thesis will provide additional knowledge of the field of expeditionary marketing. It will see if the method of beta-sales can help the launch of successful products and thereby contribute to insights on the product development process. It will also be investigated to see if routines can be established regarding the marketing of beta products.

1.3 Methodology

The two above stated objectives will be reached by an adapted methodology for each part. Below follows a presentation of the methodology used for each part.

1.3.1 **Methodology of the development of the beta product**

The beta product will be built by an iterative approach. Firstly, the inherited problems from the course MMK101 will be resolved. When a solution for all the problems is found the housing will be designed. The design will be printed on a desktop 3D printer whereas it will be evaluated and redesigned until a satisfying beta-product has been constructed.

1.3.2 **Methodology of the test of the Beta Product Marketing**

The Beta Product Marketing will in this thesis consist of trying to sell the product to potential customers, not with the intention to sell but to collect insights.

The original plan was to conduct the Beta Product Marketing in stores where caulking guns are sold, this because of the intention of being in as real sale situations as possible. Due to complications in entering these markets the plan was modified.

The Beta Product Marketing will instead in this thesis be conducted at the building of Department of Design Science and at a yard sale. All insights from the product survey and the beta product sale will be collected with the intention of measuring the products market attractiveness. The test done in IKDC will be done in two formats, one standard survey and the Beta Product Marketing, so that it can be used for comparison.

To entitle some form of evaluation of the performed Beta Product Marketing, it will be compared to a standard way for testing a concept. According to Ulrich and Eppinger a forecast of the sales can be done by evaluating the results from a survey [2, pp. 166-179]. So, to evaluate the Beta Product Marketing effectiveness it will be performed alongside a traditional market survey. The results from the prediction according to the traditional manner will be compared to the result from the Beta Product Marketing. The layout of the beta market test and the standard survey format can be found in appendix B and C.

2 Detailed Design

In this chapter an overview of the development process will be given. Firstly, the inherited problems from the original caulking gun that was constructed in MMK101 will be resolved and further development will be conducted to produce a beta product.

Figure 2.1 Illustrated on the top left is the base on which the designed caulking gun is built on. Top right we can see the parts of the designed product from MMK101 in an exploded view and the image in the middle shows a rendered image of the product idea.

2.1 Improvements in Design

From the product development report (PDR) [8] a number of problems exist on the current solution of the caulking gun. Below the inherited problems from the current solution and problems discovered while prototyping is listed and explained. These improvements are continued until it can be presented as a finished beta product.

2.1.1 **Problems**

1. Gear-ratio

The feeding speed is not properly calculated, it exceeds normal standards and was calculated on the wrong basis. This needs to be redone by doing calculations on a feeding speed that is correct to market standards.

2. Choice of lead screw

The forces on the leadscrew where not considered and no calculations were made on the leadscrew to dimension according to forces.

3. Fixation of rotational freedom

There is no fixation between electric drill and caulking gun thus the caulking gun can rotate around itself, this needs to be tested while operating to see if it poses a problem.

4. Fixation of rotational freedom of lead screw

Lead screw needs to be blocked from rotation, so it moves transversally and does not begin to rotate which will prevent the piston from moving forward.

5. Axis distance - Distance between electric drill (input) and lead screw

Distance between the gears are to close which does not give sufficient space for the electrical drill. This distance needs to be remodified.

6. No handle on the caulking gun

From the concept caulking gun in MMK101 there were no handle which decreases the ergonomic.

7. Force analysis

There needs to be calculations on the designed parts to see if they can handle the forces that are generated by use.

8. Hide bolts and other Design aspects.

There are bolts on the design and other appearance flaws that needs to be taken care of for the finished beta product.

Prototype \ Problem	1	2	3	4	5	6	7	8
A	x	x	x					
B	x	x	x	x				
C	x	x	x	x	x	x		
D	x	x	x	x	x	x	x	
E	x	x	x	x	x	x	x	x

Table 2.1 this table shows what problem was resolved with each new iteration of a prototype. Thus, the reader can follow to see at which prototype a problem was discovered.

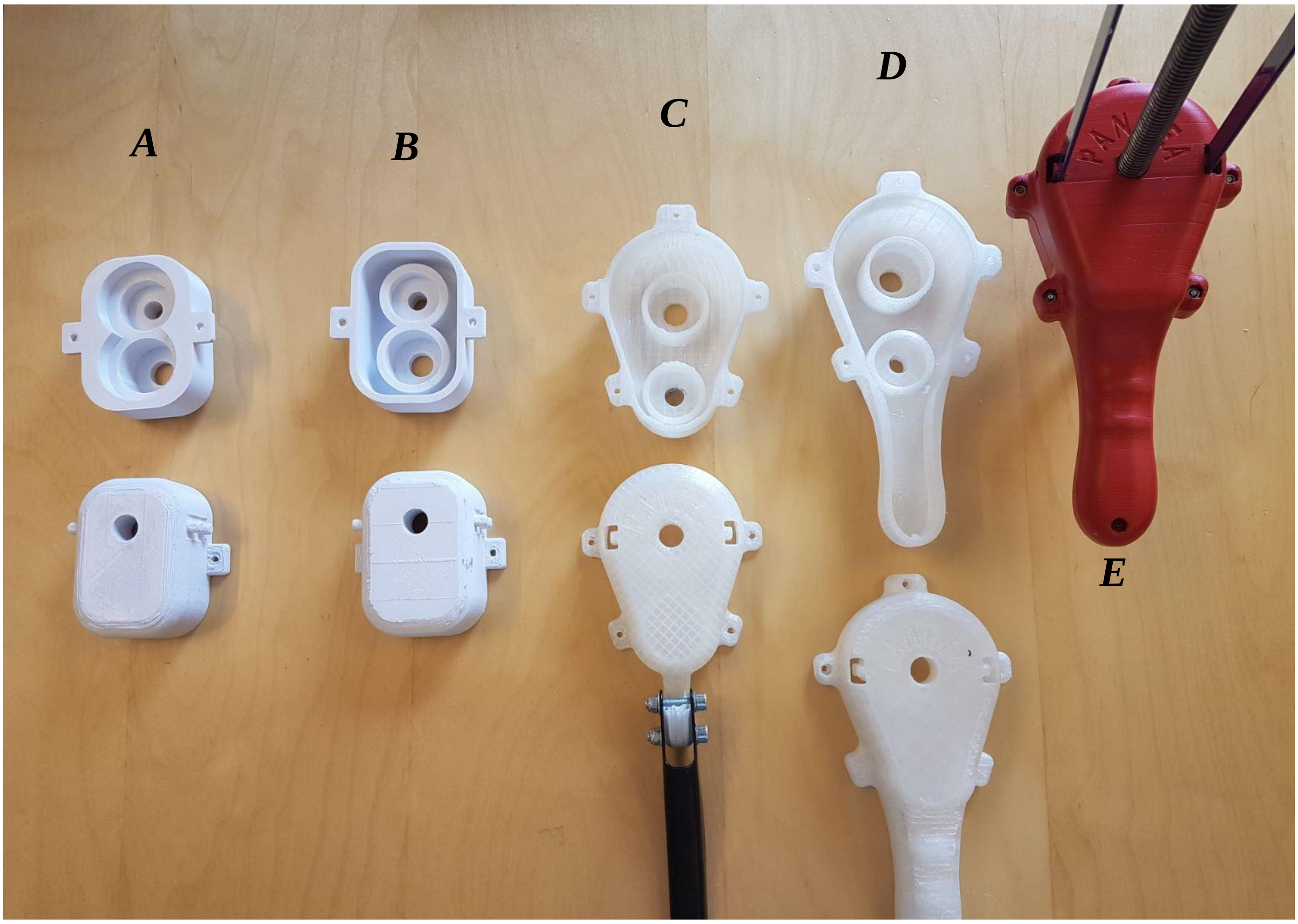


Figure 2.2 Image of prototype iteration

2.2 Resolution of Problems

2.2.1 **Choice of force axel**

From the PDR [8] the choice of rod is a leadscrew. In the majority of the existing battery driven caulking guns on the market a gear rack is used. The use of rack as a force axel is quite evident looking at the efficiency compared to leadscrew [12, p. 248].The higher efficiency also indicates that the lead screw tears out faster. The disadvantage of a rack gear is that it requires higher torque thus a reduction gear is often used [13]. The advantage of using a leadscrew is thus the need of less gears which minimizes the cost. According to the PDR [8, p. 9] the caulking gun is aimed at a market where low cost is prioritized. The choice of a leadscrew will contribute to this target and is therefore used.

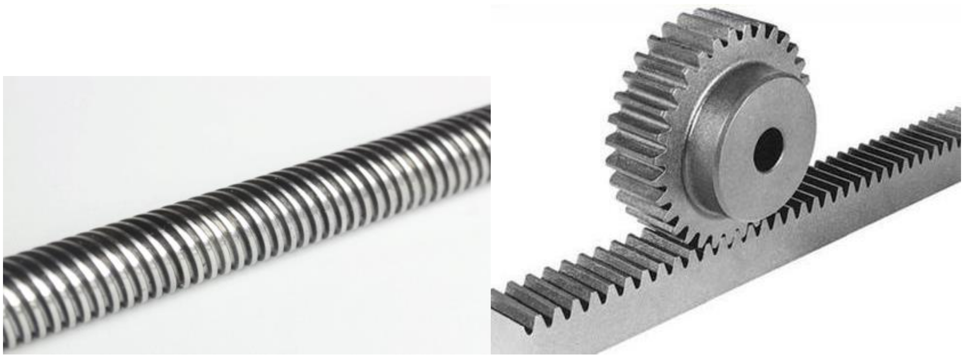


Figure 2.3 Leadscrew to the left and rack gear to the right

2.2.2 **Choice of leadscrew**

The speed output of the caulk and the transversal force output are two parameters affecting the choice of leadscrew. Firstly, we need to calculate the speed output of the leadscrew, so that a good pitch size is chosen then the forces will be analyzed to dimension the leadscrew accordingly.

2.2.2.1 Speed output

From the PDR we find that desired force output in a battery driven caulking gun should be able to reach 2000N and should be able to caulk approximately up to 10mm/s [8, p. 8].

