**University of Texas Permian Basin**

**EENG 4460 Senior Design**

**Final Report: Automated Dog Feeder**

for

Automated Dog Feeder

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Submitted to ---

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**Submitted as part of the requirement for the course**

**EENG 4460 Senior Design**

Date of Submission

(use “Month Day, Year” format)

**Executive Summary:**

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**Introduction:**

Problem Statement

Many dog owners struggle to keep their animals healthy and safe during feeding time. Overfeeding canines is a problem that countless pet owners struggle with. As a result of a continually growing market, there is a strong need for a product that easily enables dog owners to feed their dogs remotely and in a healthy manner while maintaining a safe environment for both animals and humans. It would also be necessary for this product to service multi-dog homes in a safe manner. Eliminating the need for pet owners to be present or remember to feed dogs at the correct time is a key goal in this system.

According to the Veterinary Center of America (VCA) Animal Hospitals, approximately 25-30% of the general canine population is obese in the United States, with 40-45% of dogs aged 5-11 years old weighing in above that of healthy weight range **[1]**. Additionally, stated in the Raw Bistro Blog, food aggression is quite common in dogs. One study reported that nearly 20% of all dogs show signs of food aggression **[2]**. According to the results of a 2021 survey conducted by the American Pet Products Association, dog ownership in the United States has increased by 13% since 1988 **[3]**. Most dog feeding products on the market fail to safely feed multiple animals with different types of diets and foods in a single device.

Many prescription and specialty diet dog foods are high cost and use volatile compounds to stimulate dog appetite that evaporate when open to atmosphere. Automatic dog feeding products currently on the market either continually gravity flow all stored food from an unsealed container or blindly dispense a preset amount. Many pets eat less when their owners are not home for extended periods of time. Additionally, countless individuals struggle to prevent their animals from stealing each other’s food at feeding time. This results in an unbalanced diet for every dog in the home. There is a need in the market for a multi-animal automatic pet feeder that can measure how much food was eaten, what remains, and acts on that information while sealing the remaining supply to preserve freshness and conserve food.

**Problem Formulation:**

Objectives

* Allow dog owners to feed pets remotely.
* Design product so that it is self-training for pets.
* Apparatus should be able to safely service multi-dog homes.
* Should be functional for dogs of all sizes and diet types.
* Product must be easily programmable according to individual client’s needs.

(Need to Extend this section to a full-page minimum)

In order to meet customer needs, a fully automated, self-training, dog food dispenser is to be designed that does not overfeed or underfeed animals. This apparatus should be sized in such a way that it can be situated in residential family homes without acquiring a large amount of space. It will also be designed for multi-dog owners to feed each individual dog the correct serving amount and food brand in order to meet each individual dog’s needs. Also, this product will have a training component to alert which dog needs to eat and prevent any other animal from stealing another dog’s meal. There will be multiple feeding compartments that sense if the correct dog is there before it opens. If the wrong canine comes to the incorrect compartment, it will not open. If it is already open, it will close when the wrong dog gets too close. Weight sensors will be utilized to detect if the food has been eaten or if some remains to ensure proper feeding amounts. This will all be programmable using a local keypad and displayed on the LCD screen(s). Pet owners will not have to be present at feeding times.

**Project Specifications**

Marketing Requirements:

1. Low cost.
2. Easily portable when food storage is empty.
3. User-friendly.
4. Should maintain a healthy diet for canines.
5. Should be safe and usable for multi-dog applications.
6. Be able to feed any size of dog for a minimum of 1 week.
7. Excellent sound quality for food-time alerting.
8. Keeps food sealed and fresh.

Engineering Requirements:

1. Marginal production cost should not exceed $60.
2. The dimensions should not exceed 3’x3’x2’.
3. Be able to power using a cord plug-in to a 120v, 15amp receptacle.
4. System will operate for a minimum of 28 feeding cycles in absence of power.
5. System will operate 24/7, 365 days a year given power source.
6. System should be able to operate in the temperature range of 60 to 80 degrees Fahrenheit.
7. Should be programmable for food proportions for dogs weighing 3-12lb, 13-20lb, 21-35lb, 36-50lb, 51-75lb, 76-100lb, and 100lb+.
8. Provide 1.8 gallons of food storage for each dog.
9. Owner should be able to select a unique sound per dog to be used for the alerting process.
10. System should alert dog(s) based on users inputted schedule.
11. Average feeding-time should not exceed a specified time, chosen by the user.
12. Compartments will open or close when dog is at 1m from apparatus.
13. Feeding amount accuracy will be within 90% with a resolution of ¼ cup.

