Midpoint Report

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1. Background

1.1. Introduction

The concept of kinetic can be applied in different fields to display the motion of objects. Using the kinetic concept, it can prove possible to develop a sculpture to have it working with different features that facilitate motion and movement in an attractive and stylistic manner. In kinetic sculpture work, there is the development of objects with certain features that make them product motional effects and enables them to move. In essence, it refers to the artistic work that can use various technological concepts in the implementation of different structures. Interestingly, the concept of kinetic is important in designing three-dimensional structures which can eventually demonstrate some movement and kinetic emotions. Typically, the kinetic sculptural work has different components that serve different functions and facilitates certain movements that make them appealing and attractive. The kinetic sculptures can use three different types of machines that includes the shaft, the spring motor, and gears. The application of the generator's motors and other powered sources as well as different electrical and mechanical devices makes the sculpture to move and demonstrates some kind of motions which can be attractive and appealing to see [5].

The main objective of the project is to design a device that incorporates three types of mechanisms that include the spring motor, the gears, and the shaft. The project needs to demonstrate the kinetic motion in an attractive manner using a sculpture. As a result, the project design and generating a sculpture to help show the physical example of some of the kinetic principles in mechanical engineering. The project will benefit the sponsor since it will come with a new and innovative way to demonstrate the concept of kinetic. The project can be used in teaching the mechanical engineering students the important concept of kinetic principle in a simple and entertaining manner. This can help promote learning and encourage innovativeness and creativity among mechanical engineering students. In addition, the constructed objects can be used as a sculpture and sold to many interested parties and thus generates income to the sponsor. This can make students develop new insight into the relevant application of mechanical engineering to help gain reputation and credit towards it.

1.2. Project Description

The project involves designing the kinetic sculptural work where a sculpture in the form of a bird shape with wings is made. The design of the sculpture is in such a manner that the bird lies over a box. The wings will be used in the sculpture work to demonstrate the movement when the external power is provided and the different gear, motors, and shafts will be primarily used to facilitate the movement of the wings. The main purpose of the sculpture is to facilitate learning in the mechanical engineering concepts in an attractive engaging and motivating manner. In addition, the sculpture will be used as an example of the useful application of the mechanical engineering principles in the real-life situation. In essence, the developed system will be able to carried from one place to another to provide a perfect illustration of the various engineering principles.

1.3. Original System

The original system has been created by the team members through inspirations from previous engineering principles throughout the course. Specifically, it is concerned with the design of a new kinetic sculpture system and that not original system of this type existed at the time of its design and development. As a result, the system is unique and innovative as to make it a unique device that would help inspire others.

2. Requirements

In order to design and develop the project, it is important to follow appropriate procedures and processes to ensure successful completion. In the designing the kinetic sculpture, it is necessary to perform several activities in the preliminary stages such as assessing the customer's requirements, engineering requirements, performing tests for the procedures, design of the links and ensuring house of quality.

2.1. Customer Requirements

Customer requirement is the key to the design of a project. In essence, projects are implemented to meet and satisfy the needs and requirements of the customer. As a result, it is important that the customer needs be assessed in order to determine the appropriate design of the project [1]. The requirements of the customer can be ascertained by research on the market. The customer should provide a detailed

description of the proposed project. The information received from the customer regarding the specification of the project, its use, and cost among others should be integrated when developing the project.

The customer provided a specific requirement for the project. One of the primary requirements from the customer is that the object should fit into an average door. This requirement implies that the design of the object should consider the size of the door to ensure that it can move in and out of the rooms. The weight of the object is another consideration that the customer provided. With regards to the weight, the customer mentioned that the project should be carried by two persons. Durability is another specification that the client specified in the requirements. Other specifications from the client included the entertaining, robust, portable and interactive object. The table below shows the customer requirements that guide the design and development of the sculpture.

Table 1: Customer Requirements

Requirement	Descriptions
1	Should be able to fit the average door size
2	The weight should be in such a way that two individuals should carry
3	It should be durable
4	Entertaining
5	Robust
6	Interactive
7	Portable

2.2. Engineering Requirements

Engineering requirement is another important aspect of the object. With regards to the engineering requirements, it is important for the team to ensure that it meets the technical aspects of the object [2]. The engineering requirements should be generated based on the specification of the customer as per the requirements. It should also include the technical aspects of the project such as the various dimensions and measurements that meet the requirements as per specified by the customer. As indicated in the customer specification, the object should be carried by two people and this implies that it should be light in weight. As a result, weight is a major technical requirement that should be integrated when designing the object. With regards to this, the project is designed to have a weight of 1 kg.

Another customer requirement that should be integrated into the technical aspects is concerned with the size of the object. According to the specification of the customer, the device should be of a size that is enough to fit through an averaged sized door. As a result, the volume of the object is a major consideration in the engineering design.

Table 2: Engineering Requirements

Engineering Requirements	Targeted dimensions
The weight of the device (light)	1 kg
Volume (size to fit through a door)	20 cm * 27 cm * 24 cm
Length of the wing	16 cm
Length of the r	18 cm
Crankshaft	22 cm
Torque	2 nm
The width of the wings	6 cm

2.3. Testing Procedures

It is important that the implementation process for the project should involve the testing procedure. The testing procedure from the requirement table, values are based on the previous design and will be updated with the upcoming report. The client has approved all the functions required for the device. The testing procedure should consider various components of the device that include the crankshaft and its motion. One of the tests should be involve the investigation of the movement of the device. Due to the initial

design the ability of the crankshaft to move the wings in an appropriate direction should be tested. It is also important to test the kinetic movements within the device as they play a critical role in the functioning of the device as specified in the engineering and customer specification.