The rotational speed of a standard electrical drill at lowest gear is 0-400 rev/min and torque is approximately 15 Nm at this speed in working load [14]. It is important to keep in mind that the speed of 0-400 rev/min is in no load conditions and to compensate, it is assumed that the speed is 0-300 rev/min in working load. This equals 5 rev/second, to get the output speed of 10mm/s, the screw pitch is calculated to:

$$p = \frac{10mm/s}{5rev/s} = 2mm/rev$$

Trapetsstänger

Material
Stål C35E / C45E, ISO 2901/2903 och DIN 103 tolerans 7e.
Rostfritt syrafast stål SS 2348, ISO 2901/2903 och DIN 103 tolerans 7e.

Funktion
En trapetsgängad skruv används för att omsätta en roterande rörelse till en linjär rörelse och används vanligast som en ledarskruv eller vid stödmontage och fastspänningsarbeten. En trapetsskruv passar bäst med en låg intermittents faktor på ca 20% och vid låga hastigheter utan höga precisionskrav. För att uppnå en god rostbeständighet rekommenderas en rödgodsmutter i kombination med en rostfri trapetsstång.

Gängdim	Artikelnr Höger / Stål	Artikelnr Vänster / Stål	Artikelnr Höger / Rostfritt	Artikelnr Vänster / Rostfritt	Skruv d	di	Dm dm	Mutter D	Di
Tr 10x3	TH10	TV10	TH10-SS	TV10-SS	10	6,5	8,5	10,5	7,5
Tr 12x3	TH12	TV12	TH12-SS	TV12-SS	12	8,5	10,5	12,5	9,5
Tr 14x4	TH14	TV14	TH14-SS	TV14-SS	14	9,5	12,0	14,5	10,5
Tr 16x4	TH16	TV16	TH16-SS	TV16-SS	16	11,5	14,0	16,5	12,5

Figur 2.4 The available leadscrews whereas the pitch is highlighted in yellow

The smallest available pitch found on the leadscrews is 3mm as seen in figure above [15] , thus the feeding speed becomes 15mm/s (3mm/rev*5rev/sec) which can be compared to a normal caulking gun [8, p. 8].

2.2.2.2 Force output

In Transmissioner [12, p. 88] we find the following equation to describe relation between leadscrew parameters, force and momentum. We use the momentum of an ordinary electrical drill and with screw parameters of the leadscrew with the dimensions 12x3 from the figure above.

$$M = Fax * \left(\frac{\cos(\alpha) * \tan(\lambda) + \mu}{\cos(\alpha) - \mu * \tan(\lambda)}\right) * rm \Rightarrow Fax = M/(rm * \left(\frac{\cos(\alpha) * \tan(\lambda) + \mu}{\cos(\alpha) - \mu * \tan(\lambda)}\right))$$

μ = 0.1 (friction in thread)
r_m =0.00525m (middle radius)
α = 15° (half profile-angle of thread)
λ =arctan (0.003/0.0105) =16° (increase angle of thread on the middle radius)

The calculation is made without losses thus we multiply with a loss factor of 0.5 to compensate overall losses. To get a more correct value of the loss coefficient a study of the real friction constant would need to be conducted but time has a higher prioritization then the exactness of the loss coefficient thus it is regarded as sufficient.

This calculation gives us Fax=3552 N, which compares with a good quality battery driven caulking gun which has a force output of about 4kN [16].

There are two leadscrews with the pitch 3mm, 10x3 and 12x3, as seen on the image below. We need to dimension according to the axial force (Fax).

The total length of the leadscrew will be 33 cm but the distance from the housing is 24 cm and shall thus be dimensioned for this length.

The leadscrew with dimensions 12x3 is tested as 10x3 only can withstand a force of 735N with the length 20cm (Mekanex uses safety factor 6). With the safety factor recalculated to 2 (which is considered sufficient for this project), it can withstand 2205N which still is not sufficient for the calculated force of 3.55kN.

Gäng-dim	Max dragkraft N	Max tryckkraft N vid spindellängd (m) med 6-faldig säkerhet											
		0,15	0,20	0,30	0,50	0,75	1,00	1,50	2,00	2,50	3,00	4,00	5,00
Tr 10x3	3237	1334	735	323	117	52	29						
Tr 12x3	5591	3855	2168	964	347	154	87	38					

Table 2.2 The two possible leadscrews with the equivalent maximum force they can sustain regarding their length [15]

A linear interpolation on 12x3, of the length 0.2m and 0.3m with following forces 2168N and 964N (observe Mekanex has safety factor 6), gives the maximal pressure force of 1686N and with safety factor recalculated to 2 it becomes 5058N. Thus, it can bear the calculated Fax force of 3.55kN.

Choice of leadscrew: TR 12*3, see figure 2.2 second row.

2.2.3 **Transmission**

In the section that treats the choice of leadscrew we find that the speed of the leadscrew will be maximum 15 mm/s. To make the designed beta product easy to use for the user it must be easy for the user to control the output flow of the caulk. That means that a small study needs to be made on the sensitivity of an electrical drill to see what the lowest controlled speed is on an electrical drill and what output speed on the caulk this results in.

Sensitivity test conducted on a Bosch PSR 1800 LI-2 (18V). The trigger will be pushed down until a constant speed is reached and the trigger will be further pushed down to register all the "sensitivity steps" meaning the steps of which the user can reach a constant speed.

Lowest controllable speed (measured manually with a timer):

Figur 2.5 Bosch PSR 1800 LI-2

1. 0.18 rev/sec
2. 0.24 rev/sec
3. 0.30 rev/sec
4. 0.38 rev/sec
5. 0.45 rev/sec
6. 0.71 rev/sec

These values are the results in laboratory conditions. It is important that the values represent a real use of a caulking gun, so a test was also done in a real use condition, to see how many steps one could push on the trigger of the electrical drill and what rotational speed these would result in.

Sensitivity steps on electrical drill:

1. 0
2. 0
3. 0
4. 0.32 rev/sec
5. 0.91 rev/sec
6. 1.43 rev/sec
7. 4.00 rev/sec
8. Max
9. Max
10. Max

By the sensitivity test it is noticed that there exists 10 steps which on could further press down the trigger on the caulking gun. From the values it is also indicated that the increase is exponentially. This means that there risks being problems when using the caulking gun as the caulk by a small increase on the trigger makes the output speed of the caulk exponentially faster.

To calculate the output speed of the caulk in the first step of the trigger (0.32rev/sec) the relationship of the volumetric flow rate is used,

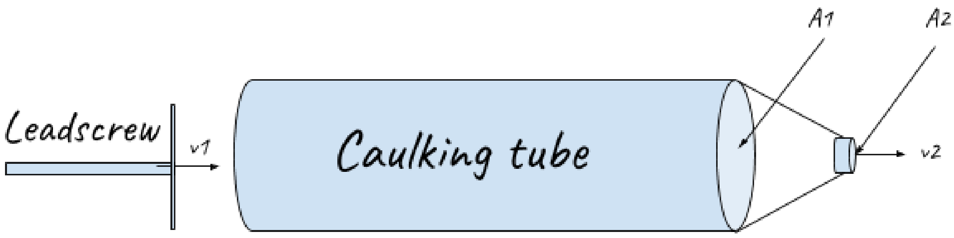


Figure 2.6 Demonstration of the volumetric flowrate relationship

Where v1 is the speed of the leadscrew, thus the speed of the caulk in the tube but the output speed (v2) will be greater because of the smaller cross-sectional area.

Volumetric flow rate is defined by:

Q=v*A

Where:

v = flow velocity, v_1 = 0.32rev/sec*3mm/rev=0.96mm/s

A = cross-sectional vector area/surface

The first controllable speed on the electrical drill will be tested, that is 0.96mm/s. The cross-sectional area of a standard tube is 1662mm^2 (23*23*3,14mm) and the output cross-section is dependent on the user, but an approximation is made to the area 28mm^2 (3*3*3.14).

This gives us the following equation:

$$Q_{1=}Q_2 => v_1 \times A_1 = v_2 \times A_2 => 0.96 \times 1256 = v_2 \times 28 =>$$

$$v_2 = \frac{0.96 * 1256}{28} = 4.3cm/s$$

This speed is a little too fast and should be decreased by a reduction gear, see Section 3.2.5.

2.2.4 **Axle distance**

We can see that the distance between the silver bar that pushes the caulking tube and the electrical drill needs to be bigger than the biggest radius on electrical drill and the radius of the silver bar together. This to prevent the silver bar from colliding with the electrical drill.

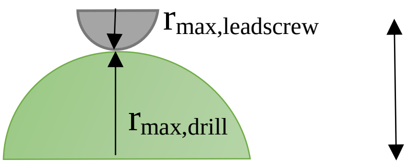
Figure 2.7 The placement of the caulking gun relative to the electric drill. Leadscrew will move above electrical drill as illustrated.

To adapt the caulking gun so that it fits all standard electrical drills a measurement of the radius on the drill of different brands was taken.

Electric drill	Bosch PSR1800	Biltema	Hitachi	Dewalt
Radius of electrical drill body (mm)	32	33	35	37

Tabell 2.4 Table with measured radius of different electrical drills

To get a distance that work on most electrical drills the maximum value found is used and 3 mm is added to take into account non-measured electrical drills. The distance will become the maximum radius of the electrical drill plus the radius of the leadscrew as seen on illustration below.



$$\boldsymbol{a_{min} = r_{max,drill} + r_{max,leadscrew} + SF\ (Safety\ Factor) = 37 + 6 + 3 = 46mm}$$

Figure 2.8 Illustration of the minimum distance between the input and output shaft

2.2.5 **Choice of Gears**

It is the dimensions of the gears that determine the distance between the electrical drill and the leadscrew. The distance between the axles (a) should be as mentioned above in section “axel distance” minimum 46mm.
To reduce number of tools used when creating a gear, a module system has been established [12, p. 121]. This also makes the choice of gears easier as gears from the same module system fits together. For the prototype module 2 was chosen from consultation with Mekanex whom are the supplier of the gear (Figure 5).

From the section on “Transmission” it is stated that it is advantageous for the control of the output speed to reduce the speed. Thus, the input gear will be smaller than output gear as the will reduce the speed according to the gear ratio [12, p. 111]:

$$R_1 * w_1 = R_2 * w_2 \ => \frac{R_2}{R_1} = \frac{w_1}{w_2}$$

R is the radius of the gear and w is the angular speed. As seen from the equation, an increase of the radius of a gear will lead to a proportionate decrease of the angular speed. If the output radius is the double of the input radius the output speed will be decreased by half. This makes the speed of the leadscrew 7.5mm/s instead of the calculated 15mm/s which still compares to a normal caulking gun, while increasing the control of the caulking gun.