System Requirements Compatibility:

Each engineering requirement is traceable to one or more of the marketing requirements. In this manor, the engineering design and specifications are implemented to meet the needs of the shareholders, as well as the customers. Table 1 lists the requirements overview to exhibit the correlations between the marketing and engineering requirements. Statements of justification explain why each requirement is relevant and necessary to meet technical and client needs. It is shown that the system requirements correspond to one another and are essential in satisfying the needs of the customers.

**Table 1:** System requirements for the automated dog feeding apparatus.

|  |  |  |
| --- | --- | --- |
| **Marketing Requirements** | **Engineering Requirements** | **Justification** |
| **1** | 1. Marginal production cost should not exceed $60. | This is based upon competitive market analysis and component research. |
| **1, 2, 3, 5, 6** | 2. The dimensions should not exceed 3’x3’x2’. | Fits in a vehicle trunk or truck bed for portability. |
| **1, 2, 3** | 3. Be able to power using a cord plug-in to a 120v, 15amp receptacle. | This aligns with the most common power source in a North American residential home. |
| **3** | 4. System will operate for a minimum of 28 feeding cycles in absence of power. | This provides a week worth of food for a 2-dog home. |
| **3** | 5. System will operate 24/7, 365 days a year given power source. | Given that the system can be easily powered by a residential outlet and very small power draw, there should be minimal equipment malfunctions. |
| **3** | 6. System should be able to operate in the temperature range of 60 degrees F to 80 degrees F. | This temperature range should not affect any of the system components and is well within the average home climate. |
| **3, 4, 5, 6** | 7. Should be programmable for food proportions for dogs weighing 3-12lb, 13-20lb, 21-35lb, 36-50lb, 51-75lb, 76-100lb, and 100lb+. | Providing a wide range of dog weights, services a diversified population of clients. |
| **2, 3, 4, 5, 6, 8** | 8. Provide 1.8 gallons of food storage for each dog. | At this volume, the product will be able to feed a 100 lb dog 4 cups a day for a week. |
| **3, 5, 7** | 9. Owner should be able to select a unique sound per dog to be used for the alerting process. | This is a vital aspect of the self-training component imbedded in this system to alert a specific dog to eat. |
| **3, 4, 5, 7** | 10. System should alert dog(s) based on users inputted schedule. | Allowing the dog-owner to customize alerting and feeding schedule fits a wider range of customer needs. |
| **3, 4** | 11. Average feeding-time should not exceed a specified time, chosen by the user. | Allowing the dog-owner to customize allowable feeding range fits a wider population of customer needs. |
| **5** | 12. Compartments will open or close when dog is at 1m from apparatus. | This will eliminate any stealing of or fighting over food between dogs. |
| **1, 5, 6** | 13. Feeding amount accuracy will be within 90% with a resolution of ¼ cup. | Based on dispensing volumes of ¼ cup increments, the feeding accuracy will fall within this range. |
| **Marketing Requirements:**   1. **Low cost.** 2. **Easily portable when food storage is empty.** 3. **User-friendly.** 4. **Should maintain a healthy diet for canines.** 5. **Should be safe and usable for multi-dog applications.** 6. **Be able to feed any size of dog for a minimum of 1 week.** 7. **Excellent sound quality for food-time alerting.** 8. **Keeps food sealed and fresh.** | | |

Engineering-Marketing Tradeoff Matrix:

The Matrix, shown in Table 2, pinpoints how the engineering and marketing requirements affect each other. The row-headings consist of the of the marketing requirements, while the engineering requirements are listed in the column headings. Each requirement also has a designated polarity, indicating the overall benefit of that requirement to the final product. The arrows indicate how strong or weak the correlation is between each marketing requirement and each engineering requirement. This data promotes further analysis in improving system performance and affordability.

**Table 2:** Engineering-marketing tradeoff matrix for the automated dog feeding apparatus (↑↑ = strong positive correlation, ↑ = positive correlation, ↑ = minute positive correlation, ↓↓ = strong negative correlation, ↓ = negative correlation, ↓ = minute negative correlation).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Engineering-Marketing Matrix | | Production cost <= $60 | Dimensions < 3'x3'x2' | 120v 15A receptacle | Power Draw | Battery Capacity | Reliability | Programmability | Food Capacity | Unique Sounds | Speed | Dog Detection | Accuracy |
| - | - | / | - | + | + | + | + | + | + | + | + |
| 1) Low Cost | - | ↑↑ | ↑ | ↑ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 2) Easily portable when empty. | - |  | ↑↑ |  |  | ↓ |  |  | ↓↓ |  |  |  |  |
| 3) User-friendly | + |  | ↑ | ↑ |  |  | ↑ | ↑↑ | ↑ | ↑ |  |  | ↑ |
| 4) Maintain Healthy diet for K9 | + |  |  |  |  |  |  | ↑ | ↑ |  |  | ↑↑ | ↑↑ |
| 5) Safe and usable for multi-dog | + | ↓ | ↓ |  |  |  |  | ↑↑ | ↑ | ↑↑ | ↑ | ↑↑ | ↑↑ |
| 6) Feeds any size dog for 1 week | + | ↓ | ↓↓ |  |  | ↑ | ↑ | ↑ | ↑↑ |  |  |  | ↑↑ |
| 7) Sound alerting | + | ↓ |  |  | ↓ |  |  | ↑↑ |  | ↑↑ |  |  |  |
| 8) Keeps Food Fresh | + | ↓ | ↓ |  |  |  |  |  | ↑ |  | ↑ |  | ↑↑ |