2.4 House of Quality

The house of quality is another important requirement of the project that should be given a priority in the design and development. The house of quality basically gives the description of the project and the relationship between the customer needs and the principles of engineering. In essence, each of the requirements of the customer should be matched with a given engineering principle to ensure that the project is successful. Ideally, the requirement of the customer should be compared to the engineering requirement and the respective percentage weight applied [3]. Using the determined weight, the absolute effective value is established to help determine the relativity so as to rank the requirements of engineering in a manner that can make the design efficient to accomplish its necessities. The values of the weight are determined based on the attributes and needs of the clients. The client raised several requirements that are integrated into the development of the project and include fitting in the sizeable door and able to carry by two persons which were ranked 9 and 3 respectively based on their importance. The other additional client's requirements include the durability, robust, interaction, and portability which was ranked as 1, 3, 3 and 3 respectively based on their importance.

From the requirements of the customer, there was an integration of the engineering principles to ensure that it is achieved. The requirement of the client that the device should fit through a door was accommodated with the engineering requirement that provides the specifications regarding the volume and size and this requirement of having the device fit through the door was ranked 9 in order of priority. Besides, the ability of two people to carry the device related to the weight of the object and achieved lower rankings. Table 3 below shows the ranking for each of the requirements for the sculpture.

Table 3: QFD

Customer requirement/Engineering requirements	Importance	Lightweight	Volume	Wing length	Spring Length	Gear System	Torque	Wing width
Fits into the door	9	9	3					
Two persons can carry	3	3	9	1	1	3		1
Durable	1	1	1	3	3		3	
Entertaining	1	1	1	3		1		3
Robust	3	1	3	3	1	3	1	1
Interactive	3	3	1	1		1	1	3
Portable	3	3	1	1	3	1	1	3
Technical Importance: Raw Score		113	71	24	16	25	12	27
Technical Importance: Relative weight		39.0 %	24.5 %	8.3 %	6.2 %	8.6 %	4.1 %	9.3 %
Technical target value		50	80	6	4	5	10	3
Upper target limit								
Lower target limit								
Units		Lb.	Ft^{-3}	In	In	-	Nm	in

Based on the result indicated in the above table 3 for QFD, it can be argued that the lightweight of the device is the most important factor that should be considered based on its highest ranking as compared to other requirements. Torque is the requirements with the lowest ranking as indicated in the table above.

3. Existing Designs

Design project cannot start without research which gives an idea of how to do that project and by finding similar implemented ideas can explain their experience and identifies the difficult you may face.

Therefore, design ideas can implement by doing the research and then find its functions which will play major role in its working. Some existing designs need to consider as well for doing the project, and these existing designs need to search for the complete project and also for its subparts.

3.1 Design Research

Design research was done on the internet, using different websites, which included IEEE websites where some articles were found related to the Kinetic sculpture. To understand kinetic sculpture properly some definitions have studied as well. And more research has done using Google Scholar to learn about kinetic sculpture and found some kinetic sculptress as well.

There is additionally a segment of kinetic craftsmanship that incorporates virtual development, or rather development saw from just certain points or areas of the work [1]. This term additionally conflicts oftentimes with the expression "evident development", which numerous individuals utilize when alluding to a craftsmanship whose development is made by engines, machines, or electrically controlled frameworks [1]. Both clear and virtual development are styles of kinetic craftsmanship that as of late have been contended as styles of operation workmanship. The measure of cover among kinetic and operation workmanship isn't sufficiently critical for specialists and craftsmanship students of history to think about consolidating the two styles under one umbrella term, however there are refinements that presently can't seem to be made [1].

"Kinetic workmanship" as a moniker created from various sources. Kinetic craftsmanship has its starting points in the late nineteenth century impressionist specialists, for example, Claude Monet, Edgar Degas, and Edouard Mamet who initially tried different things with complementing the development of human figures on canvas [1]. This triumvirate of impressionist painters all tried to make workmanship that was more similar than their counterparts. Degas' artist and racehorse pictures are models of what he accepted to be "photographic realism" specialists, for example, Degas in the late nineteenth century wanted to challenge the development toward photography with clear, cadenced scenes and representations [1].

By the mid-1900s, certain specialists developed consistently nearer to crediting their specialty to dynamic movement. Naomi Gabo, one of the two craftsmen ascribed to naming this style, composed much of the time about his work as models of "kinetic rhythm" [2]. He felt that his moving sculpture Kinetic Construction was the first of its kind in the twentieth century. From the 1920s until the 1960s, the style of kinetic craftsmanship was reshaped by various different specialists who explored different avenues regarding mobiles and new types of sculpture [2].

The various assortments of the class incorporate sculptures whose segments are moved via air flows, as in the outstanding mobiles of Calder; by water; by attraction, the claim to fame of Nicholas Takes; by electromechanical gadgets; or by the investment of the onlooker himself. The neo-Dada satiric nature of the kinetic sculpture made amid the 1960s is exemplified by crafted by Jean Tingly. His self-destructing "Tribute to New York" idealized the idea of a sculpture being both a question and an occasion, or "occurring." The point of most kinetic stone carvers is to make development itself a necessary piece of the outline of the sculpture and not only to grant development to an effectively total static protest. Calder's mobiles, for instance, depend for their stylish impact on continually changing examples of relationship occurring through space and time [3]. Whenever fluids and gases are utilized as segments, the shapes and measurements of the sculpture may experience consistent changes. The development of smoke; the dissemination and stream of shaded water, mercury, oil, et cetera; pneumatic swelling and collapse; and the development of masses of air pockets have all filled in as media for kinetic sculpture. In the complex, electronically controlled "spatial-dynamic" and "luminous-dynamic" developments of Nicolas Schaffer, the projection of changing examples of light into space is a noteworthy element [3].