Modul 2

Material
Stål SS EN 10083-1 - C45E (1.1191), kuggkvalitet 8e25

			KUGGBREDD b = 20 mm				
Kugg	**Artikelnr**	**Typ**	**Dk**	**Do**	**H**	**N**	**d H7**
12	20012-S20	N	28	24	15	18	10
13	20013-S20	N	30	26	15	20	10
14	20014-S20	N	32	28	15	20	10
15	20015-S20	N	34	30	15	24	10
16	20016-S20	N	36	32	15	25	10
17	20017-S20	N	38	34	15	25	10
18	20018-S20	N	40	36	15	25	10
19	20019-S20	N	42	38	15	25	10
20	20020-S20	N	44	40	15	30	10
21	20021-S20	N	46	42	15	30	12
22	20022-S20	N	48	44	15	30	12
23	20023-S20	N	50	46	15	30	12
24	20024-S20	N	52	48	15	35	12
25	20025-S20	N	54	50	15	35	12
26	20026-S20	N	56	52	15	40	12
27	20027-S20	N	58	54	15	40	12
28	20028-S20	N	60	56	15	40	12
29	20029-S20	N	62	58	15	40	14
30	20030-S20	N	64	60	15	40	14

TYP N

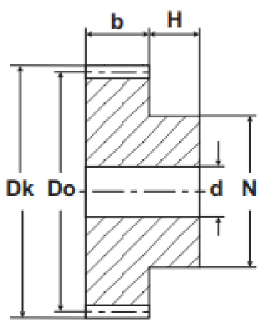


Figure 2.9 Image of different gears and the chosen highlighted in yellow.

In figure above we see the chosen gears that allows the axel distance to be 46 mm.

$$a = \frac{D_{0,1} + D_{0,2}}{2} = \frac{32mm + 60mm}{2} = 46mm$$

This reduction will increase the control of the trigger at low speeds without making the proportions of the gear differ too much which would complicate the design of the housing.

2.2.6 Choice of nut

We need a nut that is threaded for a leadscrew with the diameter 12mm. There are different kinds of nuts that we find at Mekanex base of nuts [15]. The nut will be fixed on the gear so that when the gear rotates also the nut will rotate and thereby drive the leadscrew forward.

Flänsmuttrar, inbyggbara

Material
Rödgods SS 5204, ISO 2901/2903 och DIN 103 tolerans 7H

	Artikelnr									
Gängdim.	H-gänga	V-gänga	D1	D2	D3	d	För bult	L1	L2	L3
Tr 10x3	TFLH10R	TFLV10R	25	42	34	5	M4	25	10	6
Tr 12x3	TFLH12R	TFLV12R	28	48	38	6	M5	35	12	8
Tr 14x4	TFLH14R	TFLV14R	28	48	38	6	M5	35	12	8
Tr 16x4	TFLH16R	TFLV16R	28	48	38	6	M5	35	12	8
Tr 18x4	TFLH18R	TFLV18R	28	48	38	6	M5	35	12	8
Tr 20x4	TFLH20R	TFLV20R	32	55	45	7	M6	44	12	8
Tr 22x5	TFLH22R	TFLV22R	32	55	45	7	M6	44	12	8
Tr 24x5	TFLH24R	TFLV24R	32	55	45	7	M6	44	12	8
Tr 26x5	TFLH26R	TFLV26R	38	62	50	7	M6	46	14	8
Tr 28x5	TFLH28R	TFLV28R	38	62	50	7	M6	46	14	8
Tr 30x6	TFLH30R	TFLV30R	38	62	50	7	M6	46	14	8
Tr 32x6	TFLH32R	TFLV32R	45	70	58	7	M6	54	16	10
Tr 36x6	TFLH36R	TFLV36R	45	70	58	7	M6	54	16	10
Tr 40x7	TFLH40R	TFLV40R	63	95	78	9	M8	66	16	12
Tr 44x7	TFLH44R	TFLV44R	63	95	78	9	M8	66	16	12
Tr 50x8	TFLH50R	TFLV50R	72	110	90	11	M10	75	18	14
Tr 60x9	TFLH60R	TFLV60R	88	130	110	13	M12	90	20	16

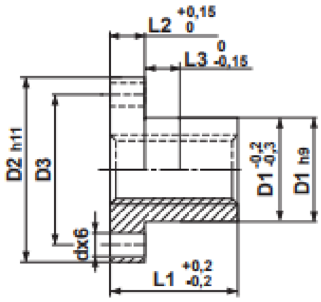


Figure 2.10 List of available nuts with flange from Mekanex

The above depicted nut is interesting because the flange allows space so that a gear can be drilled on. The cost of this piece is 400 SEK. To reduce costs of the nut one could use an ordinary nut without a flange and instead of drilling it on the gear it can be incorporate in the gear as showed in figure to the right. Thus it still can drive the gear without expensive nut or assembly time.

A 6-angle nut is chosen so that it can drive a gear without slipping as seen on image to the right.

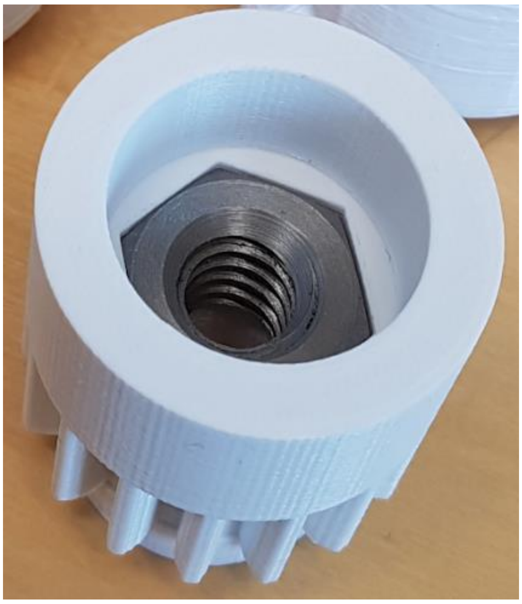
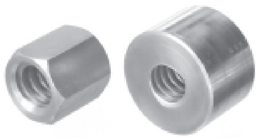


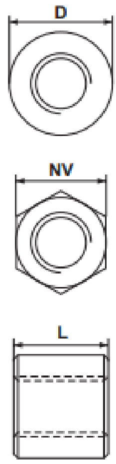
Figure 2.11 Nut encapsulated in gear

Runda och sexkantmuttrar

Material
Stål SS 1926, ISO 2901/2903 och DIN 103
Rödgods SS 5204, ISO 2901/2903 och DIN 103 tolerans 7H



Gäng dim.	Rund, stål			Lång, stål eller Rödgods			Sexkant, stål		
	Artikelnr	D	L	Artikelnr	D	L	Artikelnr	NV	L
Tr 10x3	TRU* 10	22	15	TRU* 10**	22	20	TSX* 10	17	15
Tr 12x3	TRU* 12	26	18	TRU* 12**	26	24	TSX* 12	19	18
Tr 14x4	TRU* 14	30	21	TRU* 14**	30	28	TSX* 14	22	21
Tr 16x4	TRU* 16	36	24	TRU* 16**	36	32	TSX* 16	24	24
Tr 18x4	TRU* 18	40	27	TRU* 18**	40	36	TSX* 18	27	27
Tr 20x4	TRU* 20	45	30	TRU* 20**	45	40	TSX* 20	30	30
Tr 22x5	TRU* 22	45	33	TRU* 22**	45	44	TSX* 22	30	33
Tr 24x5	TRU* 24	50	36	TRU* 24**	50	48	TSX* 24	36	36
Tr 26x5	TRU* 26	50	39	TRU* 26**	50	52	TSX* 26	36	39
Tr 28x5	TRU* 28	60	42	TRU* 28**	60	56	TSX* 28	41	42
Tr 30x6	TRU* 30	60	45	TRU* 30**	60	60	TSX* 30	46	45
Tr 32x6	TRU* 32	60	48	TRU* 32**	60	64	TSX* 32	50	48
Tr 36x6	TRU* 36	75	54	TRU* 36**	75	72	TSX* 36	55	54
Tr 40x7	TRU* 40	80	60	TRU* 40**	80	80	TSX* 40	60	60
Tr 44x7	TRU* 44	80	66	TRU* 44**	80	88	TSX* 44	65	66
Tr 50x8	TRU* 50	90	75	TRU* 50**	90	100	TSX* 50	75	75
Tr 60x9	TRU* 60	100	90	TRU* 60**	100	120	TSX* 60	90	90

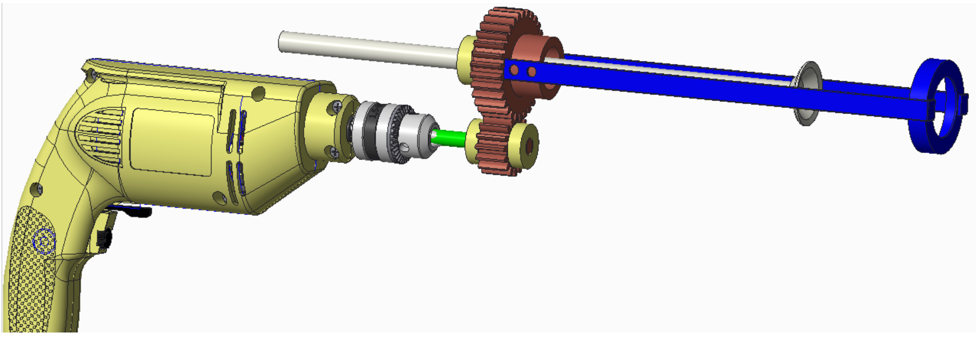


Artikelnr förklaring: Vid * skriv H för högergänga eller V för vänstergänga, t.ex. TRUV 36
Vid ** skriv in L för lång stål eller R för rödgods, t.ex. TRUV 36R

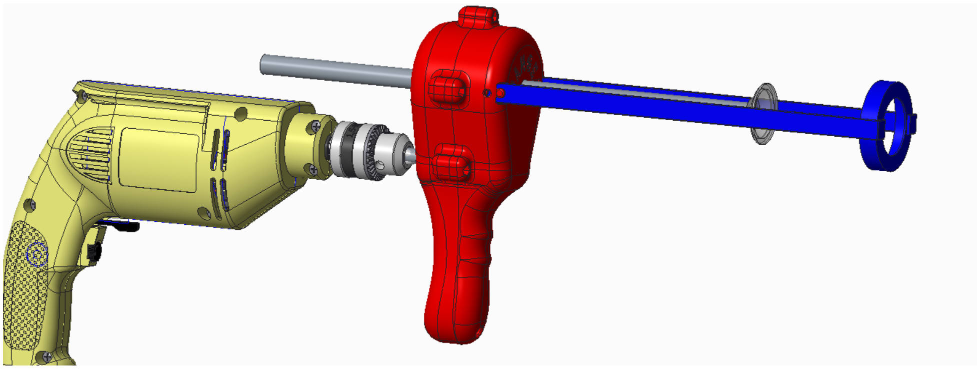
Figur 2.12 Nuts without flange and the chosen highlighted in yellow

2.2.7 **Design of Each part**

All choices of components that should be in housing is now made. All components need now to be designed so they interact properly and the housing needs to keep all components in place. Below the process of designing the components and the housing is presented. During design, common ways of mass production are kept in mind, so that the found solutions does not differ too much from a realistic mass production solution. That is why the site Mekanex [15] will be consulted regularly so that the solution is adapted to existing components in the market.