Engineering Tradeoff Matrix:

It is also necessary to do a comparison within the engineering requirements themselves. This analysis further bolsters marketing and technical needs. As shown in Table 3, a tradeoff matrix is implemented with engineering requirements consisting of both rows and columns. Similar to Table 2, positive and negative correlations are specified, as well as the strength of the correlation. The bottom diagonal is blacked out due to redundancy. It is paramount to maximize and compare the importance of and effect each engineering requirement has on each other. In doing so, the product specifications can be narrowed down to meet functionality benchmarks.

**Table 3:** Engineering tradeoff matrix for the automated dog feeding apparatus (↑ = positive correlation, ↓ = negative correlation).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tradeoff Matrix | | Production cost <= $60 | Dimensions < 3'x3'x2' | 120v 15A receptacle | Power Draw | Battery Capacity | Reliability | Programmability | Food Capacity | Unique Sounds | Speed | Dog Detection | Accuracy |
| - | - | / | - | + | + | + | + | + | + | + | + |
| Production cost <= $60 | - |  | ↑ | ↑ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Dimensions < 3'x3'x2' | - |  |  |  |  | ↓ |  |  | ↓ |  |  |  |  |
| 120v 15A receptacle | / |  |  |  |  |  |  |  |  |  |  |  |  |
| Power Draw | - |  |  |  |  | ↑ |  |  |  | ↓ | ↓ |  |  |
| Battery Capacity | + |  |  |  |  |  | ↑ |  |  |  |  |  |  |
| Reliability | + |  |  |  |  |  |  | ↓ |  |  | ↓ |  |  |
| Programmability | + |  |  |  |  |  |  |  |  | ↑ |  |  |  |
| Food Capacity | + |  |  |  |  |  |  |  |  |  |  |  | ↓ |
| Unique Sounds | + |  |  |  |  |  |  |  |  |  |  |  |  |
| Speed | + |  |  |  |  |  |  |  |  |  |  |  | ↓ |
| Dog Detection | + |  |  |  |  |  |  |  |  |  |  |  |  |
| Accuracy | + |  |  |  |  |  |  |  |  |  |  |  |  |

House of Equality:

By integrating the analysis performed in Tables 2 and 3, an all-encompassing representation of data is executed utilizing the House of Equality (HOE). This is demonstrated for the automated dog feeding apparatus in Figure 1, below. In this development process, known as quality functional deployment (QFD), product development is incorporated to meet customer needs throughout the system life cycle. The QFD process consists of design, manufacturing, sales, and marketing. The HOE serves a critical role in the development phase of the product and is utilized in communications between different organization units.

Diagram, engineering drawing

Description automatically generated

**Figure 1:** Complete House of Quality for the automated dog feeding apparatus, integrating the components from Tables 1, 2, and 3.

**Objective Tree** – a hierarchical and graphics-based representation of the needs based on functional similarity with the relative weights of the needs identified.

**Detailed design**

**Design Description**

**Iterative Nature of Design Changes (1-page)**

#### **Cost Analysis**

**Ethics and standards (one page with separate headings)**

**Hazards and Failure Analysis (one page)**

**Management of the project**

**Prototyping**

**Testing Verification**

**Environment and Global issues**

**Conclusions**

**References**

1. “Obesity in dogs: VCA Animal Hospital,” *Vca*. [Online]. Available: <https://vcahospitals.com/know-your-pet/obesity-in-dogs>. [Accessed: 25-Jan-2023].
2. [Online]. Available: <https://rawbistro.com/blogs/raw-bistro/food-aggression-in-dogs#:~:text=Try%20these%20seven%20steps%20to%20help%20put%20a,eat%20food%20from%20a%20bowl%20on%20the%20floor>. [Accessed: 25-Jan-2023].
3. “Pet ownership statistics [2022]: U.S pet population,” *Spots.com*, 07-Dec-2022. [Online]. Available: <https://spots.com/pet-ownership-statistics/>. [Accessed: 25-Jan-2023].

**Appendices**