FINAL REPORT ON GLUE GUN

Reported by

Team 2 – G2

|  |  |
| --- | --- |
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EXECUTIVE SUMMARY

The team designed and developed a product that would be manufactured and sold in the market. The product was to be made of at least three different materials and would be based on something that is currently in the consumer market, but not infringe on patents. Data and consumer preferences were collected from customers and then a product was designed that would meet the demands of customers.

The purpose of this paper is to provide an overview of the methodology used to create a cordless glue gun for a consumer and then what needs to be done to take the product to market. A main focus was on the administrative and business aspects of creating a product and how a company can estimate the manpower needed, as well as the financial means necessary to launch a new company and begin manufacturing.

The scope areas of this project were to design one product that could compete in the market against similar products in a costly manner and to set up a manufacturing facility that could produce the product. The team was tasked with developing and identifying consumer needs, then creating product targets that would fulfill their demands. A product was to be designed from scratch that met our design parameters and specifications and from there the team would analyze how to set up a facility to manufacture the product inhouse and market it.

For our research methodologies, surveys were created that asked potential consumers about our product and what design parameters were of the most important to them. From these surveys a house of quality was created that tied important metrics in the survey to tangible goals for our product. These could be the size of the product, certain features, or characteristics of the product that needed to be incorporated. A functional decomposition was performed on the product and from that key quality indicators and conceptual designs were created.

Research limitations could include subjective interpretations of the researched material. In addition, there was a largely insufficient number of people to fill out the customer surveys since it was only sent out to the members of this class. To better improve the design parameters of this project, the class survey should be sent out to more people.

This report found that there is a sufficient demand in the market for a cordless glue gun. Based on our surveys the consumer would like a product that fulfills that need. The team found that we could make a cordless glue gun out of ABS plastic, steel, and aluminum for a total cost of $10.77. When the labor rate is factored in the total cost to product a glue gun is $12.03. The total investment capital needed to startup the company and run it for the first four months is approximately $478,251. The working capital for the first year is a positive $136,382.

The team found that we could produce a glue gun that is priced competitively in the current market and bring it to market within a reasonable amount of time. We also found that we would have a positive return on investment and make a successful company that would turn a profit and continue to survive based off our projected sales for the first five years.

# Market Analysis, Customer Survey, and House of Quality

A hot glue gun is known as an equipment designed to melt a thermoplastic adhesive that comes in the form of sticks. Using a continuously operating heating element at a temperature of 120 ℃, the plastic glue sticks, which are often of 7-centimeter long, are melted. [1] Glue guns are popular among crafters, both for affixing and as an inexpensive alternative to resin casting. Hot glue guns are also versatile in the manufacturing industry. While not only used for gluing, a hot melt glue gun can even be used for wound closure by extruding tissue bio adhesive onto the wound. [2]

Team G2 designed a series of survey questions aimed to explore the latest trends and preferences among customers. The detailed survey questionnaire can be found in Appendix A. The results of the customer survey showed that half of the informants were willing to spend 20 to 40 dollars on either an average or a high-quality glue gun. This was a hint for the pricing strategy. Many product specifications were presented to the customers to rank. Customers were also encouraged to give any unique opinions. Highlighted product specifications were easy to use, easy to control, lightweight, easy to plug in and charge, and minimized the risk of burns. These specifications were given high level of attention, which would be considered in the design phase. Some specifications got lower credits in the survey, like attractive appearance, which indicated that customers may not care much about the appearance for a glue gun. Moreover, a child protective lock would attract the customers to purchase the glue gun. Leakproof material is required by all the customers, so the choice of material used is of the highest importance for designing.

Having these product specifications summarized, four main categories of product specifications were built, which were accessibility, reliability, safety, and service. The house of quality, (Appendix B) a basic design tool of the management approach known as quality function deployment, was developed using customers rating for each specification. [3] On the bottom line of the house, the targets for the glue gun were set. Summary of engineering requirements is in Table 1‑1.

| Weighted Importance Rank | Engineering Requirements | Target |
| --- | --- | --- |
| 1 | Number of components | 5+ |
| 2 | One button to dispense glue | Y |
| 3 | Modular and able to glue small areas | Y |
| 4 | Insulation for product | Y |
| 5 | One battery life | 3 hours |
| 6 | Accepting Standard glue stick size | Y |
| 7 | Size of Glue Gun | 80 inches |
| 8 | Refillable time | 15 seconds |
| 9 | Reasonable price | 30 dollars |
| 10 | Charging Time | 5 seconds |
| 11 | LED Display | Y |
| 12 | Mean time to clean | 0.25 hours |
| 13 | Easy to dispense glue | Y |
| 14 | Weight | 1.5 pounds |
| 15 | Spare parts available | Y |
| 16 | Safety lock | Y |

Table 1‑1 Engineering Requirements Ranking

Sure Tack Systems, Banseok Precision Industry Co. Ltd, Musashi Engineering Inc., Shenzhen Tengsheng Industrial Equipment Co. Ltd., and Twin Engineers Private Limited., Nordson Corporation, Glenmar Technology, Ellsworth Adhesives India PTY Limited, and others are among the major players in the global Hot Melt Equipment market.[4] An average price for a cordless glue gun by these competitors exceeds $30 and takes about 3 to 5 minutes for preheating. Lithium-ion batteries are the most widely used kind for a cordless product and most glue guns in the market currently weight 1 to 1.5 pounds.