Figur 2.13 Yellow: electrical drill, blue: housing for caulking tube, white: Leadscrew, golden: bearings, green: input shaft



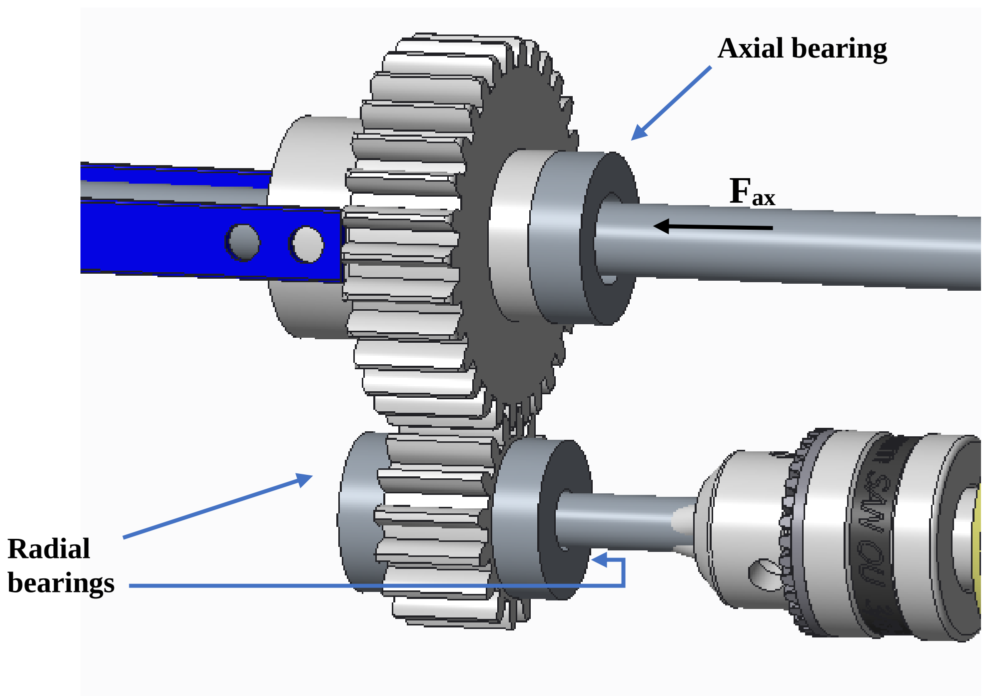
Figur 2.14 illustration of finished caulking gun

2.2.7.1 Bearings

For the caulking gun according to the PDR there will be needed three bearings, one axial to withstand to force trying to prevent the above gear from moving forward and two radial bearings to support the input shaft so that it can rotate and withstand weight of caulking gun.

The above bearing needs to have the inner diameter bigger than 12mm which is the diameter of the leadscrew. There closest which can be bought within reasonable time is an axial bearing with the dimensions 17×30×9 (inner diameter×outer diameter×width) [17].

The two below radial bearings needs to be bigger than the input shaft which has a diameter of 9.5mm. There is found an easy accessible bearing from Biltema with the following dimensions (10*26*18) [18].



Figur 2.15 Illustration showing the placement of the bearings

2.2.7.2 Gears

The caulking gun consists of two gears, and from the choice of gears we have the dimensions of the gear. The CAD files of the gears are imported and modified to fit other components.

Output gear

The output gear needs to have a cavity for the nut and needs to be supported on both sides.

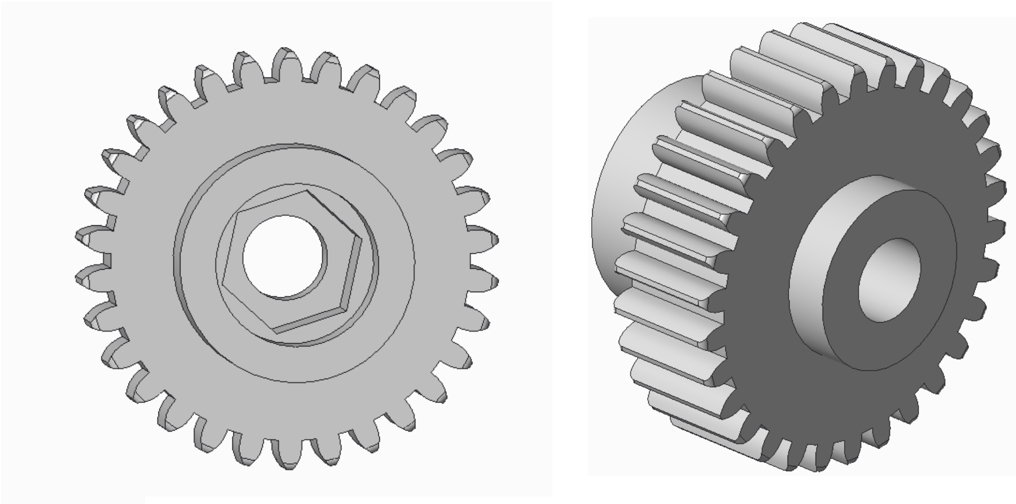


Figure 2.17 Output gear with cavity for nut and axle on both side to carry itself

Figure 9 shows to the left the cavity for the nut to be placed and the shaft that surrounds it.

On the right part of the illustration the other side of the gear is showed with a shaft to keep it in place. Throughout the gear, the leadscrew that will push the caulk, will pass.

Input gear

The input gear has a cavity for the input shaft and a shaft on the other side.

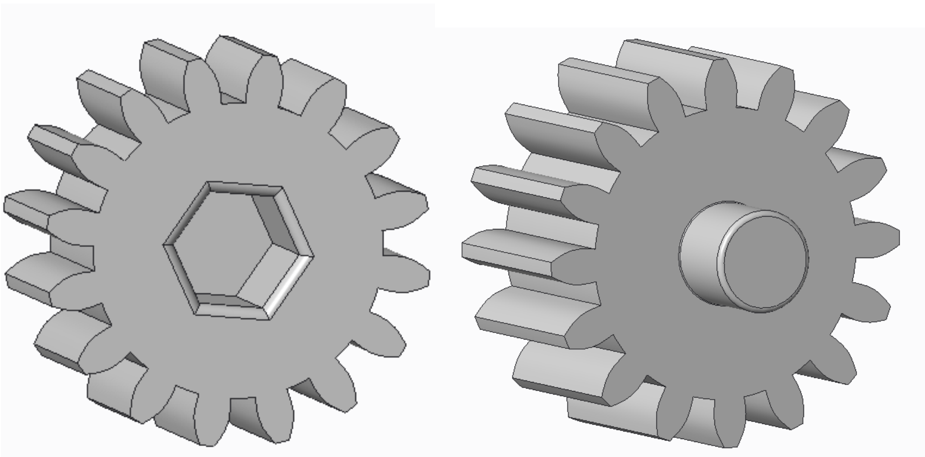


Figure 2.18 Both sides of input gear with the cavity for the input shaft to the left

2.2.7.3 Input shaft

The input shaft will drive the gear. One side of the shaft is six sided so that it can drive the input gear and other side is circular so that it fits the bearing and can be attached to an electrical drill.

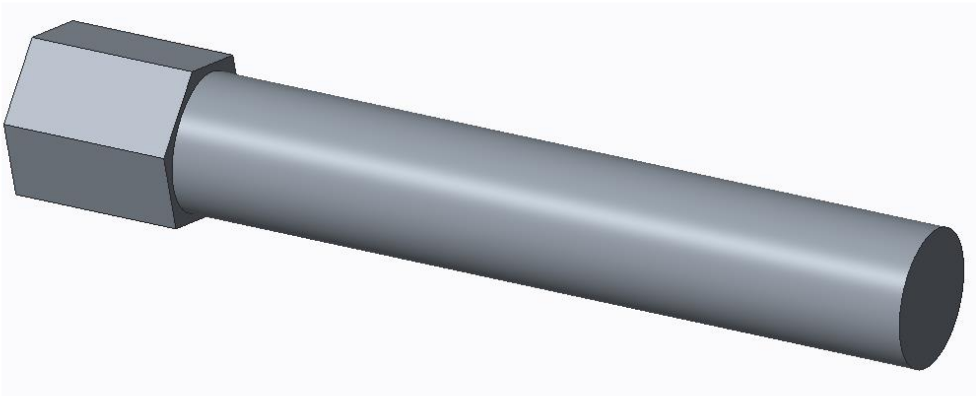


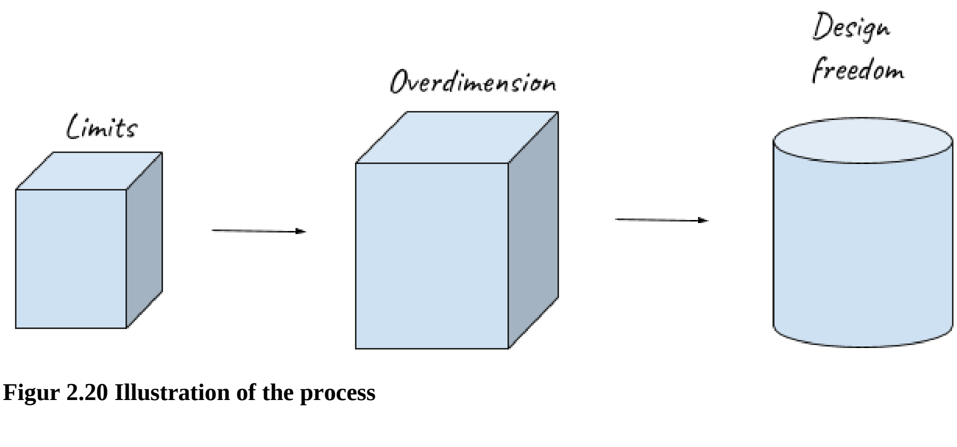
Figure 2.19 Input shaft

2.2.7.4 Handle

When design was finished a handle was to the design after having been discovered as a need from the prototype testing. The handle was firstly drawn on CAD then printed – tested and the process was redone until a comfortable handle was made.