A one-week course in kinetic sculpture was intended to acquaint center school understudies with the marriage of art and engineering. Since art can speak to unexpected sensibilities in comparison to engineering alone, it can fill in as a way to widen points of view of understudies with various inspirations

[3]. In light of expanding accentuation on the improvement of projects in STEM (Science, Technology, Engineering, and Math) in U.S. training, this undertaking fills a requirement for more open doors in STEAM (Science, Technology, Engineering, Arts, and Math). Despite the fact that the accessibility and prominence of STEAM programs for kids is developing, these open doors for youthful youngsters are as yet constrained. Along these lines, there is a business opportunity for a course that joins art and the engineering configuration process like this one. Every day exercises in a starting week-long kinetic sculpture course are characterized. Every day's exercises are given along assets for further examination. The structure of the course depends on sound academic practice [3]. The quality of the course is its capacity to consolidate science and art funky that will bid understudies. Future work would comprise of the development of the exercises with more detail for instructors and the expansion of more exchange exercises [3].

3.2. System Level

There was also a need to conduct research on some of the existing designs of the kinetic craftsmanship. The research on the existing system was considered critical since it can help in making important decisions on how the project should be designed and developed to ensure that it meets all its major requirements. The existing design of the kinetic craftsmanship was achieved by researching on various online sites such as Google Scholar. In addition, various articles were researched to investigate various aspects of the existing designs. The idea and information obtained in the process of the research were important in making major decisions that can help ensure the successful completion of the project.

3.2.1 Existing Design # 1: Gear Bird

This kinetic sculpture is about the bird, in which two gears have attached with the wings to show the motion of wings. Wings are used in this project as well and working of motion of wings has described in the existing design article. This design can be useful for the project because it has used similar concept.

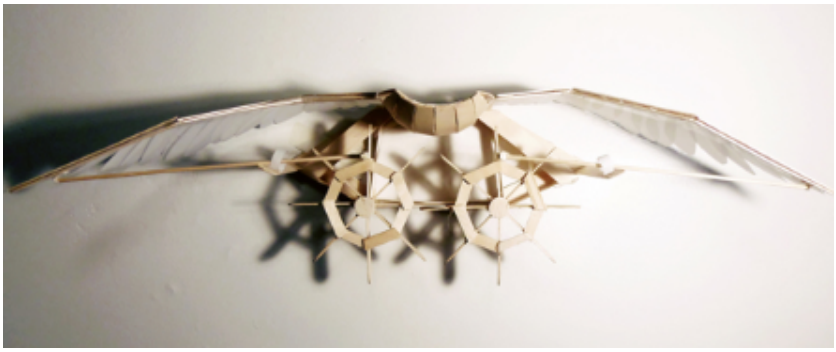

Figure 1: Gear Bird [4]

3.2.2 Existing Design # 2: Make Faire

This is also a design of faire which shows the motion of wings and this design can be helpful for the designing phase because the team will use any similar project idea. This idea is also useful for the project in a way that team members are building the same concept of showing the motion of wings so such design idea can help in making similar design idea therefore this existing design can provide some support to the design.

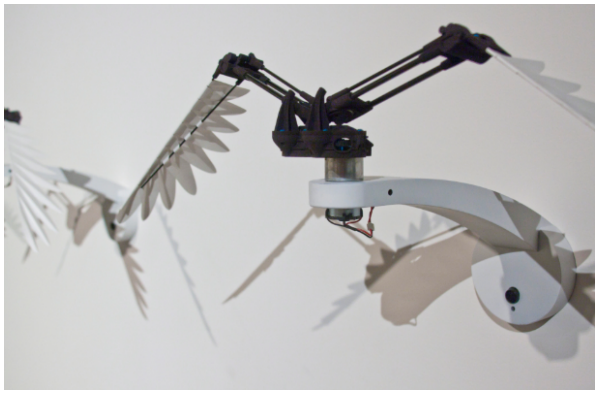

Figure 2: Make Faire [6]

3.2.3 Existing Design # 3: Mimic Rings

This existing design has shown the movement of wings and the project will be similar so this design can also help making the project specially in designing and implementing phase. This is moving the wings with the help of string and the team will also move the wings using the string so this existing is quite close to the project to help understand the motion of wings using the string from this concept and will apply it to the project.

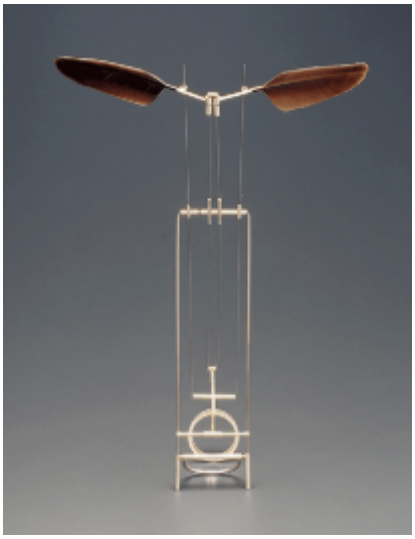

Figure 3: Mimic Rings [7]

3.3. Subsystem Level

Since the mechanical engineering project to construct the sculpture has different activities and sub-activities to accomplish, it was important to evaluate the design and the subsystem level. The evaluation of the design at the subsystem level was important towards ensuring that the project is on the right path to accomplish its major objectives. The assessment of the existing design was important in indicating the various sections and subparts to consider such as wings, box, and springs.

3.3.1. The Box

One of the subsystems considered for the design of the sculpture was the box. The box was an important subsystem in the design of the sculpture as it provides support to all the other components. The box will typically lie at the base of the sculpture to provide it with the necessary support.

There are various types of boxes that can be applied for the construction of the sculpture and can include the wooden box, the steel box, and the plastic box. Based on the different materials that can be used to make the box, it is important that appropriate materials identified that can meet the engineering and customer requirements.
The wooden box can be appropriate for the project and is already available on many projects. It offers an ideal material to be used and its existing design is appropriate for the project. The existing design for the wooden box is shown in the figure below.

Figure 1: Wooden box

The other design that can be appropriately applied to make the sculpture is the steel box. The steel box is an important material that can be used to make the box to be placed at the bottom of the sculpture. The steel box is strong and can prove ideal for the project. The design of the existing steel box is as shown in the figure below.

Figure 2: Steel box

The other sub-material that can be used as a box in the kinetic sculpture is the plastic box. The plastic box is also hard enough to support the sculpture. The design of the plastic box is as shown in the figure below.

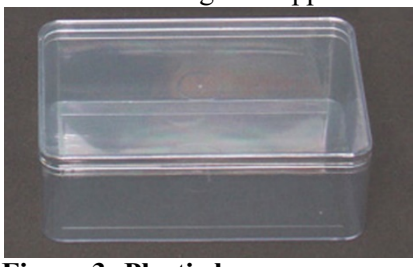

Figure 3: Plastic box

3.3.2. The Wings

The wings will play a vital role in the design of the devices constructed in the project. The analysis of the materials and design to be used in the wings considered some of the existing designs which are presented as follows.

One of the existing designs of the wings is argued to be the Roblox wings. The Roblox wings are an existing design that is available for use in the construction of a bird sculpture. This type of wing is light in shape and thus requires less force to be lifted from the ground. As a result, the idea regarding an appropriate type of wings can be generated from the research on the Roblox wings which is shown in the diagram below.

Figure 4: Roblox wings

The other type of wing is the angle shape wings which can also be used to complete the project. This type of wing is seen as diverting straight backward and this makes it long and moveable. This type of wing is appropriate for the project due to its ability to move up and down. The diagram for this type of wing is shown in the figure below.

Figure 5: Angle shaped wing

The mechanical wing is the third type of wing that can be applied to construct the kinetic sculpture device. The mechanical wing refers to the design of the wing in the mechanical form. It is one of the appropriate wings that can be used in mechanical design. Some of the features that make it appropriate for the mechanical project is its ability to move as required and its strength.

Figure 6: Mechanical wing

3.3.3. Springs

Springs is another subsystem that should be considered when implementing the project. The main purpose of the spring in the project is to be used as a force to move the wings. This can enable the wings made movements similar to the birds. As a result, the assessment of the existing springs to determine the most appropriate is important for the project.

One of the existing springs is the Helical Back Springs which is basically a type of the springs having the hooks fitted in both sides. The availability of the hooks on both sides enables the springs to be attached for both its side and this makes it the most appropriate for the project. This is because, it this project, there is a need to attach the spring from both sides.

Figure 7: Helical Back Springs

The other notable spring type is known as the garage door springs. The garage door springs are the one that is primarily used in the rotational processes. This kind of spring normally has a high rotational value. It is evident that the existing design of this type of spring can prove suitable for the project.

Figure 8: Garage door springs

Another design of the spring that was research to be used in the project is the trampoline springs. The trampoline springs basically is an existing design that has been applied in the construction of various objects. The design contains hooks in both of its sides but it has a wide body that originates from the

center. This design of the springs is also suitable to be used in the project and can effectively attach the wings to the device.

Figure 9:Trampoline spring

4. Designs Considered

There are various designs that were considered to be used in this project. Each single design of the project was assessed to determine the one that is considered appropriate for the project. The selection of the design to be used in the project was based on their features and characteristics as well as the specification of the customer and the engineer's specifications. In essence, the designs were evaluated by considering the functional model, the customer requirement and the evaluation of the existing designs.

4.1. Bird Sculpture (Crankshaft)

The first design consideration was a bird sculpture (crankshaft). The design was considered with the sole purpose of generating a type of sculpture that can show the movements resembling a flying bird. In this model specification, the box includes a crankshaft while placing the bird on top of the box. The motion of the wings is held from the rotational movement of the PEX pipes which is specifically causing a vertical movement.

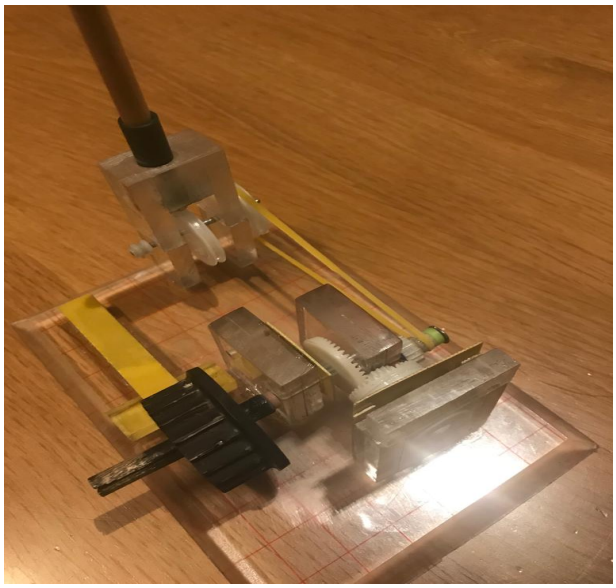

Figure 10: Crankshaft

This design is associated with several pros and cons. The main advantages of the design include the attractiveness, ability to entertain, display of mechanical processes, easy to operate and easy to move from one location to the other. Although it has various advantages, the design has also certain limitations that include difficulties in the connection of the wings to the rods and the restriction movement of wings.

4.2. Bird Sculpture (Gear Box)

With regards to the bird sculpture (gearbox), the intention is to develop a bird sculpture that has outer lines portraying movements. Under this design, the bird sculpture is placed over the box containing the gear systems that help create motions in wings.

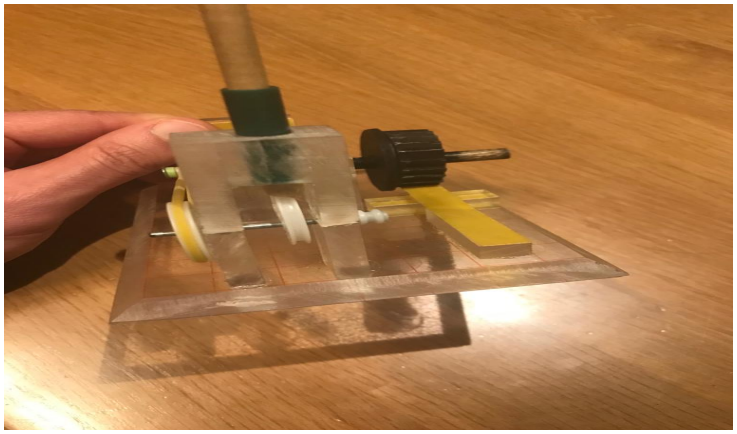

Figure 11: Gearbox

This type of design has a major benefit since it enables the effective movement of the wings. However, the limitations associated with the design are that it proves difficult to balance as well as have a large and extended body.

4.3: The Rotating Gears System

The rotating gears system is another design that was considered in making the design. The rotating gearbox uses an interlocked system which has gears that are linked to each other and rotates in a manner that shows the interactive display. It is argued that the rotation of the gears is largely based on the input rod which is an important component for moving the gear.

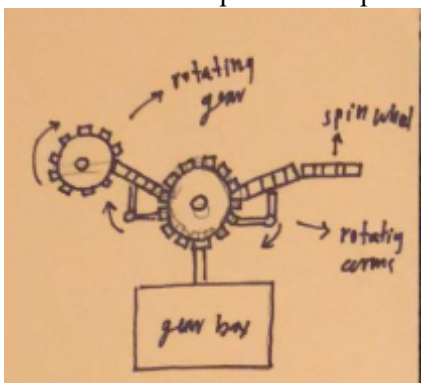

Figure 12:Rotating gear system

There are several pros and cons associated with the rotating gears system design. The notable pros of this design are associated with its interactive display. However, the design has certain limitations that can make it ineffective to be used in the construction of the device and include its interlocking nature which can cause trouble and the extended body.

4.4. Clocking Rolling

The design is based on the concept of a clock that is rolling to show some movements from top to down. It is a design that can also be used to demonstrates the movement of a pendulum in motion.

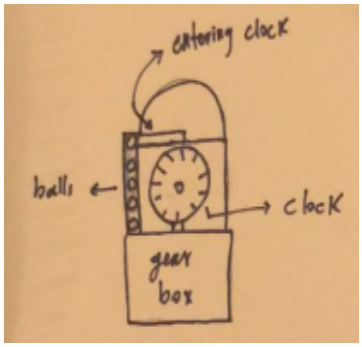

Figure 13: Clocking rolling

The design of the clocking rolling is beneficial since it shows some elements of motion due to the rolling of the balls. However, its major limitations are that it is not an interactive display system.

4.5. The Train Message

The training message is another design where a moving train spread messages. In this case, the train will move over the trail as it displays the messages over the board.

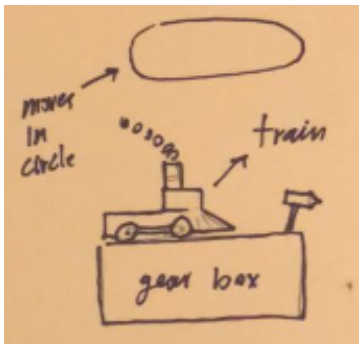

Figure 14: Train message

The main advantage is that the design has a good display that sends message and advice. However, its major shortcomings include its inability to portray the interactive display and the fact that it is not robust.

5. Designs Selected

Based on the analysis of the different designs that the project should take, it is appropriate to select a good design that can help effectively accomplish the needs of the project. The ideal design of the project should meet the specification of the customer as well as the necessary technical requirements. From the analyzed designs, the first design that includes the kinetic sculpture of a bird with flying wings has been selected. In essence, the bird sculpture (crankshaft has been selected as an appropriate project to be implemented.

5.1. The rationale for the design selection

It is important to identify the rationale for choosing the project. In order to choose the ideal design for the project, the Pugh chart was applied. Typically, the Pugh chart proves as an essential tool for choosing the design of projects by considering various elements such as customer requirements. In this case, the Pugh chart was used to compare the design the various designs considered for the project so as to identify the datum and marks have positive, negative or the same in relation to the ER. The result of the Pugh Chart is shown in the diagram below.

From the result, it is evident that the final three designs for the study include the bird sculpture (Gearbox), rotating box and the bird sculpture (crankshaft).

The decision matrix was also used in making decisions regarding the appropriate design to implement. The decision matrix considered all the identified designs that were considered appropriate for the study. It assisted in the identification of the best design that should be used to implement the project. The three

designs that were selected from the Pugh chart were then subjected to the decision matrix and the result observed as follows.

Table 4: Pugh Chart Results

Decision Matrix	Fits into the door	Two can Lift	Durable	Entertaining	Robust	Interactive	Portable	Total
Weight	7	6	5	4	3	2	1	
Bird Sculpture	42	36	20	24	18	12	5	157
Rolling Ball Clock	28	18	10	16	9	4	2	87
Train Message Sculpture	14	18	15	12	6	4	3	72

From the decision matrix, it can be concluded that the decision to choose a bird sculpture has the highest score of about 157 and thus it is ranked as the most important project to implement.

5.2. Design description

Based on the decision matrix the team have finalized the design to be a bird sculpture as it has the highest final score calculated. After some of the work done on this project, and have decided to make other sculpture than the bird sculpture.

A CAD model of the initial design is shown in the figure below;

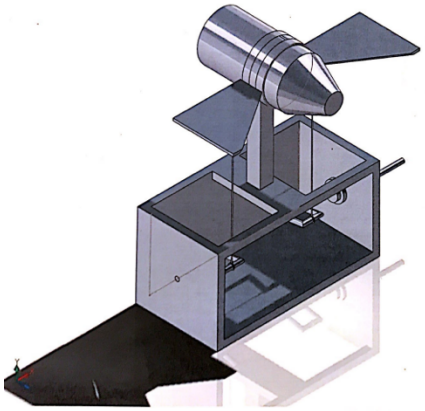

Figure 15: CAD model

Looking at the above design, through following the ways in which customer requirements are fulfilled by the design.

- The device's size is adequate that it can easily fit into a basic size door (Generally, entry door widths of 30 inches to 36 inches and a standard height 75 inches to 85 inches) so first CR has been fulfilled.
- The weight of Device is light because of its small size so two persons can easily carry this device so second CR has fulfilled as well by the design.

- Because of Wood, Aluminum, And Steel use in the design so it long lasting and reliable, the bird is made from wood, the crankshaft is made from Aluminum and the rods and rings are made from steel. The actual weight for the materials should be 1 kg to enable it to be carried by two people as specified by the customer.
- Robust, as it doesn't need a lot of assembling, so it can carry and use at any instant which makes it robust. Because the current design is small in size thus can be easily transported with no risk of it coming apart.
- Interactive, as the design is entertaining and attract people because of its shape and working.
- Portable as it can be lifted at any instance
- Entertaining because it is unique and attractive as the fins move with the help of the rod.

6. Proposed Design

As the project is going to implement and make the kinetic sculpture so it is important to know how the plan will process for the implementation. To implement the product, it is necessary to determine the required items that will use for the implementation.

- Box
- Rod
- Gears
- Shaft
- Fins
- Eccentric and centric pulley
- V-Belt
- Wings
- Springs

First, the need to build the box using acrylic sheets and then create a hole to put the shaft in it. By using the bracket to put the crankshaft on it and then attach the crankshaft with the gears inside the box. Install the fins in the rotor which can easily move. The complete breakdown has been presented in the Bill of Material. The crankshaft was made with aluminum, the rods are made from plastic PEX pipes and the bird statue is made with dense Styrofoam. The crankshaft was manufactured in a machine shop in Phoenix along with the rods. The bird statue was created from Styrofoam.

7. Implementation

7.1 Materials

The implementation process will follow a series of steps and stages. Each stage will have a specified activity to accomplish. A schedule has been defined in the form of Gantt chart, which is a bar chart in which all the bars describe and show the timeline from starting point until finalizing every step of the design. The Gantt chart is a process of helping track the achievements and what got accomplished within a period provided based on due dates. The team will ensure that it avails all the required resources from week one to week four before the start of the project. It should avail all the materials needed to make the sculpture as discussed in the previous sections of this study. Those materials include box, rod, gears, fins, rotor and square brackets as documented in part 6 of the study.

7.2. Implementation Steps

Steps started with having a ratchet gear including a spring within and a shaft going through a hole. The reason ratchet gear was picked instead of any other type of gear for the spring to be able to add a stopper to have the ratchet gear move one direction, but not the other. From there the shaft made out of aluminum is then attached to two bevel gear (small gear of 2 inch and a bigger one of 6 inch) giving a 90 degree mechanism in order to move the eccentric wheels into moving the plastic PEX pipes vertically to have the wings flap. Going back to the shaft after it connect to the gear at the very end tip of the shaft there is a timing pulley with V-Belt attached to a bigger timing pulley to a small rod to move the eccentric wheel in order to have the wings move vertically besides the wings.

The Gantt chart shown in appendix 3 below shows the steps taken during the implementation of the activity to make the sculpture. According to the Gantt chart, the first step is the postmortem report that should start in week four. The postmortem report was to begin on 22nd January and continue for three

days ending January 24th. The second stage is the initial design phase 1 that should start immediately before postmortem ends on 24th January and stop on 30th January 2019. It was to continue from week four and end in week five. The meeting minute 1 was also scheduled for January 24th and ended on the same day.

Initial design working was to occur in week six between fourth February and 7th February. The team would then organize the first clients' meeting starting from 8th February to 11th February. A one day meeting minute started then two would then occur on the 11th February during week seven followed by staff meeting on the next day on 12th February in the same week seven of implementation. The final activity in week seven would be gears mechanism resource starting from 13th February and ending on 16th of the same month. The team would then perform a single operation in week 8. It would source for the durable materials starting from 19th of February and ending on 21st of the same month.

The implementation initialization was one of the most extended activity for the organization as it would run from the ninth week and ends in a the10th week. According to the implementation plan documented in the Gantt chart in appendix 3, the implementation initialization would commence on 25th February 2019 and end on 8th March the same year. After the initialization, the team would hold the second client meeting on 11th of March, 2019 which will be on the 11th week. It would then conduct the first presentation between 12th and 18th March between 11th and 12th week. The initial design testing would then occur for two days from 20th March to 21st March in week 12. The final design phase 1 would then start from 22nd of March in week 12 and end on 29th of March n week 13 followed by the final design phase 2 from first April to 4th April in week 14.

Another long activity performed by the team is the final implementation that would commence on the fifth of April and run through to 16th of the same month. The action would begin in week 14 and end in week 16. Testing of the final design would then follow for three days starting on 18th April and ending on 20th of the same month in week 6. The team would then perform improvements on a design from 22nd April to 25th April. The UGARD poster would be the send last activity beginning on 26th April and ending on 30th of the same month. The team will finalize the project with the preparation of the final report between 25th April and 4th May.

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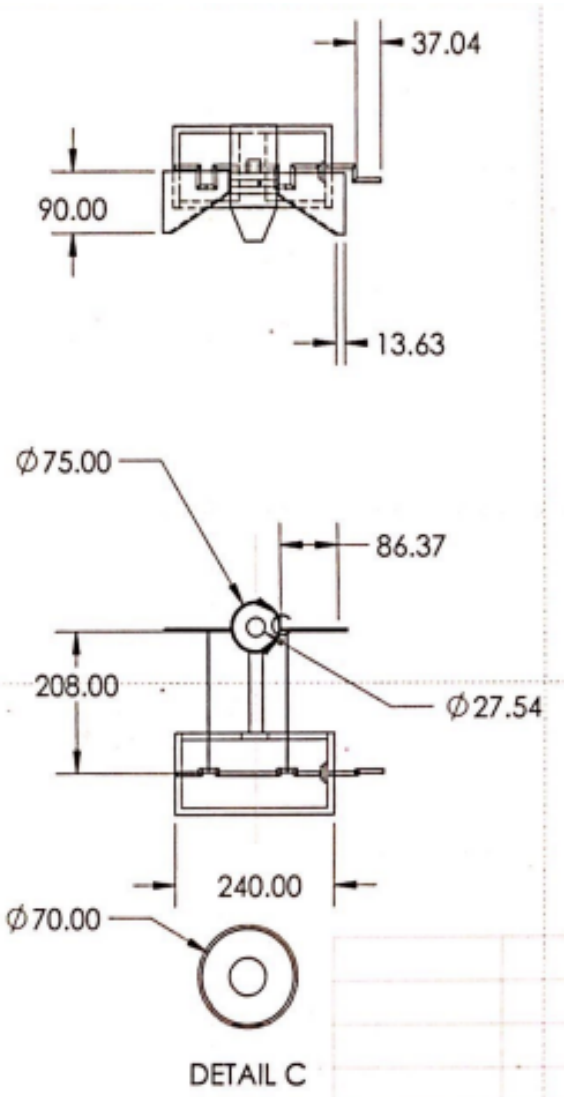
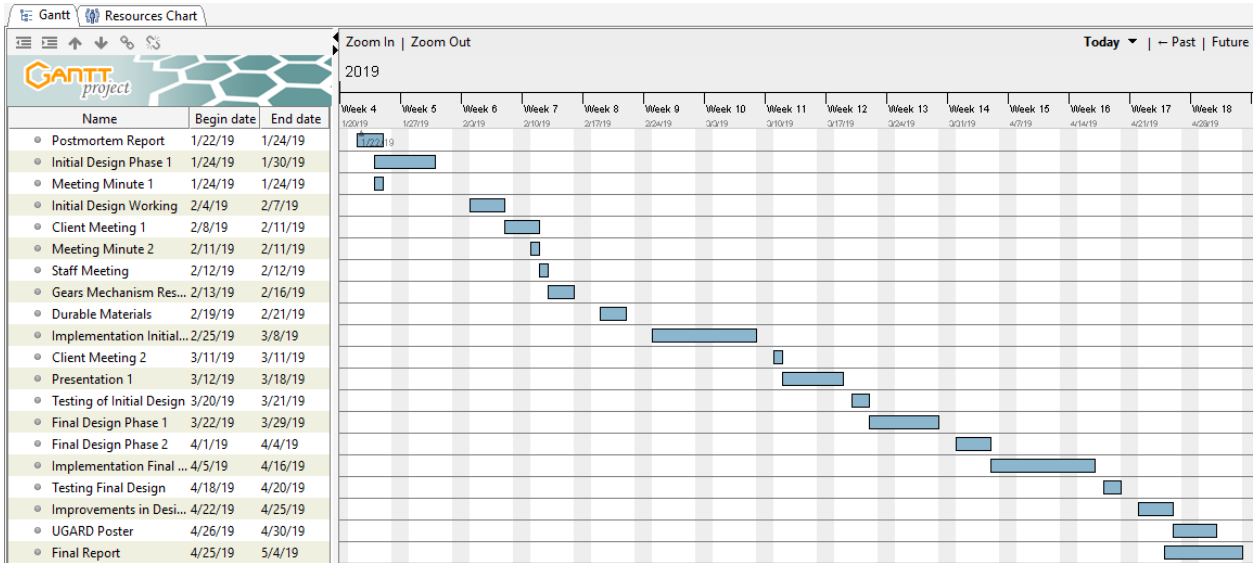
Appendix 1: Pugh Chart

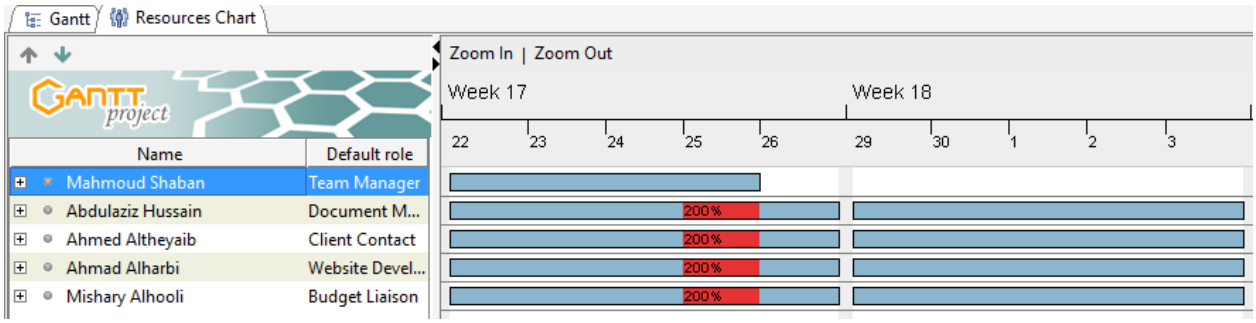
KINETIC SCULPTURE	Weight	Catapult Sculpture	Bird Sculpture (crankshaft)	KINETIC SCULPTURE DATUM	Rotating Gears	Clock Rolling	Train Message	Bird sculpture (Gear Box)	Football Sculpture	Walking Robot	Ball Rolling
Fits into the Door	7	+	+	D	+	-	-	-	+	+	-
Two can lift	6		+	D	-	+		+	+	+	+
Durable	5	-	+	D	+	-	-		+	+	-
Entertaining	4	+	+	D	+	-		-	-	+	
Robust	3	+	+	D	S	-	+	-	+	+	
Interactive	2	+	+	D	-	+	-	+	-		+
Portable	1	-	+	D	+	-	-	-	+	-	-
Pluses		4	7	-	4	2	1	2	5	5	2
Minus		2	0	-	2	5	4	4	2	1	3
Total		2	7	-	2	-3	-3	-2	3	4	-1

Appendix 2: Initial CAD file



Appendix 3: Gantt Chart





Appendix 4: Bill of Materials (BOM)

Bill of Materials

		Team						
Part #	Part Name	Qty	Description	Functions	Material	Dimensions	Cost	Link to Cost estimate
1	Liquid Super Glue	1	Use to stick the material	Create strong bonding	Chemical	-	$5.97	Homedepot
2	Poplar Board	1	For the box	To put items in the box	Wood	0.25 x 3.5 x 48 i	$5.98	Homedepot
3	Black PVC Project Board	1	PVC board is strong to bend	For making the upper part	PVC	0.118 x 24 x 36 i	$4.04	Homedepot
4	Stop Set	1	to stop the running part	Put to stop the rotation	Aluminum	1/4 in	$1.92	Homedepot
5	Stop Set	1	to stop the running part	Stop the motion	Aluminum	1/16 in	$1.24	Homedepot
6	Strap Hinge	1	Provide open close option	To put on the door	Steel	2 in x 4 in	$2.97	Homedepot
7	Brazing Rods	1	For making connection	Hold the top system with the rod	Aluminum	36 x 4 x 4	$4.21	Homedepot
8	Flat Plate	1	A straight sheet to make anything	Make the fins	Aluminum	36 x 4 x 8	$4.28	Homedepot
9	Hinge	1	Hold for open close	To put the door with it	Steel	2 x 5 in	$1.97	Homedepot
10	Round Rod	1	A rod to attach things	Make the Central standing part	Steel	36 x 2 x 2	$5.77	Homedepot
11	Dowel	1	Cylinderical rod	Put in the system	Wood	1/4 x 48 in	$4.98	Homedepot
12	Dowel	1	Cylinderical rod	Put in the system	Wood	1/2 x 48 in	$1.75	Homedepot
13	Dowel	1	Cylinderical rod	Put in the system	Wood	1/8 x 48 in	$4.48	Homedepot
14	Round Rod	1	A rod to attach things	Make the Central standing part	Zinc	36 x 3 x 1/16 in	$2.97	Homedepot
15	Wood Glue	1	Sticky action	Create strong bonding	Chemical	-	$3.97	Homedepot
16	Shaft	1	An aluminum pipe	welded to be a shaft	Aluminum	D=1" , L=48"	$27.49	Amazon
17	Shaft	1	An aluminum pipe	welded to be a shaft	Aluminum	D=0.5", L=48"	$19.99	Amazon
18	Blower pulley	1	A pulley made from steel	Pulley to help turn the V-belt	Steel	10 x 1 "	$13.78	Homedepot
19	Motor Pulley	1	A pulley made from steel	Pulley to help turn the V-belt	Steel	3-1/4 x 1/2	$9.88	Homedepot
20	V-Belt	1	Made from rubber	Help transfer the energy or mechanism	rubber	69"	$5.78	Homedepot
21	Galv roll	1	A roll of steel	In order to create the spring inside the gear	Steel	8" x 10'	$13.34	Homedepot
22	F-150	1	Will be chopped down to meet needs	To help make the base	Wood	1" x 4' x 8'	$23.00	Homedepot
23	Melamine White Pannel	2	Helps fitting through cutting	Cut it down to create the base	wood	75" x 48"	$33.84	Homedepot
24	White PEX Pipe	1	Works as rods	They are going to help move the wings	Plastic	3/4" x 5'	$3.26	Homedepot
25	PEX Pipe	1	Works as rods	To connect to timing pulleys	iron	1/2" x 5'	$1.86	Homedepot
26	Aluminum Flashing	1	A roll of Aluminum	Help make a spring compared to the steel	Aluminum	6" x 25'	$12.58	homedepot
27	Center snips	1	Tool for pipes	Cuts down the pipes to required sizing	Steel	No	$9.97	Homedepot
28	3-D Gears	2	Source of mechanism	rotates energy	PLA	D=6" , L=2.25"	$42	Makerlab
29	3-D Gears	2	Source of mechanism	rotates energy	PLA	D=3.5" , L=2"	$19.35	Makerlab
30	3-D Gears	1	Source of mechanism	Ratchet Gear needed for spring	PLA	D=7", L=3.5	$66.21	Makerlab
31	3-D Gears	2	Source of mechanism	rotates energy	PLA	D=2", L=1.5"	$9.38	Makerlab
32	3-D Gears	2	Source of mechanism	rotates energy	PLA	D=6", L=2.5"	$51.63	Makerlab
							$419.84	
	$491.21							**= Total Cost**