With the rapid growth of the global packaging industry and the growing demand for hot melt equipment, glue guns are being used more in emerging industries, especially in electronic packaging, pharmaceutical packaging, and food packaging. For the competition in the glue gun market, the core features and values of the products are the same, but they differ only in terms of performance and quality. Under the premise of meeting the basic needs of customers, enterprises also need to continue to innovate to meet the individual needs of customers, implement product differentiation, conduct targeted product development, production, and sales to create more business opportunities. From the result of house of quality, customers expect less components and a higher convenience of using glue guns. The design of our new product should focus on such specifications. The market positioning of the glue gun lies in customer groups like middle income and above families, with a standard economic base, a strong acceptance of new things, and with a pursuit of high quality of life. The product positioning of glue guns follows the principle of adaptability and competition. It adapts to the needs of customers and the relevant configuration of the enterprise, combines the situation of competitors in the same field, avoids similarity, and reduces the risk in competition. The product designed in the project will be easy to disassemble and will be cordless as the highlight of the product.

Sales forecast of glue gun in the next five years is provided in Table 1‑2.

|  |  |
| --- | --- |
| Year | Quantity (Units) |
| 1 | 50,000 |
| 2 | 50,000 |
| 3 | 60,000 |
| 4 | 60,000 |
| 5 | 70,000 |

Table 1‑2 Sales Forecast for Next Five Years

# Definition of Product Functionalities, Quality Parameters, Key Quality Indicators, Conceptual Design

Functional decomposition breaks down the operating procedures of the glue gun into smaller, easier to comprehend units (Figure 2‑1). As previously discussed in the house of quality, product specifications were divided into four categories, which inspired the functions being generated. For accessibility, the glue gun must be able to accept one glue stick and eject hot glue, which are fundamental functions of a glue gun. The rate of gluing should be easily controlled by the user otherwise the product would not be preferred. For reliability, the way the battery attaches is the key point. For safety, a child lock is the highlight for such an accessible tool for children.

Diagram

Description automatically generated

Figure 2‑1 Functional Decomposition of Glue Gun

Concepts were generated based on functional decomposition from the above five aspects, which were battery attachment, switch mechanism, child locking mechanism, and gluing rate controlling device. Original ideas given by the team were presented in Table 2‑1.

| No. | Battery Attachment | Switch Mechanism | Child Locking Mechanism | Gluing Rate Controlling Device |
| --- | --- | --- | --- | --- |
| 1 | Snap on battery pack on back. | Push button switch | Cover for switch mechanism | Changing nozzle tip |
| 2 | Slide on battery pack on back | Side mounted switch | Mechanical stop so switch cannot be triggered. | A rotating mechanism to increase or decrease nozzle size. |
| 3 | Battery pack slides in on side with cover. | Center mounted trigger mechanism. | Electronic Stop for the switch | Small flap that can cover a part of the nozzle area. |
| 4 | Battery slide on pack but mounts with screws | Side mounted trigger mechanism | Squeeze and twist mechanism to cover the switch. |  |
| 5 | Inbuilt lithium-ion battery | Shake to switch | Hard push on the lock button to turn on. |  |
| 6 |  | Knob switch | Two steps to unlock the glue gun. |  |
| 7 |  |  | Stop when detecting long-time running. |  |

Table 2‑1 Concept Generation

To select the satisfying concept for each element, concept screening and concept scoring matrices were used. Detailed scores are reserved in Appendix C. Credits were given to evaluate each concept. A weighted importance ranking was synthesized and created from the data of the customers who were surveyed. Only concepts with the highest net scores could be candidates for product design. Summarizing the results, inbuilt lithium-ion battery is perfect for the cordless glue gun battery attachment type. Push button or a center mounted trigger can be considered as the switching mechanism. For child locking mechanism, a cover or mechanical stop device were both viable options. To control the gluing rate, several nozzle tips would be included in the product kit. The design of the tip also resolved the problem of glue hardening.

# Architectural Design

To establish the architecture of the product a schematic (Figure 3‑1) was created. This represents the teams understanding of the constituent elements of the glue gun. As can be seen here the architecture was broken down into elements of the assembly. This schematic helps show what functions and activities the team will focus on during the design process. The schematic easily shows what will need to be accomplished by our product and design.

Graphical user interface, diagram

Description automatically generated

Figure 3‑1 Schematic of the Design

After the product schematic was created the elements of it were clustered into chunks (Figure 3‑2). These chunks are organized by geometric integration as well as function sharing. Interaction among the chunks is simple so if changes are made during the design process they can easily be updated. Once the product schematic was created and clustered, a rough geometric layout was created. In this step, layout and form requirements began to take shape. Here the product elements are incorporated to see how they will fit together, and the rough aesthetics of the product are seen.

Graphical user interface, diagram, application

Description automatically generated

Figure 3‑2 Cluster of Elements

# System Level Design of the product

Since this product is relatively simple and did not have a large number of various subsystems and parts, there was not a formal system design of this product. Instead, the detailed design was done at once and this included the system level design of the product.

# Detailed Product Design

For the detailed product design of our glue gun, we sought to design a product that would work effectively while being able to be easy to assemble and manufacture. Key variables in the design process were material selection, the manufacturing process to make the parts, and the assembly methods. These elements were considered all together during the design process. The goal of our design process was to simplify the parts that we would need so that the manufacturing process would be easier and cheaper. At the same time, we sought to reduce the number of parts in our product so that the cost of the product would stay down. The glue gun has a total of eight parts that need to be manufactured. Six of these parts will be made from ABS plastic, one will be made from aluminum, and the other of steel. For all the parts of the glue gun made from ABS plastic they were designed in such a way that they could be produced by injection molding. This cut down the cost of manufacturing and the waste associated with creating a part. Injection molding machines can also create multiple parts with each stamp of the die. This allows our company to produce the product at a faster rate so we can meet our expected sales growth while also being able to use the same machine to create other parts. ABS plastic is relatively cheap at only $1.50 per pound and is durable enough to fit our needs. The outer shell of the glue gun was created by two parts of ABS. Rather than using screws or fasteners to hold the glue gun together these parts were made to snap together. This cuts down on the assembly time as well as the product cost. The tip of the glue gun was designed out of aluminum. The tip controls the flow rate of the glue as it exits the gun and must be made from a material that will not melt from the hot liquid glue. Aluminum was chosen for this as it is easily machinable, relatively cheap, and has a high melting temperature. The child lock was the only material made from steel. This was done because it needed to be relatively small while having a fair amount of strength. The steel is cheap and can easily be bent into the shape that we need it to be. Four parts on the glue gun will be bought off the shelf and not manufactured. These parts are the spring, battery, heater, and coupler. This was done as the cost to manufacture those products as well as the labor associated would cost more than it would to buy the product. These material selections, manufacturing processes, and assembly methods were considered concurrently in the design process so we could implement a product that had the cheapest cost, automation, producibility, and quality. The CAD and tolerances for the manufactured products can be seen in the Appendix under the CAD drawings.

# DETAILED PROCESS DESIGN

In this section, we will see the detailed process of manufacturing like what machines are we using, the order of the manufacturing process, and the time taken by each process.

**Machines used**:

* In-house Processes:
  + Injection molding machine
  + CNC Lathe
  + Bar bending machine.
* Assembly line:
  + Conveyor belt
* Injection molding machine:
* An injection molding machine is a machine for manufacturing plastic products by the injection molding process.
* Plastic injection molding is a manufacturing process for producing parts by injecting molten material (thermoplastic and thermosetting polymers) into a mold. Material for the part is fed into a heated barrel, mixed, and injected into a mold cavity, where it cools and hardens to the configuration of the cavity.
* Injection molding is widely used for manufacturing a variety of parts, from the smallest components to entire body panels of cars

|  |  |  |  |
| --- | --- | --- | --- |
| Part | #of units produced per lb. | Wastage per lb.  % | #of parts manufactured in one hour |
| Trigger | 20 | 10 | 200 |
| Linkage | 40 | 10 | 250 |
| Right side shell | 8 | 25 | 100 |
| Left side shell | 8 | 25 | 100 |
| Gripper | 12 | 10 | 200 |
| Glue gripper | 15 | 15 | 250 |

Table: Shows no. of parts produced using the machine per lb. and wastage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Part | Material | Amount  Lb. | Life of mold  #of pressings | #of cavities |
| Trigger | ABS Plastic | 0.03 | 125000 | 4 |
| Linkage | ABS Plastic | 0.03 | 120000 | 4 |
| Side shell | ABS Plastic | 0.17 | 120000 | 2 |
| Gripper | ABS Plastic | 0.05 | 125000 | 3 |
| Glue gripper | ABS Plastic | 0.01 | 125000 | 4 |

**Summary of Manufactured Plastic Components:**

We have summarized the usage of the machine for making each product in each timespan like, no. of pressings made by the molding machine and operating time.

**YR 1 & YR 2: (50,000 units)**

Trigger: 278 hours; 13,889 pressing

Linkage: 223 hours; 13,889 pressing

Side Shells (Right & Left): 667 hours; 66,667 pressing

Gripper: 278 hours; 18,519 pressing

Glue Gripper: 236 hours; 14,706 pressing

**YR 3 & YR 4: (60,000 units)**

Trigger: 334 hours; 16,667 pressing

Linkage: 267 hours; 16,667 pressing

Side Shells (Right & Left): 800 hours; 80,000 pressing

Gripper: 334 hours; 22,223 pressing

Glue Gripper: 283 hours; 17,647 pressing

**YR 5: (70,000 units)**

Trigger: 389 hours; 19,445 pressing

Linkage: 312 hours; 19,445 pressing

Side Shells (Right & Left): 934 hours; 93,334 pressing

Gripper: 389 hours; 25,927 pressing

Glue Gripper: 330 hours; 20,589 pressing

* CNC Lathe:

The CNC lathe is used to manufacture the tip of the glue gun which is made from aluminum.

* Bar bending machine:

The bar bending machine is used to bend the carbon steel rods for the child lock.

**Manufacturing process:**

Usually, any manufacturing process starts with a sales order and ends with shipping the completed goods. We created a process flow chart indicating all those steps.

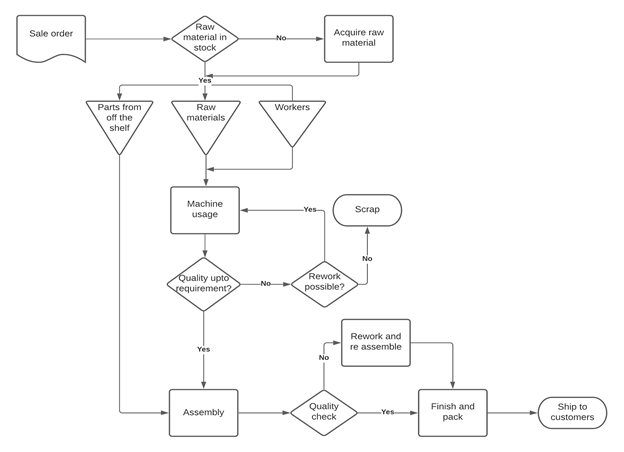


Fig: Process flowchart

**Assembly:**

* Task time:

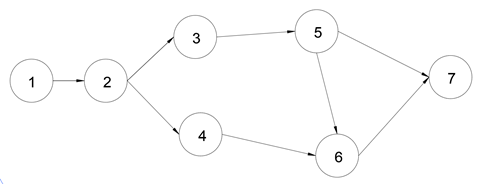
We need to know the time it takes to complete the entire assembly process, so that we can set goals like, the no of shifts needed per day, units to be produced per shift, etc. For this, we created a close approximation of time taken by each task in the process. The below table indicates the same.

|  |  |  |
| --- | --- | --- |
| **Task** | **Process** | **Task time(min)** |
| 1 | Take parts to assembly area | 0.3 |
| 2 | Assemble heater into side shell | 0.5 |
| 3 | Assembled linkage, trigger | 0.4 |
| 4 | Assembled glue gripper | 0.4 |
| 5 | Assembled tip. | 0.3 |
| 6 | Assembled other side shell. | 0.7 |
| 7 | Insert battery | 0.5 |
| 8 | Quality Control | 2 |
| Total time | | 5.1 |

* We have made a precedence table indicating the order in which these tasks should be done.

|  |  |  |
| --- | --- | --- |
| Task number | Immediate predecessor | Time |
| 1 | - | 0.3 |
| 2 | 1 | 0.5 |
| 3 | 2 | 0.4 |
| 4 | 2 | 0.4 |
| 5 | 3 | 0.3 |
| 6 | 4,5 | 0.7 |
| 7 | 6 | 0.5 |

* Based on the above table, precedence diagram for the assembly line is made.



**IDEAL CYCLE TIME:**

A total of 195 units is required per day. Factory will operate 1 shift per day at 90% efficiency. 195 units per shift.

Productive hours per shift= 8 hours per shift x 0.93efficiency = 7.44hour per shift

Desired Cycle time= 7.44 x 60/195= 2.289min, For 4 workers= 2.289 x 4= 9.156min

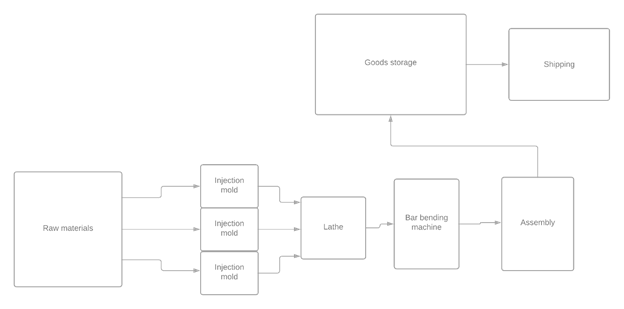
# FACILITY DESIGN

We found a facility in Gainesville, Fl. The address is 4750 NW US 441, Gainesville, FL 32609. The area of the facility is 7480 square feet.



**PLANT LAYOUT:**

We used process layout principles and created our plant layout which is shown below.

**AREA REQUIREMENTS:**

* Before creating a floor plan, we need to calculate area needed for each section.
* For that we used production center method in which, we calculated area required for each machine, parts and other areas and multiplied them with the required amount to get the total area needed.
* The area requirements are divided into two parts: i) Productive and ii) Non-productive.

1. Productive Areas

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Process | Equipment | Number required | Dimensions  ft | Area per unit  Sq. ft | Total area  Sq. ft |
| Lathe | CNC lathe | 1 | 5x2 | 10 | 10 |
| Molding | Ax90 | 3 | 11.7x4.1 | 50 | 150 |
| Bend | Bar bending machine | 1 | 3x3 | 9 | 9 |
| Assembly |  | 1 | 30x40 | 1200 | 1200 |
| Packaging |  | 1 | 20x40 | 800 | 800 |
|  |  |  |  | Total | 1449 |
|  |  |  |  | 50% aisle space | 991.5 |
|  |  |  |  | **Total area** | **2173.5** |

1. Non- Productive Areas

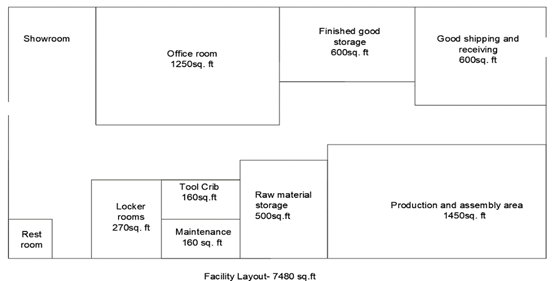
|  |  |
| --- | --- |
| Activity | Area sq. ft |
| Raw material storage | 500 |
| Finished goods storage | 600 |
| Office | 1250 |
| Locker rooms | 270 |
| Maintenance | 160 |
| Tool crib | 160 |
| Shipping and receiving | 600 |
| Showroom | 1080 |
| Restroom | 100 |
| **Total space** | **4570** |

**Total area needed: 2173.5+4570 = 6743.5 square feet.**

For raw material storage, the approximate volume of each part was calculated and multiplied with the number we may need for at least 4 months.

1. Trigger- 0.3996 cub inch
2. Gripper- 0.74 cub inch
3. Child lock- 0.2 cub inch
4. Linkage- 0.04 cub inch
5. 2 side shells- 28.7 cub inch
6. Battery- 3.906 cub inch
7. Coupler- 0.45 cub inch
8. Heater- 1.7 cub inch
9. Total ~ 40 cub inch. Multiplied with 20000 units and converting to sq. fts gives 450sq.ft.

**Floor plan:**  Based on the data above, a floor plan is created.



# Economic Analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Size sqft** | **Price per sqft** | **Price per month** | **Total** |
| Office/Warehouse Space for lease | 7480 | $0.58 | $4,338 | $17,353 |
| Utility cost | 7480 | $2.10 | $15,708 | $62,832 |
| Property/Liability Insurance |  |  | $80 | $320 |
| Building Maintenance |  |  | $150 | $600 |
|  |  | **Total** | **$20,276** | **$81,105** |

To get our product to market, we needed to assess the financial impacts it would take for this to happen. Initially we set out to estimate the cost it would take to get this business off the ground and running for the first four months. This analysis was based on different rates such as hourly labor cost, cost per square feet of facility, etc. After a brief market research (the assumed rates are specified in appendix).

|  |  |  |  |
| --- | --- | --- | --- |
| **Role** | **Quantity** | **Price per person** | **Total** |
| Technician | 4 | $13,325 | $53,300 |
| Office Manager | 1 | $13,750 | $13,750 |
| Office Assistant | 1 | $11,675 | $11,675 |
| Engineer | 1 | $26,600 | $26,600 |
|  |  | **Total** | **$105,325** |

|  |  |  |  |
| --- | --- | --- | --- |
| **Raw Material Costs** | **Quantity for 4 months** | **price per unit** | **Total** |
| Abs Plastic | 10,000lbs | 1.5lb | $15,000 |
| Aluminum 6061 T6 rod | 695 12" rods | 9.15 per foot | $6,359 |
| Steel rod | 5,334 12" rods | 1.53 per foot | $8,161 |

|  |  |  |  |
| --- | --- | --- | --- |
| **COTS Costs** | **Quantity for 4 months** | **Price per unit** | **Total** |
| Spring | 16,667 | $2.38 | $39,667 |
| Coupler | 16,667 | $1.30 | $21,667 |
| Glue Gun heating element | 16,667 | $4.00 | $66,668 |

Total raw material cost = Cost or raw materials of non-COTS parts + Cost of raw materials of COTS parts. Hence, making estimated raw material cost of $128,002.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Inventory** |  |  |  |  |
|  | Amount needed for four months | Desired end inventory | Total Inventory | Total Price |
| Gripper | 16,667 | 7,333 | 24,000 | $21,600 |
| Glue Gripper | 16,667 | 7,333 | 24,000 |
| Trigger | 16,667 | 7,333 | 24,000 |
| Linkage | 16,667 | 7,333 | 24,000 |
| Right Side Shell | 16,667 | 7,333 | 24,000 |
| Left Side Shell | 16,667 | 7,333 | 24,000 |
| Tip | 16,667 | 7,333 | 24,000 | $9,150 |
| Child Lock | 16,667 | 7,333 | 24,000 | $11,751 |
| Spring | 16,667 | 7,333 | 24,000 | $57,120 |
| Coupler | 16,667 | 7,333 | 24,000 | $31,200 |
| Glue Gun Heating Element | 16,667 | 7,333 | 24,000 | $96,000 |

This capital investment would be money we needed at the onset of the project to buy materials, machines, and hire workers to assemble the goods produced. After four months we estimated that we would start to see a return on our investment and money from sales would start flowing and allow us to not take on any more debt. As can be seen in Table 8‑1 we have calculated the total estimated investment capital needed for the first four months. The price of $478,251 takes into account the cost of the facility, labor, materials, and machinery needed to produce 24,000 glue guns which is roughly half of our target of 50,000 glue guns a year.

|  |  |
| --- | --- |
| **Overall Investment for four months** | **Cost** |
| Labor Rate | $105,325 |
| Rent/Utilities | $81,105 |
| Raw Materials | $42,501 |
| COTS Parts | $184,320 |
| Cost of Machinery | $65,000 |
| **Total Investment Cost** | **$478,251** |

Table 8‑1 Overall Investment for Four Months

Working Capital was calculated for our business during its first year (Table 8‑2). Working capital measures the health of a company as it is growing and establishing itself. Since we have a positive working capital that shows that our current assets exceed our current liabilities. This is attractive to investors and shows that our company has potential to be invested in and will most likely grow over the next couple of years.

|  |  |  |  |
| --- | --- | --- | --- |
| **Working Capital for the First Year** | **Liability** | **Assets** | **Cost** |
| Labor, Rent, Utilities | Yes |  | $664,612 |
| Materials, Cost of Machinery | Yes |  | $449,006 |
| Inventory, Accounts Receivable |  | Yes | $1,250,000 |
|  |  | Working Capital | $136,382 |

Table 8‑2 Working Capital for the First Year

The sales forecast was estimated based on the cost analysis of the first 4 months and the cost sales forecast.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Forecasted sales** | **Direct labor cost** | **Property expenses** | **Raw material cost** | **Cost of machinery** | **Total Investment** | **Gross margin** | **Net Margin** | **Total revenue** |
| **Year 1** | **50,000** | **$421,300.00** | **$243,312.00** | **$384,006.00** | **$65,000.00** | **$1,113,618.00** | **$828,700.00** | **$136,382.00** | **$1,250,000.00** |
| **Year 2** | **50,000** | **$421,300.00** | **$243,312.00** | **$384,006.00** |  | **$1,048,618.00** | **$828,700.00** | **$201,382.00** | **$1,250,000.00** |
| **Year 3** | **60,000** | **$505,560.00** | **$243,312.00** | **$460,807.00** |  | **$1,209,679.00** | **$994,440.00** | **$290,321.00** | **$1,500,000.00** |
| **Year 4** | **60,000** | **$505,560.00** | **$243,312.00** | **$460,807.00** |  | **$1,209,679.00** | **$994,440.00** | **$290,321.00** | **$1,500,000.00** |
| **Year 5** | **70,000** | **$589,820.00** | **$243,312.00** | **$537,608.00** |  | **$1,370,740.00** | **$1,160,180.00** | **$379,260.00** | **$1,750,000.00** |

Table 8‑3 Net margin for the first 5 years of sales.

From the table above we are forecasted to make net revenue of $1,297,666 in the first 5 years. This shows that the product is very profitable. These results are calculated assuming the product selling price of $25.00 per product which is a very reasonable compared to other competitors in the market. We are also projecting a total profit of $817,529 in our first 5 year of sales after taxes at 37% of net margin per year. Based off these profit numbers it will take us approximately 44 months to pay back the initial investment taken out to run the company for the first four months. The company is projected to recover its initial investment of $65,000 within the first year of sales at the projected sales. Making a total profit of $1,765,530 in the first five years of sales.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Sales** | **Net Margin** | **Tax(@37%)** | **Profit** |
| Year 1 | 50,000 | $136,382.00 | $50,461.34 | $85,920.66 |
| Year 2 | 50,000 | $201,382.00 | $74,511.34 | $126,870.66 |
| Year 3 | 60,000 | $290,321.00 | $107,418.77 | $182,902.23 |
| Year 4 | 60,000 | $290,321.00 | $107,418.77 | $182,902.23 |
| Year 5 | 70,000 | $379,260.00 | $140,326.20 | $238,933.80 |
| **Total** |  |  |  | **$817,529.58** |

Table 8-4 Sales forecast for the first 5 years

# Reference

1. Hot-melt adhesive - Wikipedia. En.wikipedia.org. https://en.wikipedia.org/wiki/Hot-melt\_adhesive. Published 2021. Accessed April 25, 2021.

2. Shagan, A., Zhang, W., Mehta, M., Levi, S., Kohane, D. S., Mizrahi, B., Hot Glue Gun Releasing Biocompatible Tissue Adhesive. Adv. Funct. Mater. 2020, 30, 1900998.

3. John R. Hauser & Don Clausing (1988) The house of quality. Harvard Business Review, May-June, 63-73.

4. 2020. "COVID-19 Impact on Hot Melt Equipment Market," Herald Keeper (UK), June 9.

# Appendix

## A. Customer Questionnaire

1. Your gender:

Male Female Prefer not to say

1. Your age:

Under 21 21-30 31-40 41-50 51-60 61-70 Above 70 Prefer not to say

1. Your monthly income:

$0-$1000 $1000-2000 $2000-3000 $3000-4000 $4000-5000 $5000 and above

1. How much would you be willing to spend on an average hot glue gun?

$5-$10 $10-$20 $20-$30 $30-$40 $40 and above

1. How much are you willing to spend on a high quality glue gun?

$10-$20 $20-$30 $30-$40 $40-$50 $50 and above

1. If a high-quality glue gun was available to be bought at $20, would you buy it right away?

Yes No Maybe

1. Do you or your family own a glue gun now?

Yes No Maybe

1. When given the choice between a wireless product and a wired one, which one do you prefer?

Wireless product Wired product It depends

1. Survey Questions

| Survey Questions | Very much | Somewhat | Neutral | Very little | Not at all |
| --- | --- | --- | --- | --- | --- |
| How often do you routinely make crafts as a hobby or for fun? |  |  |  |  |  |
| How often do you find yourself needing to repair or fix broken items made of wood, glass, plastic, or metal? |  |  |  |  |  |
| How important is it if the product is easy to use? |  |  |  |  |  |
| How important is it if the product is easy to control? |  |  |  |  |  |
| How important is it if the product has a long battery life? |  |  |  |  |  |
| How important is it if the product has an attractive and appealing appearance? |  |  |  |  |  |
| How important is it if the product is lightweight? |  |  |  |  |  |
| How important is it if the product is easy to plug in and charge? |  |  |  |  |  |
| How important is it if the product is durable? |  |  |  |  |  |
| How important is it if the product uses industry standard glue sticks rather than its own brand and size? |  |  |  |  |  |
| How important is it if the product is relatively quiet? |  |  |  |  |  |
| How important is it if the product minimizes risk of burns? |  |  |  |  |  |
| How important is it if the product can withstand high temperatures? |  |  |  |  |  |
| How important is it if the product has a child protective lock? |  |  |  |  |  |
| How important is it if the after-sales service is quick-responded? |  |  |  |  |  |
| How important is it if this product uses industry standard glue sticks rather than its own brand? |  |  |  |  |  |
| How often do you find yourself having to glue something in a week? |  |  |  |  |  |
| How important is it for the product to be child safe? |  |  |  |  |  |
| How important is it to be able to refile easily? |  |  |  |  |  |
| How important is it for the product to be leak proof? |  |  |  |  |  |
| How important is the products small size for handling? |  |  |  |  |  |
| How important is it for the product to be easy to clean? |  |  |  |  |  |

1. What is your preferred mode of operation?

Manual Automatic

1. Is there any additional needs that you expect for this newly-designed glue gun? (Optional)
2. Would you like to mention anything specific in your experience with a glue gun which was not asked in the survey? (Optional)

## B. House of Quality



## C. Concept Selection

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Concept Screening | **Concepts for Battery Attachment** | | | | | | | | | | |  |
|  | **A** | | **B** | | **C** | | **D** | | **E** | | |  |
| **Selection Criteria** | **Snap on a battery pack** | | **Slide on a battery pack** | | **Battery pack slides in with one side covered** | | **Slide on a battery pack mounting with screws** | | **Inbuilt lithium-ion battery** | | |  |
| Easy to use | S | | S | | S | | - | | + | | |  |
| Lightweight | S | | S | | S | | - | | + | | |  |
| Affordable | S | | S | | S | | S | | - | | |  |
| Durable | S | | - | | S | | S | | + | | |  |
| Long lasting battery | S | | S | | S | | S | | - | | |  |
| Minimize risk of burns | S | | S | | + | | S | | - | | |  |
| Withstand high temperature | S | | S | | + | | S | | + | | |  |
| Leakproof | S | | S | | + | | S | | + | | |  |
| Easy to charge | S | | S | | - | | - | | + | | |  |
| **Sum +'s** | 0 | | 0 | | 3 | | 0 | | 6 | | |  |
| **Sum S's** | 9 | | 8 | | 5 | | 6 | | 0 | | |  |
| **Sum -'s** | 0 | | 1 | | 1 | | 3 | | 3 | | |  |
| **Net Score** | **0** | | **-1** | | **2** | | **-3** | | **3** | | |  |
| **Rank** | 3 | | 4 | | 2 | | 5 | | 1 | | |  |
| **Continue ?** | y | | n | | y | | n | | y | | |  |
|  |  |  | |  | |  | |  | |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Concept Scoring |  | **Concepts for Battery Attachment** | | |
|  |  | **A** | **B** | **C** |
| Selection Criteria | Weight | **Snap on battery pack** | **Battery pack slides in with one side covered** | **Inbuilt lithium-ion battery** |
| Easy to use | 12% | 3 | 4 | 5 |
| Lightweight | 12% | 3 | 2 | 5 |
| Affordable | 8% | 3 | 4 | 2 |
| Durable | 12% | 3 | 3 | 4 |
| Long lasting battery | 11% | 3 | 4 | 5 |
| Minimize risk of burns | 12% | 3 | 4 | 5 |
| Withstand high temperature | 11% | 3 | 4 | 4 |
| Leakproof | 12% | 3 | 3 | 5 |
| Easy to charge | 12% | 3 | 2 | 5 |
| **Total** | **100%** | **3.03** | **3.33** | **4.59** |
| **Rank** |  | 3 | 2 | 1 |
| **Continue ?** |  |  | Y | Y |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Concept Screening | **Concepts for Switching Mechanism** | | | | |
|  | **A** | **B** | **C** | **D** | **E** |
| **Selection Criteria** | **Push button** | **Center-mounted trigger** | **Shake to switch** | **Knob switch** | **Selection screen** |
| Easy to use | S | - | + | S | + |
| Easy to control | S | - | - | S | S |
| Affordable | S | + | - | + | - |
| Durable | S | S | - | S | - |
| Saves time | S | + | + | S | - |
| Easy to replace | S | + | - | S | - |
| No additional circuitry needed | S | S | - | S | - |
| Power efficiency | S | + | - | S | - |
| **Sum +'s** | 0 | 4 | 2 | 1 | 1 |
| **Sum S's** | 8 | 2 | 0 | 7 | 1 |
| **Sum -'s** | 0 | 2 | 6 | 0 | 6 |
| **Net Score** | **0** | **2** | **-4** | **1** | **-5** |
| **Rank** | 3 | 1 | 4 | 2 | 5 |
| **Continue ?** | Y | Y | Y | Y | Y |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Concept Scoring |  | **Concepts for Switching Mechanism** | | |
|  |  | **A** | **B** | **C** |
| **Selection Criteria** | Weight | **Push button** | **Center mounted trigger** | **Knob switch** |
| Easy to use | 14% | 4 | 3 | 2 |
| Easy to control | 14% | 5 | 3 | 1 |
| Affordable | 9% | 3 | 4 | 2 |
| Durable | 13% | 3 | 5 | 3 |
| Saves time | 14% | 5 | 5 | 3 |
| Easy to replace | 11% | 4 | 3 | 4 |
| No additional circuitry needed | 13% | 5 | 5 | 3 |
| Power efficiency | 12% | 4 | 5 | 3 |
| **Total** | **100%** | **4.19** | **4.14** | **2.60** |
| **Rank** |  | 1 | 2 | 3 |
| **Continue ?** |  | Y | Y |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Concept Screening | **Concepts for Child Locking Mechanism** | | | | | |
|  | **A** | **B** | **C** | **D** | **E** | **F** |
| **Selection Criteria** | **Cover for switch** | **Mechanical stop so switch cannot be triggered** | **Hard push on a button to lock mechanism** | **Fingerprint authentication** | **Two steps to unlock glue gun** | **Electronic stop for the switch** |
| Easy to use | + | S | + | + | S | + |
| Durable | S | S | + | + | + | S |
| Affordable | - | S | S | - | S | - |
| Saves time | + | S | S | S | - | + |
| Easy to replace | + | S | - | - | + | - |
| No additional circuitry needed | + | S | - | - | + | - |
| Power efficiency | + | S | S | - | S | - |
| **Sum +'s** | 5 | 0 | 2 | 2 | 3 | 2 |
| **Sum S's** | 1 | 7 | 3 | 1 | 2 | 1 |
| **Sum -'s** | 1 | 0 | 2 | 4 | 1 | 4 |
| **Net Score** | **5** | **0** | **0** | **-2** | **2** | **-2** |
| **Rank** | 1 | 3 | 3 | 4 | 2 | 4 |
| **Continue ?** | Y | Y | Y | N | Y | N |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Concept Scoring |  | **Concepts for Child Locking Mechanism** | | | |
|  |  | **A** | **B** | **C** | **D** |
| **Selection Criteria** | Weight | **Cover for switch** | **Mechanical stop so switch cannot be triggered** | **Hard push on a button to lock mechanism** | **Two steps to unlock glue gun** |
| Easy to use | 16% | 5 | 5 | 4 | 3 |
| Durable | 15% | 3 | 4 | 3 | 4 |
| Affordable | 10% | 5 | 5 | 3 | 5 |
| Saves time | 16% | 5 | 3 | 5 | 4 |
| Easy to replace | 12% | 5 | 4 | 3 | 3 |
| No additional circuitry needed | 15% | 5 | 4 | 5 | 3 |
| Power efficiency | 14% | 5 | 3 | 5 | 5 |
| **Total** | **100%** | **4.690** | **3.956** | **4.077** | **3.808** |
| **Rank** |  | 1 | 3 | 2 | 4 |
| **Continue ?** |  | Y | Y |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Concept Screening | **Concepts for Gluing Rate Controlling Device** | | | |
|  | **A** | **B** | **C** | **D** |
| **Selection Criteria** | **Changing nozzle tip** | **A rotating mechanism to increase/decrease outflow** | **A digital display to adjust flow rate** | **Small flap inside nozzle which can be triggered to cover a part of nozzle area** |
| Easy to use | + | + | + | S |
| Durable | S | + | - | S |
| Affordable | - | - | - | S |
| Saves time | - | + | + | S |
| Easy to replace | + | - | - | S |
| No additional circuitry needed | S | S | - | S |
| Power efficiency | S | S | - | S |
| **Sum +'s** | 2 | 3 | 2 | 0 |
| **Sum S's** | 3 | 3 | 0 | 9 |
| **Sum -'s** | 2 | 2 | 5 | 0 |
| **Net Score** | **0** | **1** | **-3** | **0** |
| **Rank** | 2 | 1 | 3 | 2 |
| **Continue ?** | Y | Y | N | Y |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Concept Scoring |  | **Concepts for Gluing Rate Controlling Device** | | |
|  |  | **A** | **B** | **D** |
| **Selection Criteria** | Weight | **Changing nozzle tip** | **A rotating mechanism to increase/decrease outflow** | **Small flap inside nozzle which can be triggered to cover a part of nozzle area** |
| Easy to use | 16% | 4 | 4 | 3 |
| Durable | 15% | 4 | 2 | 3 |
| Affordable | 10% | 3 | 1 | 4 |
| Saves time | 16% | 2 | 4 | 3 |
| Easy to replace | 12% | 5 | 1 | 3 |
| No additional circuitry needed | 15% | 5 | 2 | 3 |
| Power efficiency | 14% | 5 | 3 | 5 |
| **Total** | **100%** | **4.00** | **2.57** | **3.39** |
| **Rank** |  | 1 | 3 | 2 |
| **Continue ?** |  | Y |  | Y |

## D. CAD Drawings (Remarks or figure names for the CAD design are needed)

Diagram, engineering drawing

Description automatically generated

Diagram, engineering drawing, schematic

Description automatically generated

Diagram, engineering drawing

Description automatically generated

Diagram, engineering drawing

Description automatically generated

Diagram, engineering drawing

Description automatically generated

Diagram, schematic

Description automatically generated

Diagram

Description automatically generated

Diagram, engineering drawing

Description automatically generated

COTS Parts

Diagram, engineering drawing

Description automatically generated

Diagram, engineering drawing

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

## E. Identifying the meaning of numbers, how the numbers come out