2.2.7.5 Housing

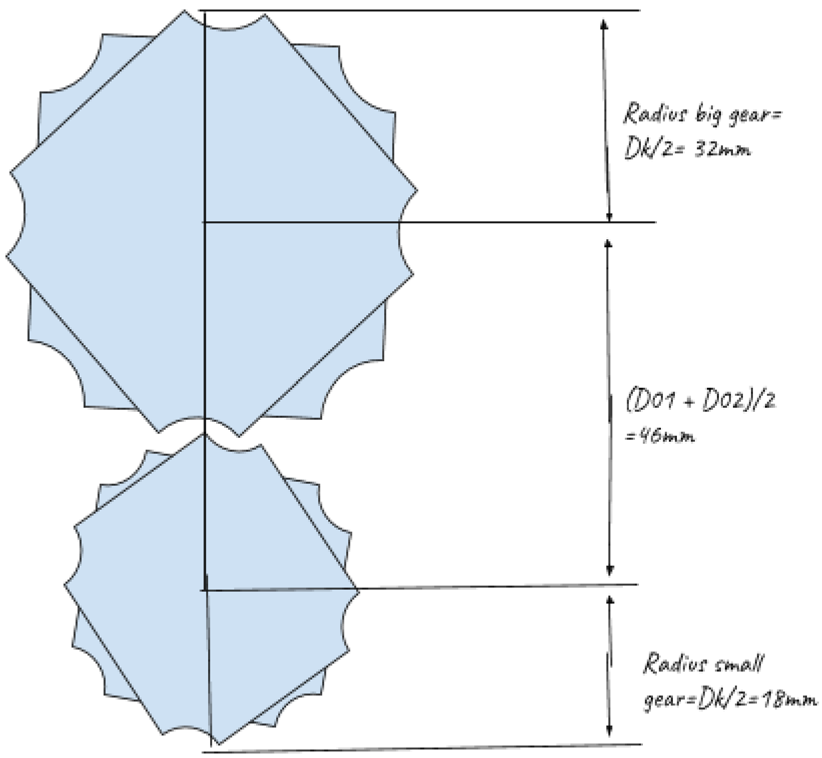
Now when all components of the housing are determined a housing is drawn so that it keeps all components in place and that it is easy assembled. To construct the housing the outer dimensions of a rectangular box is taken through constraints from the components, when limits are taken extra size will be added on to give design freedom.



Figur 2.20 Illustration of the process

Height limit
The shaft distance is 46mm as calculated in the section concerning gears. To find the minimum height limit of the housing the radius of each gear needs to be added, se illustration below. This gives us the height limit (HL):

$$HL = 46mm + r_{p,gear} + r_{g,gear} = \mathbf{96mm}$$



Figur 2.21 Illustration of the height that is defined by the distance between the gears and the radius of the gears.

Width limit
The width of the box is limited by the diameter of the gears, Dk, which equals to **36mm**.

Depth limit
Lastly the depth of the box is limited by the depth of the gears and bearings.

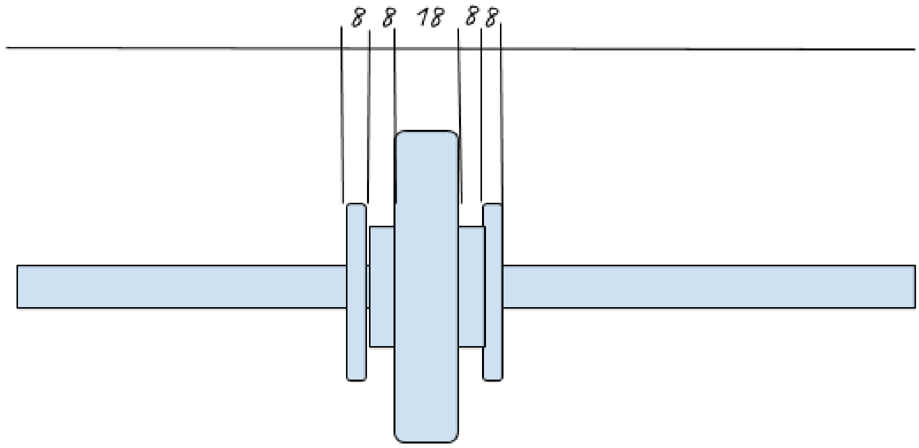


Figure 2.22 The illustration shows the depth of gears and other components such as bearing

Here we see the width of the gear in the middle, and the shaft of the gear and lastly the bearings. This axel illustrates the input shaft. The depth of the limits box need to be **50mm.**

For the limits box, see figure 12, we get the following dimension 96*36*50(height*width*depth). Then we over dimension this box to get some design freedom, big rounded radiuses to make it look futuristic and to account for the thickness of the walls. After trying to fit the components drawn in CAD with some trials and errors the dimension for the over dimensioned box should be 110*57*60 (height*width*depth).

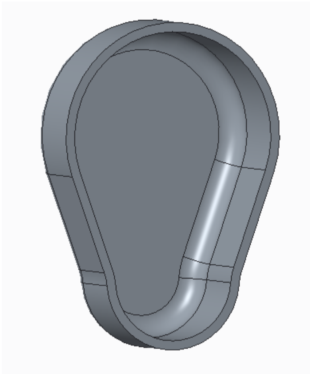
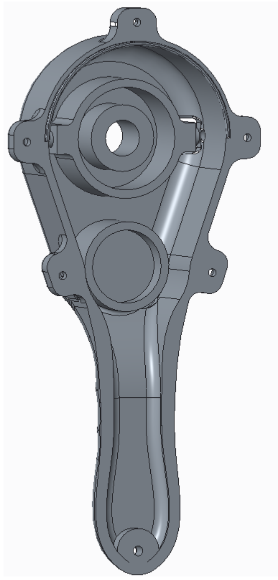
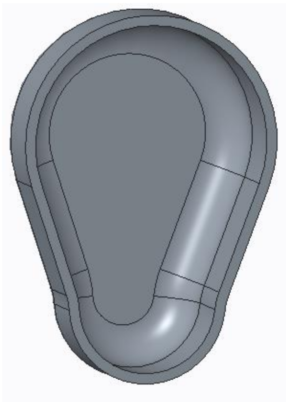
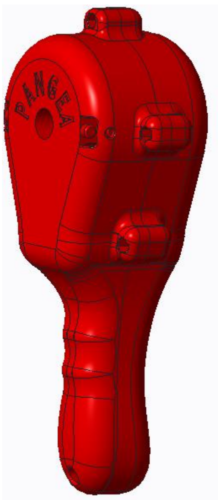
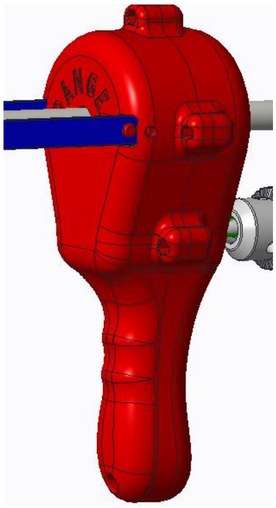
Part	***Design Freedom***	***Space for Components***
Front part of housing		
Back part of housing		
Final design		

Figure 2.23 Tabell illustrating the design at the design freedom phase and after space for components is made

2.2.8 **FEM Analysis on Different Components**

To be sure that our beta product does not fail it is important to do calculations to see if any part on the prototype will break. The method used to do the calculations is finite element method also called FEM.

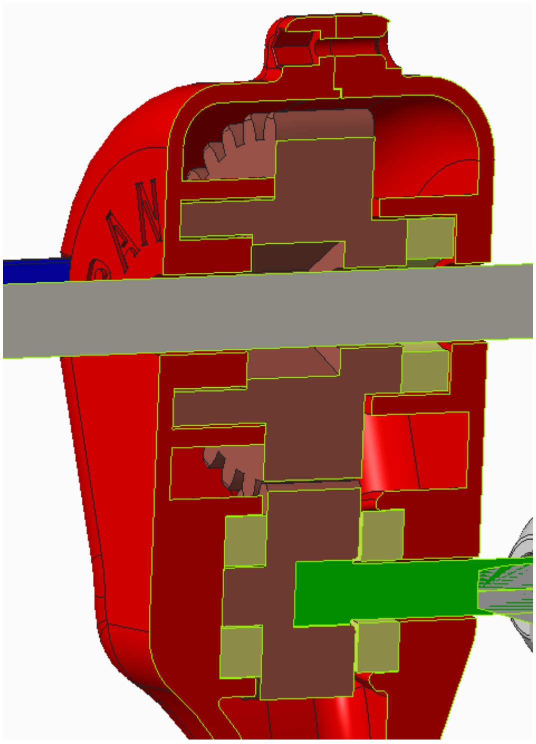


Figure 2.24 Section on caulking gun

In the figure to the left we see a section of the caulking gun. From this crucial components are identified and analyzed to make sure that they can bear the load.

Identified components are gears, ears on housing and handle. The maximum force on these components can be calculated as following [12, p. 145]:

$$F = \frac{M}{l}$$

Where M is the momentum from the drill and l is the length from the momentum axis. The equation gives us the force F=1100 N acting on the smallest gear which is the gear with the highest force as radius is smaller. The tensions will be controlled to the ultimate tensile strength of the printing material of the 3d printer [19]: Polylactic acid (PLA): 50 Mpa

Firstly a failure on prototype B was identified, see figure 2.2, then a FEM analysis was made to control the source of failure, which was identified being the ears. The number of ears was thus increased by the identification of the weak point done with the help of FEM. It was also confirmed that the beta product can be printed in PLA because the highest found stresses are 37 Mpa which is below the tensile strength of PLA. For more information about the FEM analysis and its boundary conditions consult appendix F.

2.3 Construction of Beta-Product

The construction of a product is always an iterative process as it where in this case. Following are images and descriptions that depict the construction of the final beta product.

Figure 2.25 Process of getting the housing from the original caulking gun

A caulking gun is purchased and disassembled. All parts are removed and kept is only the blue housing for the calking tube.

Figure 2.26 The 3D printed parts. Housing and gears.

Parts that were designed, housing and gears was printed on a desktop 3D printer. After 4 days of printing the parts where ready. The print time can be reduced by experimenting with the printing parameters which was not made in this case.

Figure 2.27 Sand paper and spray paint

Parts where sanded and then primed multiple times to get a nice surface finish. When desired surface was reached the housing was spray painted with a red color.

Figure 2.28 All components disassembled to the left and assembled to the right

A six edged bar is cut and lathed so it fits the bearing. All purchased parts (leadscrew, nut and bearings) were then put in place and the parts where assambled.

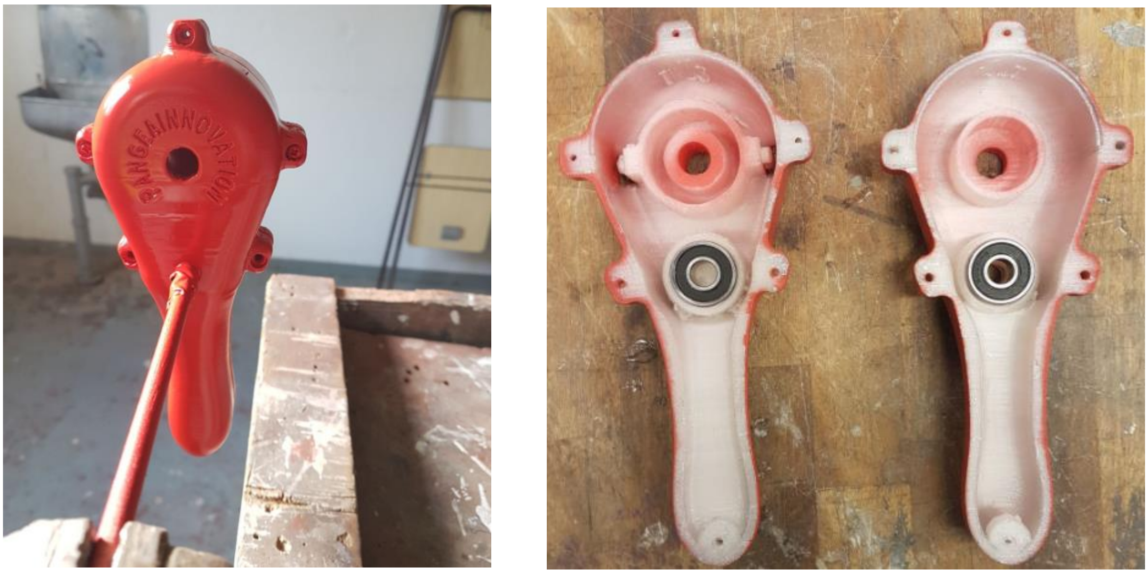


Figure 2.29 The colored housing to the left and the inside of the housing to the right with bearings assembled

Figure 2.30 Colleague happy while holding beta product

The finished design fulfills well its intention in being a beta product. This because it demonstrates all aspects of the real product without compensating with the design. It could be imagined that the future product on the shelf would look and behave like the prototype thus it can be called a beta product. If the market perceives the idea as a finished product real reaction can be collected and thus the product fulfill its meaning.

2.4 Potential Improvements for Large Scale Manufacturing

Even though the design can be considered fulfilling the criteria for a beta product, there is still a lot that needs to be modified to be able to put the product into productions. Below some comments on future design changes that should be made for the product to be ready to launch in a full-scale production.

It would be advantageous for a price and manufacturing aspect if the product could be injection molded. To injection mold a plastic component, it is important that the wall thickness is even, so that the plastic does not distort because of different cooling time. In the current design there is also lumps of plastic that needs to be removed so there is no material waste.

For future manufacturing, it should be considered to produce the caulking gun without any bearings and/or with a cheaper leadscrew. The current beta product is dimensioned to be able to compare itself with the battery driven caulking guns, if one where to dimension according to hand driven caulking guns the beta product could be redesigned to save costs. The beta-product can help determine at what price potential customers are willing to pay and design after this target.

The input shaft is now made by a six-edge bar that is lathed so that it can be supported by the bearing. It should be considered to injection mold a small component that encases the six-edged bar so that it can be supported by bearing without the additional processing work of lathing the bar. This would additionally reduce costs.

3 Market

The basis to conduct the Beta Product Marketing is that it is conducted on people that reflects the products target segment [s.226, Eppinger]. Therefore it is important that the market is studied and understood so that insights on potential future customers can be made.

3.1 Insights of external factors

From the PDR [8] , two target groups where identified, handy men/women and working professionals where of caulking is not their main work. These are the actors that will be identified before the market approach. As the beta market sales will be done in Sweden this will also be the limits of the market search.

3.1.1 **Main actors**

From searches online with different keywords following resellers are identified; Leif Arvidsson, Proffsmagasinet, Bauhause, Jula, Biltema, verktygsproffsen, Wurth, Casco, paintpro, Clas Ohlson, Byggmax, Harald Nyborg.

Reading from forums of target group [20] the following actors are mentioned: Biltema, Clas Ohlsson, Casco and K-rauta.

For the market analysis used in this thesis actual stores will be used so online options can be disregarded which leads us to the following actors divided in two subgroups.

International companies: Bauhous, K-rauta, Byggmax, Harald Nyborg
National companies: Biltema, Clas Ohlson and Jula

Construction companies are very easy to find and there exists a lot. Some examples of found companies in Lund are Topanga Bygg, Thage I Skåne AB and Gilleskrokens Bygg AB.

3.2 Market approach

The market test will be approach from two angles simultaneously. While performing the market test the method will be variated between beta product sale and face to face survey. The survey is performed so that the beta product sale can be compared to a current way of testing a concept.

3.2.1 **Survey and Beta Product Marketing**

According to Ulrich and Eppinger a concept test consists of 7 steps [2]:

1. Define the purpose of the concept test.
2. Choose a survey population.
3. Choose a survey format.
4. Communicate the concept.
5. Measure customer response.
6. Interpret the results.
7. Reflect on the results and the process

The Beta Product Marketing follows the step steps as the concept test with the exceptions that that step 3 is removed and replaced with a step after step 4 that is when the sale is performed.

We define the purpose for the test as we defined the objective of the beta market sale “to evaluate the market attractiveness for the developed caulking gun”. The survey population will be the target group for the product and consists of handy men or women that from time to time uses a caulking gun. The survey format will be one that is conducted face to face so that most possible qualitative information can be collected. The concept will be communicated with an oral explanation followed by the customer testing the beta product. In the case of a survey the response will be gathered by a form filled in by the customer and in the case of the beta sale the response will be measured by the customers willingness to buy the product or not. The form can be found in the appendices. These responses will later be compared to each other to evaluate the method of Beta Product Marketing.

3.2.2 **Results from Survey and Beta Product Marketing**

The results from the survey and the Beta Product Marketing can be found in Appendix D and E. Here we present the result from these appendices. There were in total 19 respondent for the standard survey whereof 9 fitted the target group and the beta marketing had about 25 respondents whereof 11 fitted the target group. So, data consists of 9 respondents for the survey and 11 for the Beta Product Marketing.

Figure 3.1 The market survey at IKDC. Seen on photo, Fadi to the left and Per-Erik to the right

3.2.2.1 Results from survey

Respondents	**Level of interest**				
	Definitely not	Probably not	Might or might not	Probably would	Definitely would
9	1	0	3	2	3

Tabell 3.1 The responses from the survey

From [2] we know that the **Q**uantity of sold products in a time are calculated in the following way:

$$Q = N * A * P$$

Where **N** is the **N**umber of potential customers, A is the fraction of these potential customers for which the product is **A**vailable, and P stands for the **P**robability that the potential customer that is aware of the product purchases it.

For the case of the comparison in this thesis the parameters N and A can be disregarded as it is the same product being compared thus these parameters will be the same. It will only be the parameter P that is different from the two different methods being tested.

The P is calculated in the following manners:

$$P = C_{definitely} * F_{definitely} + C_{probably} * F_{probably}$$

Where P stands for **P**rofit, C stands for a **C**orrection factor and F stands for **F**raction of respondents. In scientific foundation the standard correction values used for $C_{definitely}$ and $C_{probably}$ is 0.4 and 0.2. This gives us following probability:

$$P = 0.4 * \frac{3}{9} + 0.2 * \frac{2}{9} = \mathbf{0.18}$$

3.2.2.2 Results from Beta Product Marketing

Respondents	**Sale**	**No Sale**
11	0 (2)	11

Tabell 3.2 Responses from Beta Product Marketing

The hypothesis is that this will be the real probability of the sale and thus the probability is:

$$P = \frac{0}{11} = 0.0$$

Two persons clearly indicated a big interest of buying the product but wanted to think about it. As it was not in the thesis time limit to redo the sale it was not redone. If these to persons are considered as sales the probability would be:

$$P = \frac{2}{11} = \mathbf{0.18}$$

4 Discussion

This chapter will discuss the results of the two parts of this thesis. It will hopefully shed a light on the results from the survey and Beta Product Marketing. It will also take a critical stance on the method to evaluate its effectiveness in its purpose.

4.1 Discussion on product development

The end result of the product development process resulted in a product that could be considered a shelf ready product by a potential customer. This statement is made by having consulted different people such as colleagues. This was not further analyzed because of time limits but one could discuss the validity of this statement and the potential affect it can have in the sales of the Beta Product. If a real and thorough Beta Product Marketing is conducted it is important that experts examine the visual appearance to see if it can be regarded as a finished product or if further alterations needs to be conducted. For the sake of this thesis it is considered that the prototype can be regarded as a finished product, thus the main goal of the product development process and was achieved. Although the goal of the first part was successful it took longer time than predicted to finish the beta product. The reason for this might be that the development process had the tendency to be treated as a normal product development project. Thus, it was forgotten that the importance in the development process was not having a production ready prototype but a product, which by the potential customer is considered a finished product. This resulted in time consuming activities that could have been skipped so that more time where given to the second part of the master thesis, the Beta Product Marketing.

A very important aspect for future work with this method consists in a clear goal that should impact the way the product is developed. Only activities that affect the user experience should be regarded as these are the only factors affecting the beta product. This will save important time and resources that could be allocated to the Beta Product Marketing efforts. Also, it is important to know if one during the Beta Product Marketing, is doing a real sale or only presenting it as a sale, but then letting the potential customer know that the product, is not for sale but only used to collect insights. If the Beta Product Marketing consists of real sales of beta products, it is important that the product fulfills the user needs during its life time. If the product will be sold fictively one could disregard dimensioning that takes into account the life time, which this also will save time.

Concerning the developed product many of the respondents of the survey and Beta Product Marketing reacted on the controllability of the caulking gun. Some found it hard to get the correct speed and not to push out the caulk to fast. This can be adjusted by using an electrical drill with better speed control or by additionally increasing the gear transmission. Personally, I believe that one gets used to the sensitivity of the trigger regarding the output speed, after having used the product a while. It was the first-time experience for all the respondents and it is obvious that is hard to control then. But it is important to take this fact into account and see if anything can be done to create a better user experience. It is important to note that changing the gear transmission implies additionally increasing size relation of the large and small gear, this is a pay-off to make. Either, one gets better control of the trigger but then the housing because even more disproportionate and both the material use and costs increases.

Some commented on the rotational freedom that the caulking gun had in relation to the electrical drill. But when the advantages were explained they tended to change their mind. It is true that the rotational freedom makes the user take up the momentum in the hand, but it also has advantages as a bigger degree of freedom while using the caulking gun. When one is aware of the momentum it becomes very natural in its use. If one where to fix the rotation between the caulking gun and the electrical drill one needs to take into account following factors: weight increase, price increase, set-up time for user and as mention loss of freedom during use.

Some of the respondents found the product a bit heavy on the hand. The beta product weight is 0.8kg without the electrical drill. A normal drill weighs 1.2 kg [14] which gives it a total of 2kg. Compared to a normal electrical caulking gun that weighs about 2.3kg [16]. So, comparing to a battery driven caulking gun the beta product is fine. What might have impacted their input is either that they compared to a hand driven caulking gun or that the beta product is not as balanced as the electrical caulking guns. This is worth taking into consideration by letting professionals that use battery driven caulking guns use the beta product and come with input. The weight of the beta product could decrease my removing lumps of plastic in the housing and eventually downgrading the leadscrew and bearings.

4.2 Discussion on the Beta Product Marketing

The Beta Product Marketing was conducted, but the amount of data collected is considerably low. The Beta Product Marketing was performed alongside a standard market survey and the results will here be discussed. Also, the method in this thesis called Beta Product Marketing will be evaluated and its methodology and principles will be questioned and discussed.

As seen in the results for the Beta Product Marketing two results are presented. This is because no definition was made beforehand on how to judge if a sale has been done. Is it a sale if the potential customer says he'll come back and buy it next week? As the sale was performed as a one-time event I cannot judge if this kind of response should be regarded as a sale or not. Therefore I recommend for future use of this method to conduct the Beta Product Marketing during a certain period of time so that one gets a clear answer and can see if a sale is made or not. Otherwise one may have to take into account of factors such as a customers whom will not buy it the first time but another time. This tendency of customers not to buy the product directly will always be a weakness of this method as one cannot conduct Beta Product Marketing for an unlimited period of time. By prolonging the Beta Product Marketing the error factor can be decreased.

Secondly, we'll comment on the results collected by the Beta Product Marketing. As already mentioned the participations on these surveys where low, nine and eleven persons that fit the target group and responded to the survey and Beta Product Marketing. To be able to make a legitimate judgment on the results one would need to have more data collected. A discussion on the results will be made with the reservation for the small participation.

From the survey the probability factor of the interest of the market was 0.18 while it could not be determined for the Beta Product Marketing. This because there were two cases, where the potential customer said he would buy it next week. If the definition of the sale would be widened to include these sales the result is astonishing exact the same as the survey. But one needs to increase the data on both above-mentioned methods and also conduct the Beta Product Marketing during a certain time period so that the results can be confirmed.

Nevertheless, it was clear that the Beta Product Marketing gave responses that were more likely to be true than the survey. But as seen on the results from the survey the coefficient handles this gap well and one could pose the question if it is not re-inventing the wheel by developing a method by which results already can be reached using correction factors. The advantage using the Beta Product Marketing according to me is that one removes the uncertainty around the choice of the coefficient factors Cdef and Cprob and thus needs less estimating dependency. Another advantage is that the respondents of the Beta Product Marketing gave a response that was substantially more precise and thoughtful. It seemed to be the case, that when asked to buy the product, the respondents needed to supply hard core evidence of why they would not buy the product. This entitled me as the developer to get valuable insights with another depth when using the Beta Product Marketing.

Also, the way a Beta Product Marketing is conduced needs to be discussed. Should the goal always be, like stated in the background, producing a small-scale production so that real sales can take place, or is it sufficient that one beta product is made and that this is used to simulate a sale. In the case of this thesis only one beta product was made due to time limit and cost aspects. These are two legitimate reasons but the question rests, how does this affect the Beta Product Marketing?

The moral aspect of faking a sale made it hard for me to conduct the marketing. This fact needs to be further looked upon because it risks having people abandoning the method because it doesn't fit the marketing philosophy and makes it hard to find people who would like to perform the test. Also, the fake sale can damage the brand of the company as the potential customer can feel tricked and create a negative feeling towards the company performing the Beta Product Marketing. My view is that a small-scale production should be a criterion for the method and should be included in the budget regarding both investments in time and money. I feel it is not valid to perform a fake sale, motivated by the lack of time or money, because it hurts the core of Beta Product Marketing which is having an intimate exchange with first time users and exchanging valuable insights. This is a fragile meeting between the company and the market and it is a shame that the first contact with the market requires a risk of damaging the potential customers trust. Therefore, I would recommend any further use of this method to require that a real sale takes place.

Not only the number of products but also the type of product that is evaluated will have an effect on the Beta Product marketing. As was the case for this thesis, the caulking gun where at sale mainly by large size companies. This made the marketing effort harder to conduct, as the large organization contacted where not so keen on cooperating with my small and local project. Also, it is important to note that Beta Product Marketing is not suitable for all products, such as cellphones. Cellphones cannot be produced at a low scale and at low cost, thus making Beta Product Marketing not a suitable method. That is why I would strongly recommend future studies of Beta Product Marketing, an honest judgment, on the capability of one entering the market of the product. This aspect is crucial as it is the core of Beta Product Marketing, to create a sale environment that to the highest extent possible reflects the one of a real sale.

Another issue of the test is the fact that the Beta Product Marketing was done without any marketing efforts such as publicity. It is of common sense that commercial is an essential part of a person's willingness to buy a product. For a more proper conducted Beta Product Marketing is that a publicity effort should be done before trying to sell the product. It would be more resembling of a real product launch if some publicity first where done, which would make the responses more credible. The purpose of Beta Product Marketing is to imitate a real scenario thus a marketing effort before the sale is important. One need to consider this fact in comparison to the cost of conducting the marketing effort and how this compares to the cost of doing a full-scale launch. If the marketing effort is limited to the survey population it could save costs and make it easier accessible for start-ups and entrepreneurs with low budget to perform.

Another flaw with the performed Beta Product Marketing is that it was not conducted in an environment where one would ordinarily purchase a caulking gun. An ideal situation would be performing this study at one of the identified main actors. To perform the Beta Version testing in conditions where one would normally buy a caulking gun would be ideal. An email was sent to all the identified main actors, but no one wanted to participate.

The Beta Product Marketing still needed to be conducted so it was instead performed at IKDC where there is many working with construction and at a yard sale in Helsingborg to get a situation where people have the intention of buying a product.

For future studies emphasized the importance of establishing a network that can help with the study is emphasized. The establishment of a network is crucial and should by advantage be done before and during the design of the prototype. Or else one risks of getting in the same situation I got where no possibility of performing the study was given due to a phenomenon called "Not invented here (NIH) syndrome". Which is a phenomenon that describes the tendency for companies to be negative towards products not developed by them self. This could have been prevented if a network where established before approaching the market. Also, before trying to use Beta Product Marketing one should think and see if it is possible to introduce the product into the market. As the product developed in this case study, is primarily sold by large national companies, the chances of entering the market is harder than if one could speak to a local retailer to help with the marketing. Therefore, one should carefully consider one's opportunities concerning the approach of the market.

4.3 Final remarks

To really investigate Beta Product Marketing, one would need to focus more on the method of Beta Product Marketing than the product development. If one where to continue the work, it is important to primary work with the method so that more data can be collected.

It is also interesting to reflect about what has changed so that Beta Product Marketing eventually could be introduced in the sphere of development of mechanical products. We know that this type of methodology is current and also predominate in the software industry and the method of Beta Product Marketing can be resembled with the methods of the software industry. My thoughts of why this method could be entering the product development of mechanical products is because of the rise of 3D printing. What has happened is that instead of having to use expensive methods with large investment costs to develop a prototype, such as making a mold for the part, has been replaced with the 3D printing technology. My belief is that 3D printing has made alterations to the finished prototype as easy as changing the line in a code. Thus making a phenomenon that before only has been accessible to the software industry now available for the hardware industry. That being said, it is important to note that the Beta Product can be achieved by using other methods than 3D printing technology as well.

As goes for the developed caulking gun and my inputs in whether or not to give a Go or No Go decision concerning its future development I would choose to wait with the continuation of the development of the product. With reservations that more data is needed to make a more proper decision I found that none wanted to buy the product for the moment. Even though many seemed very interested it appeared that something was lacking to make them take the decision to buy the product. From The Beta Product Marketing it was realized that there where an interest in the product but I could not figure out why it was not soled. It is intriguing to reflect upon what was missing, is it that the need is not worth the cost? The market is not big enough? No advertising efforts? Not a satisfying product? This little something lacking and not making the potential customer buy the product, corresponds to the leap of faith that is missing to take the Go decision for further development of the product.

It is interesting having been the engineer behind the product and also the person conducting the Beta Product Marketing. It puts the developers work in another perspective and entitled me from the development side to enter the market aspect of the product. Being able to see my work with different eyes helped me better understand what is valued in the product from the potential customers' perspective. Even though there is a lot of work to add to the method of Beta Product Marketing I would recommend any company or entrepreneur to try the method just to enable them to approach and better understand the market.

The method of Beta Product Marketing is very interesting and would need more work to discern the value of it in the product development process. I see the work conducted in this thesis as an introduction and hopefully a help on the way to evaluate this method's potential.

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Appendix A Time plan

Here follows the project plan, the gray is the planned and the "x" marks the outcome.

A.1 Project plan and outcome

	January			February				March				April				May				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Insight				x	x	x														
Design Caulking gun							x	x	x	x	x	x	x							
Testing											x	x								
Manufacturing													x	x	x					
Marketing Plan											x	x		x	x	x	x	x		
Marketing																		x	x	x
Write thesis			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Table 1 Project plan and outcome marked with "x"

As seen from the table the mayor changes for the project was the design of the caulking gun that took more time than predicted and the marketing plan that was started to late. This was due to an underestimation of the work burden in the product developing phase and some design changes that took time solving. The marketing plan was started late because the co-supervisor was found late in the project and because of the workload that was taken up by the product development.

Appendix B Survey

This appendix shows the form of the survey that was carried out both at LTH Ingvar Kamprad Design Centrum the 17 of May and at a yard sale in Helsingborg the 20 of May.

Survey format inspired by example in Product Design and Development [2]:

CONCEPT TEST SURVEY— Electric Powered Caulking Gun

I am gathering information for a new caulking gun product and am hoping that you would be willing to share your opinions with me.

Do you own a caulking gun?___________

How often do you use a caulking gun?_____________

When you caulk today, what kind of caulking gun do you use? _______________

(If the answer is no to the first and second question thank the respondent and end the survey)

The product is a caulking gun that utilizes your own drilling machine to make the caulking gun electrical driven. Thus, you don't need to get tired in your hand and get uneven strokes as trying to manually push out the caulk.

If the product were priced at 499kr and were available from a dealer on or near campus, how likely would you be to purchase the caulking gun within the next year?

❑	❑	❑	❑	❑
I would definitely not purchase the caulk gun	I would probably not purchase the caulk gun	I might or might not purchase the caulk gun	I would probably purchase the caulk gun	I would definitely purchase the caulk gun

Would you be interested in testing a prototype of the product?

Based on your experience with the product, how likely would you be to purchase the product within the next year?

❑	❑	❑	❑	❑
I would definitely not purchase the caulk gun	I would probably not purchase the caulk gun	I might or might not purchase the caulk gun	I would probably purchase the caulk gun	I would definitely purchase the caulk gun

How might this product be improved?

____

Appendix C Beta Product Marketing

This appendix shows the form of the hat was carried out both at LTH Ingvar Kamprad Design Centrum the 17 of May and at a yard sale in Helsingborg the 20 of May

Survey format inspired by example in Product Design and Development [2, p. 176]:

CONCEPT TEST SURVEY— Electric Powered Caulking Gun

I am gathering information for a new caulking gun product and am hoping that you would be willing to share your opinions with me.

Do you own a caulking gun?___________

How often do you use a caulking gun?_____________

When you caulk today, what kind of caulking gun do you use? _______________

(If the answer is no to the first and second question thank the respondent and end the survey)

The product is a caulking gun that utilizes your own drilling machine to make the caulking gun electrical driven. Thus, you don’t need to get tired in your hand and get uneven strokes as trying to manually push out the caulk.

Would you be interested in testing the product?

Well it turns out that this product is available for presale today for a reduced price of 499kr, would you be interested in preordering this product?

If yes – Actually this question was a part of my master thesis, so it is not available but thanks for the encouragement.

If no, why not?

Appendix D Results from survey

Do you have a caulking gun	How often?	Kind?	Scale of willing-ness to buy (1-5)					Comments
Yes	1/year	H and E			x			Too much force. For 299 SEK instead of 499 SEK definitely would.
Yes	1/24month	Hand			x			
Yes	1/year	Hand					x	Good Price! Works fine
Yes	1/year	Hand			x			Better transmission
Yes	2/year	Hand				x		Yes, if
Yes	2/year	Hand				x		
Yes	Never	Hand	x					
Yes	Often	Hand					x	Yes hypothetical but no when asked to buy.
Yes	4/year	Hand					x	Yes, definitely!

Table 2 shows the results from the survey. 1. Column asks if the participant haves a caulking gun, 2. How often it is used, 3. What king of caulking gun, 4. Definitely not, probably not, might - might not, probably would, definitely would buy the product and 5. Comments

Note: Only responded with caulking gun where included in report

Appendix E Results from Beta Product Marketing

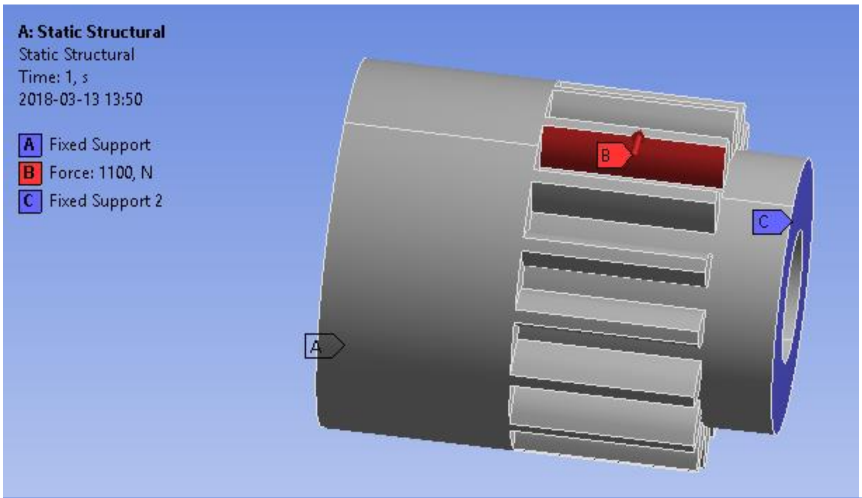
Do you have a caulking gun	How often?	Kind?	Comments
IKDC			
Yes	1/ 24month	H	No, use it too rarely.
Yes	1/year	H	No
Yes	1/month	H	No
Yes	1/year	H	No, use it too rarely
Yes	2/year	H	No, after long considerations with detailed motivation. Prefer one piece as caulking while climbing.
Backyard sale			
Yes	2/year	H	No, but yes if I had any project coming
Yes	1/year	H	No, mine is sufficient
Yes	3/year	H	No, but very interested. I'll take a photo of it.
Yes	1/year	H and E	No, but do a website and sell to professionals.
Yes	5/year	H	No, prefer by hand driven
Yes	1/year	H	Too expensive, "is the electrical drill included?"

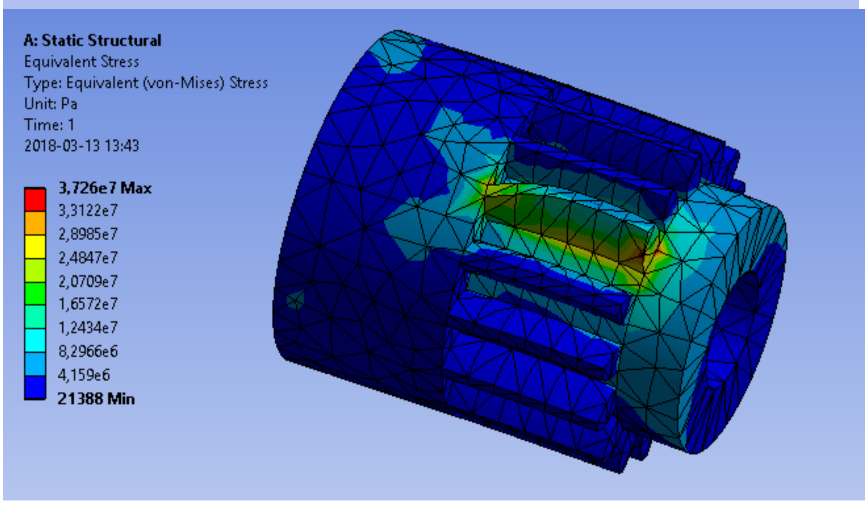
Note: Only responded with a caulking gun where included in report

Appendix F FEM Analysis

Here the finite element analysis conducted is presented

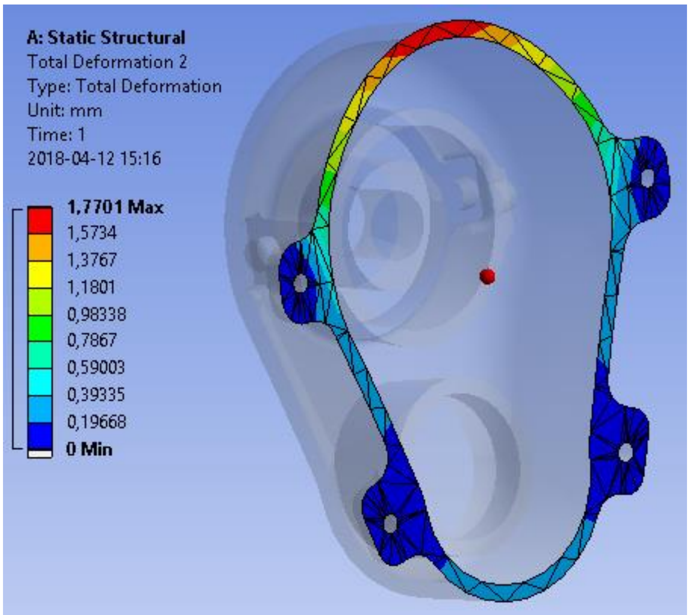
<u>Analysis on smaller gear</u>





From the image the maximum stress is 37 MPa which is below the tensile strength of PLA. This means that the PLA can handle the forces and thus the beta product can be 3D printed with PLA.

<u>2nd prototype of housing</u>



The deformation on the top showed in red is not acceptable. 1.7 mm is too large of a gap and thus additionally an ear support is added to reduce deformation.

For the result following boundary conditions were used: