Team [redacted] Final Project Report
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Abstract

The Festival International Contest is one in which design teams are responsible for machines that can accomplish tasks such as the pushing, grabbing, and placing of components through complete electrically initiated functionality. Devices such as motors, servo motors, and sensors can be utilized in machines that operate in this competitive project where four teams compete to see who can score the most points through the completion of contest tasks. Furthermore, the designers of the vehicles cannot assist their vehicles in any way during this intense competition, as the vehicle must be able to operate entirely on its own through signals communicated through written code. The “Bon Temps Machine” uses two motors and a large amount of gravitational energy to power subsystems responsible for the dismissal, collection, and relocation of objects. It does so through extendable components rather than automotive-like navigation of the track. This design is the culmination of a large deal of analysis of the problems provided by this contest, and uses information gathered from the House of Quality, Specification Sheet, and Function Tree tools. Because of this problem understanding, the “Bon Temps Machine” addresses the requirements of all its customers, especially those concerning the contest rules and the completion of contest tasks. This design ultimately did not fare well in the contest, as it came out 9th out of 15 teams in the Festival International Contest, and received a 7.76 total score out of a possible 10 in the Design Review portion of the contest. This report will provide full analysis of this “Bon Temps Machine” design, the problem understanding information that shaped it, alternate designs also fit for this contest, and the final results of the contest as it concerns the previously mentioned design.

I. Introduction

The Festival International Contest is one that requires the design and construction of machines capable of placing, dragging, securing, or displacing objects through electronically triggered mechanisms. The machine must do this through the sending and receiving of signals through use of an Arduino Redboard and an Adafruit Motor Driver Shield, and must also fit within strict size and cost restrictions. The contest consists of numerous rounds in which four teams compete on the contest track, shown in Figure 1, in an effort to earn the most contest points through the completion of events such as Dismiss Hecklers, Keep the Crowd Rocking, Make it to the Main Stage, Collect Merchandise Revenue, and Collect Festival Pins. The Hecklers are two plastic bowling pins located approximately 10 inches to either side of the Crowd plastic bowling pin, and negative 10 points are awarded for any Heckler still in a team's zone at the end of a round. 20 points are awarded to a team if the Crowd Pin, located directly between the two Heckler Pins, remains upright in the team's zone at the end of said round. Make it to the Main Stage requires placing 5 Lego figures, or band members, into or above the area occupied by the Secondary Stage, to earn 5 points per band member, or the Main Stage, to earn 10 points per band member. Collecting Merchandise Revenue consists of collecting a maximum of three sponges located an inch away from the Secondary Stage boundary and relocating these sponges to or above the Merchandise Account of the team's zone, for a total of 10 points per sponge completely within the Account. To Collect Festival Pins, plastic blocks must be dragged completely within the team's zone by the end of the round to earn 10 points per block, with a maximum of four blocks, or 40 points, available to each team for this task. The competition utilizes a double elimination format, with the two teams with the most points being considered the winners of the round and the two teams with the least points being considered the losers of the round.

This competition has been held at the University of Louisiana at Lafayette for several years, and numerous designs have achieved varying levels of success in both the number of points earned and the ingenuity of the designs. These predecessors would not, however, achieve high levels of success in this version of the competition, as the required tasks and number of competing teams have changed to the point where new designs are necessary. For this particular version of the contest, there are many engineering challenges that must be conquered. These challenges are based on the fact that this design must fit within a size of 12x24x18", use only rented out electrical components, cost less than $100, and be designed and produced in a month's time. Designing a machine that fits within these challenges and succeeds in accomplishing most, if not all, contest tasks is seemingly impossible, and can only be done through proper understanding of the challenges provided by this contest and evaluation of all potential concepts for this design.

Team Eight's final chosen design for this contest is analyzed in Section II. Then, information gathered from a comprehensive problem understanding process is delivered in Section III. Alternate designs are then presented and compared to the chosen design in Section IV. Next, final results are discussed in Section V. Finally, conclusions are drawn in Section VI.

II. Final Design

The "Bon Temps Machine," which can be seen in Figure 2, is the final machine for the Festival International Contest. This machine forgoes motor driven, automotive-like navigation of the track in favor of motor-driven extendable systems that are capable of reaching out into the track and performing four out of the five contest tasks. This machine uses just one large DC motor to power a subsystem, called the String Spool System, that allows for the completion of the tasks Keep the Crowd Rocking, Dismiss Hecklers, and Collect Merchandise Revenue through a stringed spool driven by the motor that allows for the initial fall and subsequent reeling in of the Extendable Arm System. The Extendable Arm System consists of two wooden arms that actually perform these tasks through the use of gravitational energy. The machine also uses a small DC motor to power a separate subsystem, The Band Member Extension System, to Make it to the Main Stage. Both of these subsystems are contained within the base of the machine, which also includes 10 pounds of counterweight for balancing purposes, along with the Arduino Redboard and Adafruit Motor Driver Shield, which provide the electronics of the machine with logic and instructions on when and in what manner to activate and run. The pre-competition measurements of this machine are 11.5x23.5x17.75", and these dimensions can be seen in Figure 3. The machine is primarily composed of wood, but contains other materials such as a measuring tape, tacks, Velcro, metal hinges, and iron weights to support the wooden structure and allow for movement and task completion. These materials lead to the "Bon Temps Machine having a final cost of $98.60, and the full Bill of Materials can be seen in Table 1. The code that provides the machine with instructions on how to operate is based on time, and does not include logic based on sensed distances from objects or other sensed voltages or values. Under ideal conditions, this machine is capable of earning 75 contest points in a single round, earning no point deductions from Hecklers, 20 points from the Crowd Pin, 25 points from 5 band members in the Secondary Stage, and 30 points from three sponges in the Merchandise Account.

The String Spool System, shown in Figure 4, is what gives the machine the majority of its motion capabilities, as the machine cannot complete tasks without achieving some type of motion. This subsystem consists of the previously mentioned large DC motor fastened to a Rotating String Spool around which string is wrapped. The motor, which receives power from the Motor Driver Shield and logic from the Redboard, controls which way the spool will turn through the direction in which the code tells it to run. If the motor is run forward, the wheel will turn clockwise, and will let Arm Controlling Tension String loose. If the motor is run backward, the wheel will rotate counterclockwise, and the string will be wound back into the spool. This subsystem is essential to controlling the Extendable Arm System, as the string is attached to this system by way of a hook and controls when its motion occurs. While this system does not directly score any contest points, it does allow another subsystem, the Extendable Arm System, to score the majority of the points for the "Bon Temps Machine."

The Extendable Arm System, whose components are shown in Figure 5 and dimensions are shown in Figure 6, is responsible for the majority of the functionality of the "Bon Temps Machine," despite the fact that it is only utilizes a single motor. The Arm System actually consists of two arms, the Heckler Dismissal Arm, and the Merchandise Retrieval Arm, which is attached to the top of the Heckler Dismissal Arm by means of a hinge. Upon proper wiring of the vehicle to the track and completion of the track circuit, the motor is directed to immediately run forward at full speed for a fraction of a second by way of code uploaded to the Redboard. This

allows the fall of the arm system, as the forward run of the String Spool subsystem gives the Arm System enough of a push to move from its initial perpendicular resting position. This fall allows for the Heckler Dismissal Arm, which is hinged to the front edge of the machine base, to accelerate down towards the track. This downward movement allows for the Heckler Dismissal Wedge Hammers, located on either side of the Heckler Dismissal Arm, to hit the pins in a downward movement, thereby ejecting them from the competition zone. This is done in a manner such that the Crowd Pin is not disturbed, as the legs of the Heckler Dismissal Arm are spaced so that there is ample space for the Crowd Pin to stay standing without disruption.

The downward motion of the Heckler Dismissal Arm, along with the Rotation-enabling Hinge connecting the two arms, causes the Merchandise Retrieval Arm to rotate in a clockwise motion and then move downward towards the Merchandise Revenue when the Heckler Dismissal Arm hits the track. The Revenue Collecting Spears, which are tacks attached to the Merchandise Retrieval Arm by means of Velcro attached to the front face of the Merchandise Retrieval Arm and to the bottom of the spears, then fall down on the Revenue, thereby securing them. Once a delay of 7 seconds has occurred since the initial run of the motor, the motor is then directed to run in reverse for three seconds. This allows the wheel to spin backwards, and consequently pull the Arm System back in through tension in the string. This tension pulls the Arm System to a point where the Heckler Dismissal Arm is nearly perpendicular with the track once again and the Merchandise Retrieval Arm is at a slight angle so as to have all three Merchandise Revenue sponges in the region directly above the Merchandise Account. This subsystem then remains inactive for the remainder of the contest round. In ideal conditions, the Extendable Arm System will remove the Hecklers to prevent any point subtractions, will fail to knock over the Crowd Pin to earn 20 points, and will collect all Merchandise Revenue to earn 30 points for a total of 50 points.

The final subsystem of this machine, the Band Member Extension System, shown in Figure 7, is responsible for the task Make it to the Main Stage, and uses a small DC motor to accomplish this task. At the same time that the DC Motor driving the String Wheel subsystem is beginning its reverse run, the Redboard directs the motor to run backward for a 23 second span. This run spins the Gear-Turning Axle attached to the motor, and the spinning of this axle rotates the Tension Gear Set. This rotation of the Gear Set extends the Band Member Delivery Tape, which is measuring tape pulled from its storage base, diagonally out towards the Secondary and Main Stage. At the end of this Tape is the Band Member Holding Platform, a flat Lego piece onto which the band members can be secured so that they are carried towards the stage as the tape is extended. From its activation, this subsystem remains active for the remainder of the competition round, which means that the motor continues to run and subsequently extend the tape outward towards the stage until 30 seconds have passed and the track circuit disconnects, thus eliminating power to the machines. At this 30 second mark, this subsystem ceases and remains inactive to prevent disqualification on the grounds of failing to come to a stop by the end of the contest round. This subsystem extends the band members to the secondary stage, earning 25 contest points, or 5 per band member.

III. Problem Understanding

The “Bon Temps Machine” design is based off of analysis of information gathered from comprehensive understanding of all the problems and challenges provided by the Festival International Contest. There are several customers that have a vested interest in this contest, and

these include the rules committee, the design team, the design judges, university sponsors, and the contest audience. Each of these customers have different requirements for any design entered into this contest, and all of these requirements can be seen in the Festival International Contest House of Quality, which is shown in Figure 8 and is a tool that identifies and weighs customer requirements on the basis of importance and compares them against engineering characteristics that can be measured to determine whether these requirements are being sufficiently met. The most important requirements listed in this House of Quality are those concerning the contest rules, specifically requirements such as the requirement requiring the design to fit within a 12x24x18" size restriction, the requirement demanding autonomous movement from any contest design, and those requirements concerning the completion of contest tasks such as Collect Merchandise Revenue. These requirements are the most important, as without addressing them, a design would not even be able to participate in the Festival International Contest, let alone be successful in it.

The requirements concerning autonomous movement and the completion of contest tasks mainly address the concerns of the rules committee, but the House of Quality also includes requirements addressing the other customers. For the design team, important customer requirements include those concerning the completion of project tasks, such as Collect Festival Pins and Dismiss Hecklers, and those concerning the materials used in any design, as the design team would be responsible for decisions regarding what is used to construct said designs. The design judges would be concerned with the originality and the aesthetics of the design, and these concerns are addressed through the requirements that deal with the number of original components in any design and the amount of colors present in the design. The audience of the contest will, like the rules committee and the design team, be primarily interested in the completion of contest tasks. The university sponsors care about preventing potential harm to loaned out electrical components or the competition track itself, so their requirements include that the design not damage rented out components, other designs, or the competition track.

Identification of requirements alone does not provide enough information to ensure success in design. Rather, further information regarding limits and constraints on the possibilities available in design that come from the understanding of said requirements is necessary. This information is found in the Festival International Contest Specification Sheet, which can be seen in Table 2. This sheet contains specifications on all design aspects, such as the operational, geometric, and material considerations in design. This Specification Sheet also specifies whether each specification is an absolute demand or simply a wish, and serves to erect boundaries particular to this contest on what designs can have and not have in providing solutions to contest problems. The most important specifications would be those concerning the operation of the machine, along with those concerning the contest rules, as these are the most important requirements in the House of Quality and thus are the design aspects that most need to be focused on. These most important specifications include a demand to dismiss all Hecklers and a wish for the vehicle to be able to collect all Merchandise Revenue. The contest rules are addressed through specifications that demand the vehicle fit within a 12x24x18" size and a wish for it to fit within 11x23x17."These specifications are the most important as, ultimately, the vehicles are designed with the purpose of earning points through the completion of tasks. Specifications regarding how these tasks are completed and what restrictions a design must fit within in terms of contest rules in order to be eligible to complete said tasks help to define how any vehicle designed for this contest is able to do so.

There are also specifications that serve to place limits on aspects of the contest that the other customers are concerned with. The design team, primarily concerned with the functionality and materials of the design, is addressed through specifications demanding for the placement of all band members in the Main Stage and wishes for no hot glue or wood thicker than ⅜" used in construction of the design. For the design judges, there requirements regarding design aesthetics and ingenuity are addressed through a demand for at least one color pattern on the design and a wish for at least one original design idea utilized in any contest design. Those spectating during the contest are also appeased through the previously mentioned specifications regarding design functionality, but are also addressed through a demand for a minimum of 30 machine tests. This demand is relevant to this customer as the audience wants to watch working designs, not stationary ones, and demands for rigorous testing go a long way towards ensuring designs are indeed working. The university sponsors are appeased through a specification demanding no damage to the contest track and also through a specification wishing for any motor to not run for a period longer than 25 seconds. The latter specification is in place as a means of avoiding breaking university-loaned motors.

Once all customers and their requirements are identified and accounted for through specifications, design functionality is the next subject to consider. Information regarding the required functionality of any contest vehicle can be found in the Festival International Contest Function Tree, as seen in Figure 9, which starts with a primary function and branches down to easily definable sub-functions to show the range of functionality that is required to complete the primary function and to be successful in the contest. The Festival International Contest Function Tree lists the primary goal as completing all required contest tasks in under 30 seconds. Completing this task requires any vehicle to successfully accomplish all of the tasks set forth by the contest rules, as well as to move autonomously. These sub-tasks, which include Make it to the Main Stage and Dismiss Hecklers, also require various actions in order to be properly achieved. Autonomous movement is defined as one of the most important customer requirements in the House of Quality, and is thus one of, if not the, most important primary sub-task to consider in the understanding of contest functionality. Without the ability to move autonomously, a machine would not even be able to complete the simplest of contest tasks. Autonomous movement requires a design to be able to receive logic, move, perform logic operations, and sense time in order to be accomplished. The generally movement necessary for autonomous movement to occur also requires both the sensing of obstacles and the propelling of the robot in any of the four primary directions: up, down, left, and right. At an even lower level, the sensing of obstacles requires receiving logic, converting said logic to movement instructions, and activating the subsystems on the machine capable of producing the instructed movements. This flow from high-level to low-level tasks is evident throughout the Function Tree, and shows the dependencies of various functions on other functions that provide an informative look into options for design that allow for said functions to come together to achieve the primary goal. Having large amounts of information regarding the necessary functionality for vehicles in the contest is important in terms of identifying all key problems a vehicle must be able to solve.

IV. Concept Evaluation

Problem understanding information that is gathered and analyzed allows for a variety of different designs that could successfully address a large amount of the customer requirements presented in the Festival International Contest. The "Bon Temps Machine," along with alternate

machine designs, were formed through analysis of the Festival International Contest Morphological Chart, which is shown in Table 3 and is a tool that presents design ideas for each lowest-level sub-function found on the Function Tree, and then presents different combinations of these ideas that form potential machine designs. For example, for the sub-function run electrical devices, which is critical to the completion of nearly every contest task, ideas include the use of motors, sensors, servo motors, or other electrical devices. This provides different options for how to complete this sub-function, and options similar to this were combined to form not only the "Bon Temps Machine," but also the "One-Wheel Drive Machine" and the "Average Joe Bot." The two latter designs are alternate designs to the final chosen one, and will be discussed in the following paragraphs.

The "Average Joe Bot," shown in Figure 10 with dimensions in Figure 11, is a wood-based, 10x23.5x17" machine that utilizes one small DC motor and three servo motors to complete the tasks Dismiss Hecklers, Keep the Crowd Rocking, and Make it to the Main Stage. It makes use of a single motor on an axis to navigate down the competition track on four Translational Disk Wheels, and uses servos and an additional motor to complete contest tasks. The two rear disk wheels are connected by a cord to an upper motor-driven axis, which allows the vehicle to have rear-wheel drive and to navigate forwards and backwards. This wheel to motor connection can be seen in Figure 12. The code used to send logic to the electronics of this design is based on elapsed time, and does not account for the use of any sensors. The total cost of this design is $55, excluding the cost of aesthetic materials and rented out electrical components. In ideal conditions, this machine is capable of 70 contest points, earning no point deductions for Hecklers, 20 points for the Crowd Pin, and 50 points from 5 band members in the Main Stage.

Once in motion, the "Average Joe Bot" signals servos with attached wooden Heckler Dismissing Arms, to rotate towards the Hecklers, thereby knocking them out of the zone. The vehicle Keeps the Crowd Rocking by simply driving over the center pin, as the design allows for enough space to directly pass over the pin without knocking it. Upon dismissing the Hecklers from the zone and avoiding disrupting the Crowd Pin, the vehicle drives forward until it is approximately 2 inches from the revenue sponges, or at the moment when the coded time value for the forward motor run has elapsed. At this moment, the Rotation-enabling servo on the top platform of the vehicle rotates the Band Member Swing Arm. The servo rotates this 12 inch arm with band members contained in a plastic bag attached to its end about 75 degrees from its initial position of 5 degrees, so that the band members are located directly over the center stage. The vehicle then ceases movement for the remainder of the competition to prevent disqualification.

The "One-Wheel Drive Machine," shown in Figure 13 with dimensions in Figure 14, is a wood-based, 11.5x23x15" design that uses one DC motors and three servo motors to complete the tasks Dismiss Hecklers, Keep the Crowd Rocking, and Collect Merchandise Revenue. This design uses four wheels to navigate the track, and allows for this navigation through use of a DC motor attached to the right rear wheel to power this motion, rather than an axle attached to the rear wheels by a band. This produces one-wheel drive. The code that directs this machine is based on time elapsed and does not include logic based on sensor values. The total cost of this design is $60, not including aesthetic materials or loaned out components. In ideal conditions, this machine is capable of earning 40 contest points in one round, earning no point deductions from Hecklers, 20 points from the Crowd Pin, and 20 points from 2 sponges in the Merchandise Account.

The “One-Wheel Drive Machine” drives forward at the initial completion of the track circuit, and dismisses Hecklers through activation and subsequent rotation of servo motors that rotate Heckler Dismissing Arms that knock the pins out of the zone. The Crowd Pin is undisturbed, as the machine simply drives directly over it. Immediately after the Heckler Dismissing Arms rotate outward, the machine proceeds ceases forward driving to allow a Rotation-enabling servo motor located on top of the vehicle to rotate to its maximum position. This rotation sends the Merchandise Collecting Fork, made of wire clothes hangers and connected to the servo by means of a small wooden wheel, down towards the merchandise revenue to pierce and collect the two outer sponges. At this moment, the driving motor then runs backwards, bringing the machine back towards the start zone. During this backward motion, the Merchandise Collecting Fork drags the sponges back towards the Merchandise Account in a straight line so as not to disrupt the Crowd Pin. The motor driving the machine is timed to stop at a point where the sponges are entirely within the Merchandise Account. The vehicle then remains inactive for the remainder of the competition to avoid disqualification.

Comparison of these designs, along with the previously discussed final chosen design, is required to identify the design that best answers the problems set forth by this contest. This type of comparison is put forth in the Festival International Contest Evaluation Matrix, which is shown in Table 4 and compares designs based on how well they address customer requirements set forth and ranked in terms of importance in the Festival International Contest House of Quality. This Evaluation Matrix shows that the “Bon Temps Machine” excels in Collecting Merchandise Revenue and in autonomous operation, the “Average Joe Bot” excels in Keeping the Crowd Rocking and in total cost, and the “One-Wheel Drive Machine” excels in Making it to the Main Stage and Keeping the Crowd Rocking. With the most important customer requirements in the House of Quality being those involving autonomous movement, falling within contest rules, and completing contest tasks, the “Bon Temps Machine” is the design that best addresses these most important requirements. It does this by being the design with the least issues regarding autonomous movement, as proven in trials of all three designs demanded by the Specification Sheet. It also does so by allowing for the completion of four out of the five contest tasks, whereas the alternate designs are only capable of completing three tasks each. All three designs fall within contest rules regarding size, materials, and damage potential, so one design is not better suited for the contest than the others in this regard. In terms of statistical comparison, the “Bon Temps Machine” scores significantly higher than the two alternate designs in the Evaluation Matrix, with a total score of 350 and a relative weight of .480. These scores do not determine which design is best for this contest, but rather add further evidence to the fact that the “Bon Temps Machine” is the best design for this contest. Ultimately, the “Bon Temps Machine” best addresses a large amount of customer requirements, especially the most important requirements such as autonomous movement, and is thus better for this contest than the “Average Joe Bot” and “One-Wheel Drive Machine,” despite the latter designs superiority in the Keep the Crowd Rocking task.

V. Design Performance Evaluation

The “Bon Temps Machine” was not overwhelmingly successful in The Festival International Contest when competing against other teams or when judged in the Design Review, but was about average in comparison to other teams in both regards. In the contest, the machine finished at a position of 9th out of 15th competing teams. It ran in three rounds during the

competition, coming in fourth, or last, place in the first run, second in the second run, and third in the third run. The machine scored 55 points in the third run, by far its highest point total in the competition. In the Design Review, the "Bon Temps Machine" received a 8.0/10 for ingenuity, a 7.46/10 for aesthetics, and a 7.83/10 for presentation. These scores resulted in a total average score of 7.76/10, which was the 8th highest score among the 15 teams present.

The results of the Festival International Contest reveal that several assumptions made in the design process were not correct. Among the customer requirements found in the House of Quality concerning contest tasks, the requirement of Make it to the Main Stage was not considered to be as important as tasks such as Dismiss Hecklers and Collect Merchandise Revenue. This assumption limited the "Bon Temps Machine" chances for success, as the majority of competing machines seemed to make getting all band members to the stage to earn 50 contest points a priority, while the "Bon Temps Machine" was only capable of getting band members to the Secondary Stage to earn 25 contest points. The Specification Sheet only depicted a wish for all band members to get to the Main Stage, not a demand, and this lack of focus on this particular task made the machine have a lower possible point total than its competitors. Getting this assumption right in the design process may not have directly changed the design, but it may have changed what electrical devices were used to power subsystems, as the Large DC Motor may have powered the Band Member Extension Subsystem rather than the Small DC Motor to allow for the band members to be extended out farther in the allotted contest time. This would also affect the other subsystems, as the Small DC Motor would then have to be used to power the String Spool Subsystem, and this could potentially hurt the effectiveness of this subsystem and the Extendable Arm Subsystem.

Another assumption that was proven to be incorrect by the machine's performance was the assumption that the Keep the Crowd Rocking task did not need much attention. Like the Make it to the Main Stage task, this task was not considered to be as important as other customer requirements. While completion of the Keep the Crowd Rocking was demanded in the Specification Sheet, not much time was spent on ensuring this demand was met, as the Function Tree did not show many sub-functions needed to complete said task. Therefore, it was assumed that the Crowd Pin would remain standing unless directly interfered with by the "Bon Temps Machine" or by other competing teams. The design process failed to account for the vibrations of the track that came as a result of the Extendable Arm System colliding with the track on its downward acceleration. These vibrations led to the fall of the Crowd Pin, thus eliminating 20 possible points for the machine in all contest rounds. Getting this assumption right would change the dimensions of the design, as the inclusion of foam padding to reduce these vibrations would have to fit within the size restrictions, as this is one of the most important customer requirements in the House of Quality and is demanded by the Specification Sheet.

Improvement of design implementation is another factor that can be considered in the relative failure of the "Bon Temps Machine" in the Festival International Contest. While changes in the design process and changes in assumptions would definitely be needed to produce a machine capable of placing first in the contest, the current design could potentially have placed a few places higher in the contest with improvement on how the design was carried out and constructed. For example, the Band Member Extension System could have been better constructed and implemented in order to allow for faster extension of the band members towards the Main Stage, rather than just the Secondary Stage. However, these implementation issues

affect nearly every team, whether it come in the form of a broken string or failure to hit the reset button on the Motor Driver Shield, so these issues cannot be considered the primary factor in the machine's failures. Ultimately, the failure to identify the truly important requirements in the House of Quality is what led to the "Bon Temps Machine" not being as successful as others in the Festival International Contest.

One assumption regarding customer requirements that was proven correct by the contest results was the assumption that the Collect Festival Pins task was not as important as the other four contest tasks. In the House of Quality, the Festival Pins task was not ranked as important as these other tasks, and the Specification Sheet only stated a wish for the completion of these tasks, not a demand. This assumption was based on the difficulty of completing this task not being worth the potential points earned through completion. In the contest, the majority of competing teams did not address this task, and often a contest round did not involve the movement of Festival Pins on any side of the track. Because of this, the assumption that caused the "Bon Temps Machine" to not go for Festival Pins was accurate, and helped by allowing more time to be spent addressing the completion of the customer requirements concerning the other four Festival International Contest tasks.

VI. Conclusion

The Festival International Contest is one that requires much of any team-designed vehicle that is entered into said contest. Any vehicle must be able to autonomously complete tasks in order to earn the most contest points while competing against other teams trying to do the same. The machine designed with this purpose that has been discussed in this report, the "Bon Temps Machine," uses a motor-driven arm system to knock away Heckler Pins and secure Merchandise Revenue and a motor-driven extension system to get band member Legos to the Secondary Stage in an attempt to score the most points. This creation of this design was derived from information regarding the customer requirements, specifications, and functionality of this contest found from design tools such as the House of Quality, Specification Sheet, and Function Tree. This information allows for the creation of many design ideas, that can be utilized to form many different potential designs other than just the "Bon Temps Machine," and for this contest those designs include the previously discussed "Average Joe Bot" and "One-Wheel Drive Machine" designs. These designs are compared on the basis of how they address customer requirements, and as the "Bon Temps Machine" best addresses the most important customer requirements, it is the best possible design for the Festival International Contest. The "Bon Temps Machine" did not, however, excel in the contest, as it placed 9th out of 15 teams in the contest and earned an average score of 7.76/10 in Design Review Judging. The machines failures in the contest stem from inaccurate identification of the most important customer requirements, particularly those requirements concerning the Make it to the Main Stage and Keep the Crowd Rocking tasks. Ultimately, the Festival International Contest provided a large spectrum of challenges that were met by the "Bon Temps Machine," but were not met with the precision and efficiency needed for true success in the contest.

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Plastic bag - http://3.bp.blogspot.com/6GE64GJZdYU/T_zGGRkEHI/AAAAAAAAEpg/rVqkMbouAHM/s1600/Plastic_bag.jpg

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Duct tape - http://img2.timeinc.net/health/images/gallery/living/duct-tape-400.jpg#emergency%20duct%20tape%20400x400

Arduino (Green) - http://www.simplelabs.co.in/158-thickbox_leometr/iteaduino-bt-bluetooth-arduino-clone-board.jpg

Chain Duino - http://www.geeky-gadgets.com/wp-content/uploads/2014/08/Arduino-Board1.jpg

Robot Legs - http://cache.lego.com/r/www/r/mindstorms/community/services/media/1b2033b2-5ed1-4031-aa9d-28c0383728a5/555x360/mediafile.jpg

Lego Board - http://upload.wikimedia.org/wikipedia/commons/1/15/Green_Lego_Baseplate.jpg

Rope Knot - http://www.womenshealthmag.com/files/images/0805-knot-a-problem.jpg

Broom - http://ace.imageg.net/graphics/product_images/pACE3-4958279enh-z7.jpg

Bike Gear - http://www.babs.co/gears/wikipedia_53_39_11_25_large.png

Catapult - http://www.herosarms.com/images/Catapult.jpg

Plastic Egg - http://image.made-in-china.com/2f0j00tCrazQsJOeqR/Plastic-Egg.jpg

Sponge - http://www.oppictures.com/SINGLEIMAGES/400/76969.JPG

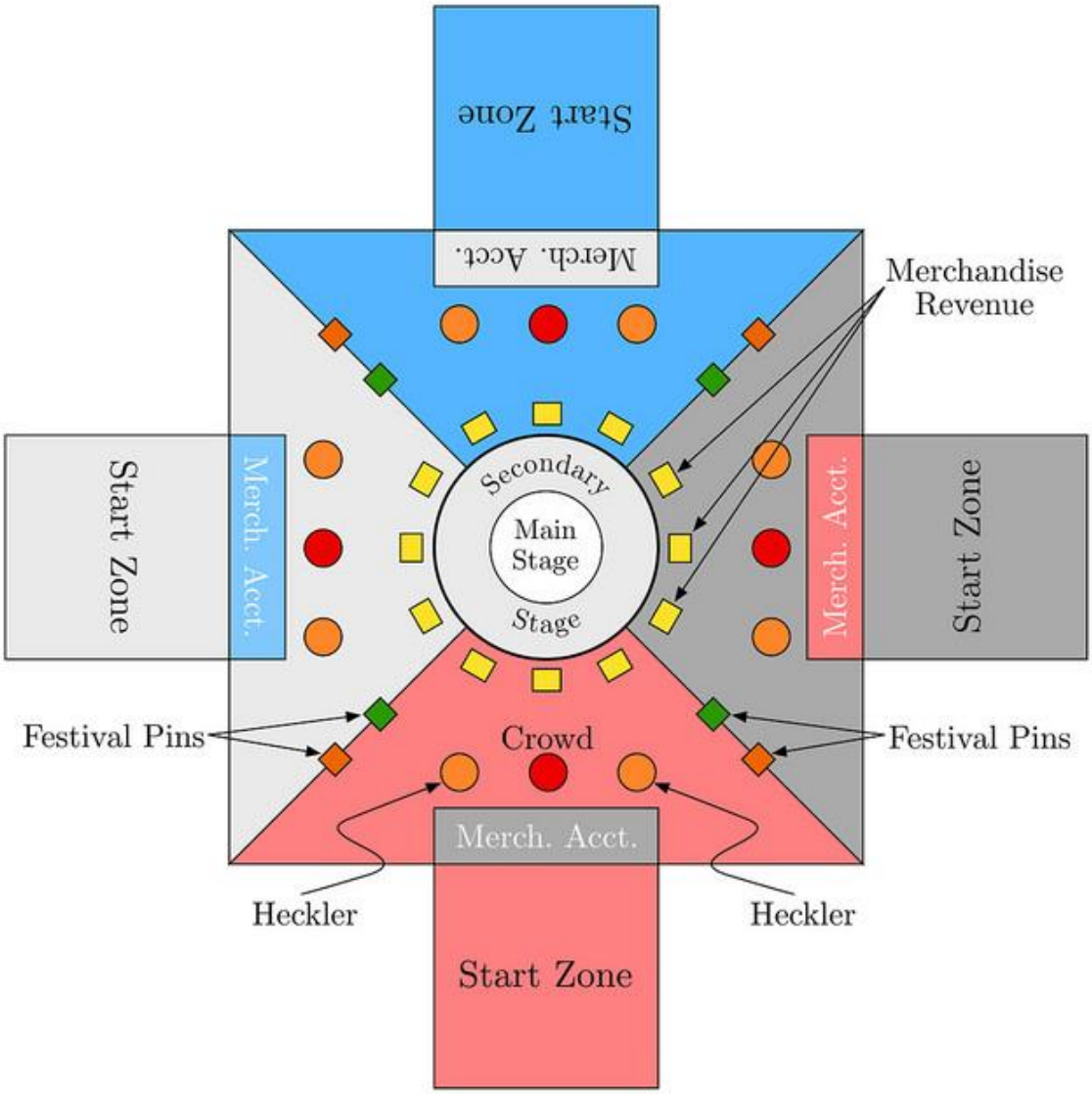


Figure 1: Festival International Contest Track [source]

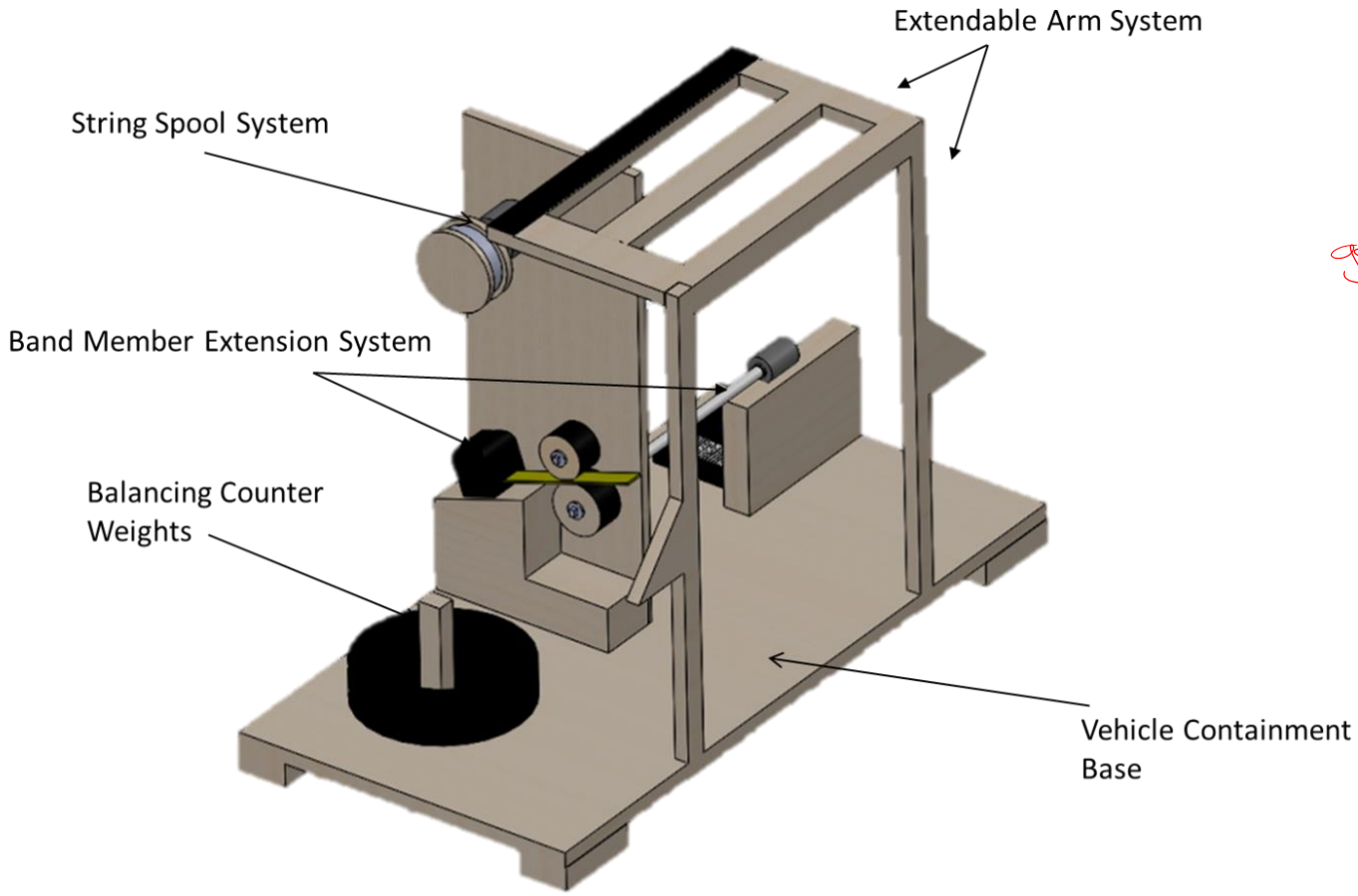


Figure 2: “Bon Temps Machine” Complete View

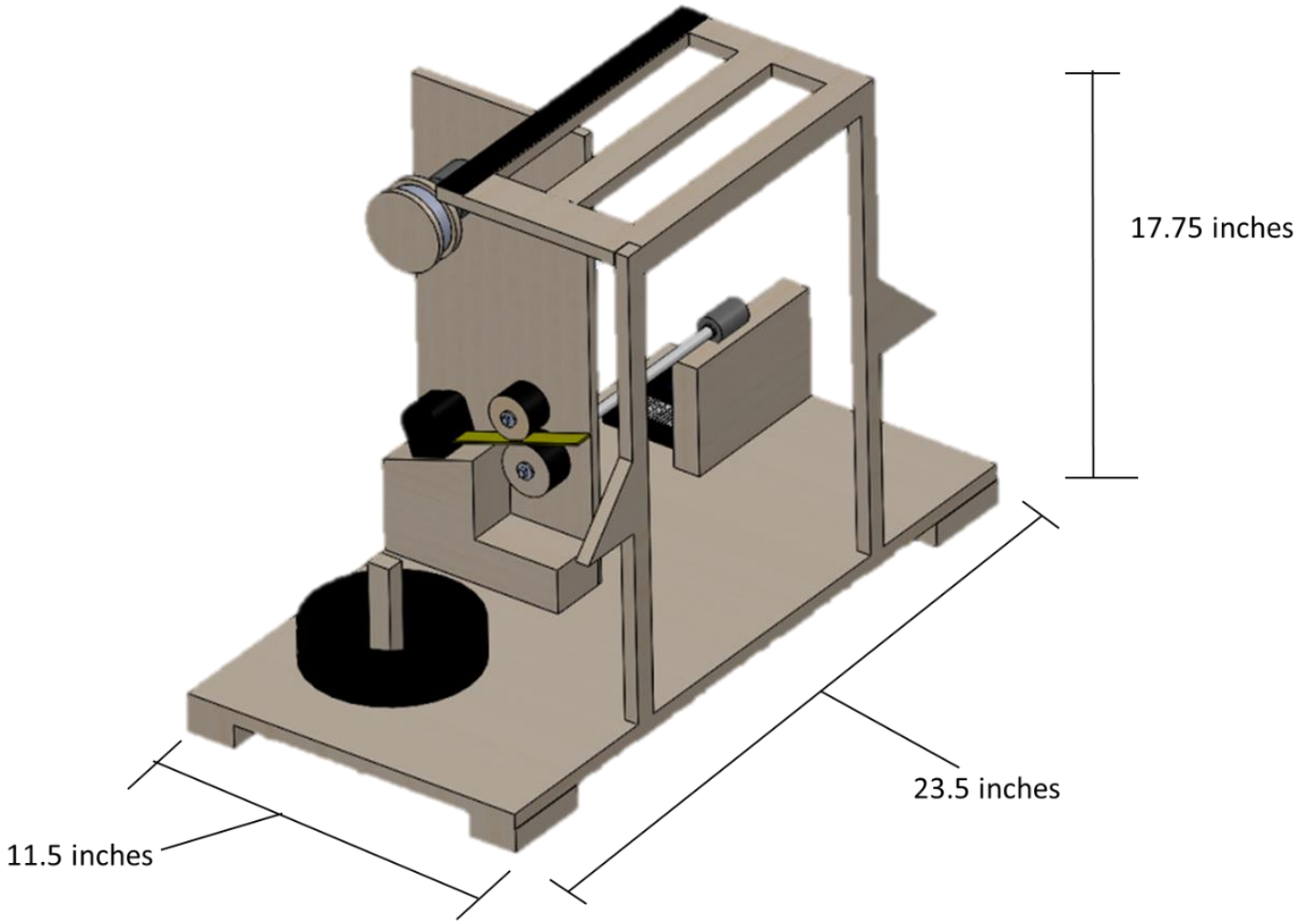


Figure 3: “Bon Temps Machine” Dimensions

Table 1: “Bon Temps Machine” Bill of Materials

Cost in Dollars	**Item**
$0.90	Eye Hook
$1.00	Lego Platform
$1.40	1 Inch Nails
$2.00	Pack of Tacks
$2.30	Threaded Shaft
$2.50	Rubber Tape
$3.00	Ear Plugs
$3.00	Wooden Wheels
$3.00	Wooden Spool
$3.30	Nuts and Washers
$4.30	Measuring Tape
$4.80	5 lb weights
$4.90	Tie Wraps
$5.20	Wood Glue
$5.40	Velcro Packs
$5.60	Paint
$5.80	Fishing String
$6.50	1 Inch Wood Screws
$11.20	Hinges (with screws)
$22.50	Scrap Wood
Total Cost in Dollars	**Budget Amount**
$98.60	**$100.00**

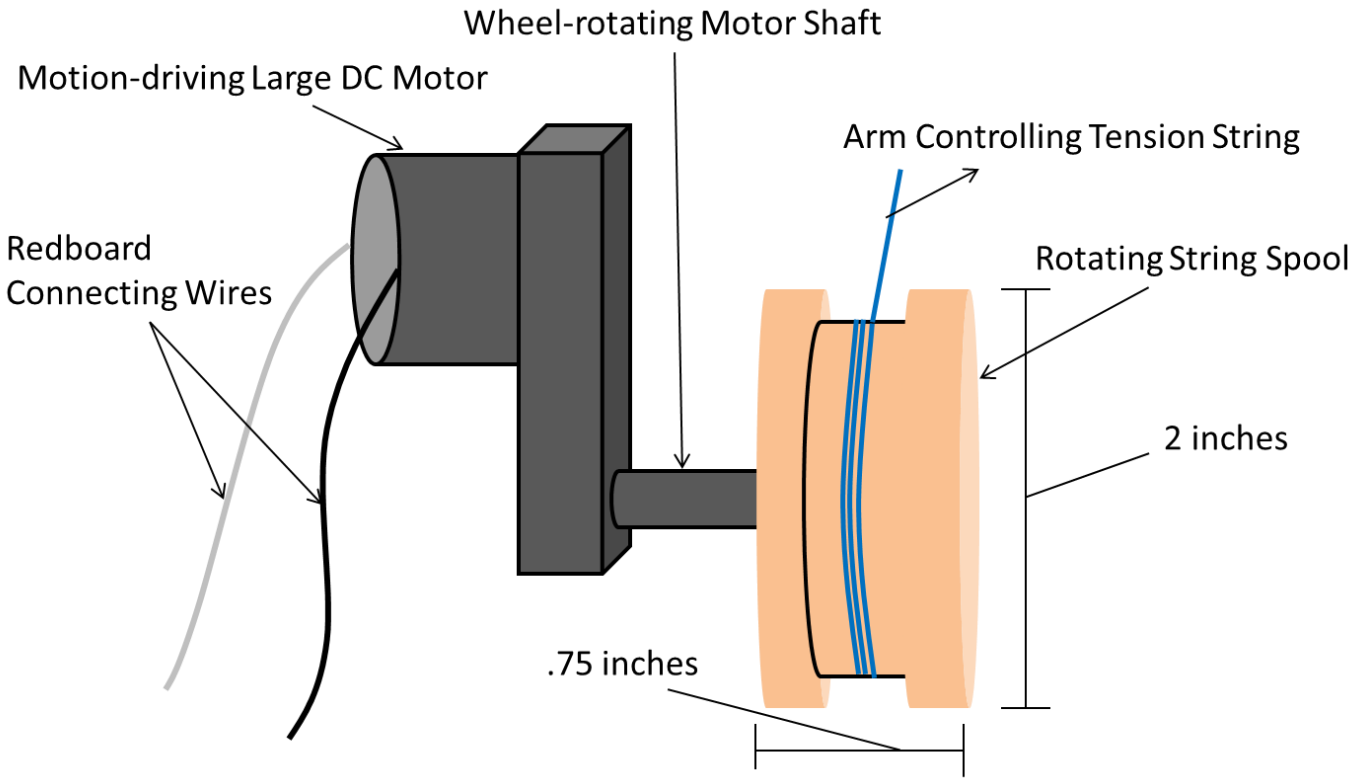


Figure 4: "Bon Temps Machine" String Spool System

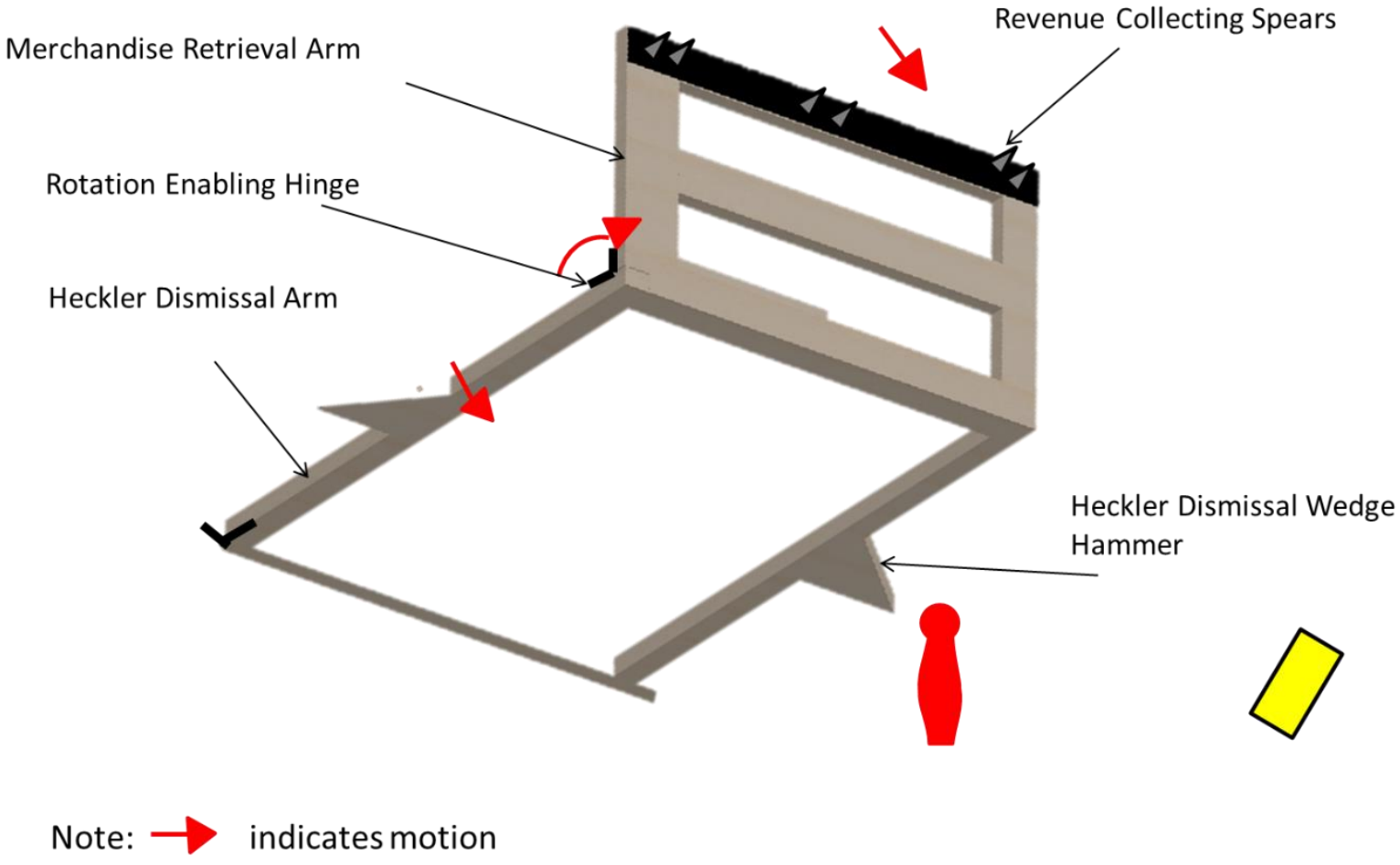


Figure 5: "Bon Temps Machine" Extendable Arm System

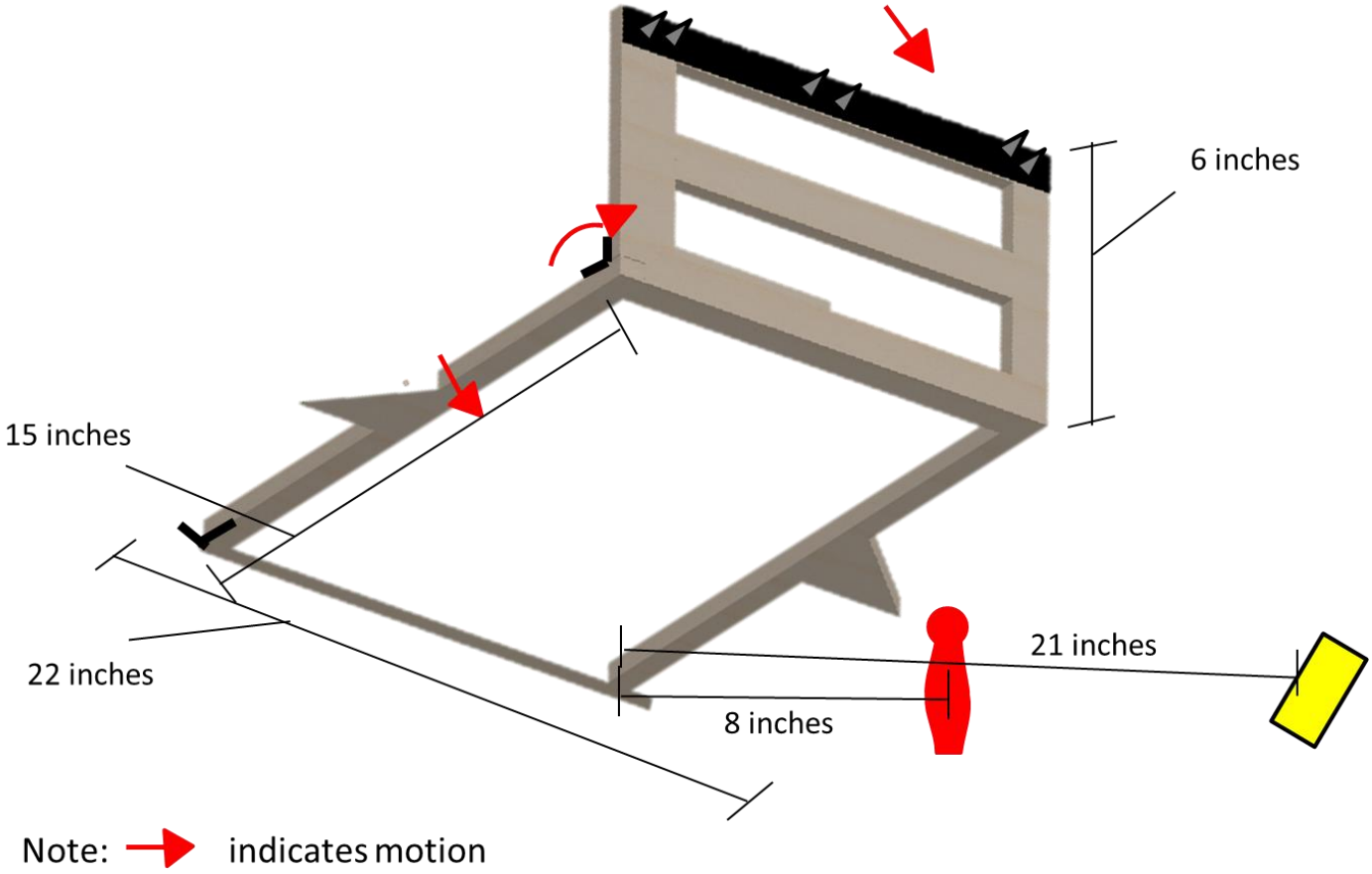


Figure 6: “Bon Temps Machine” Extendable Arm System Dimensions

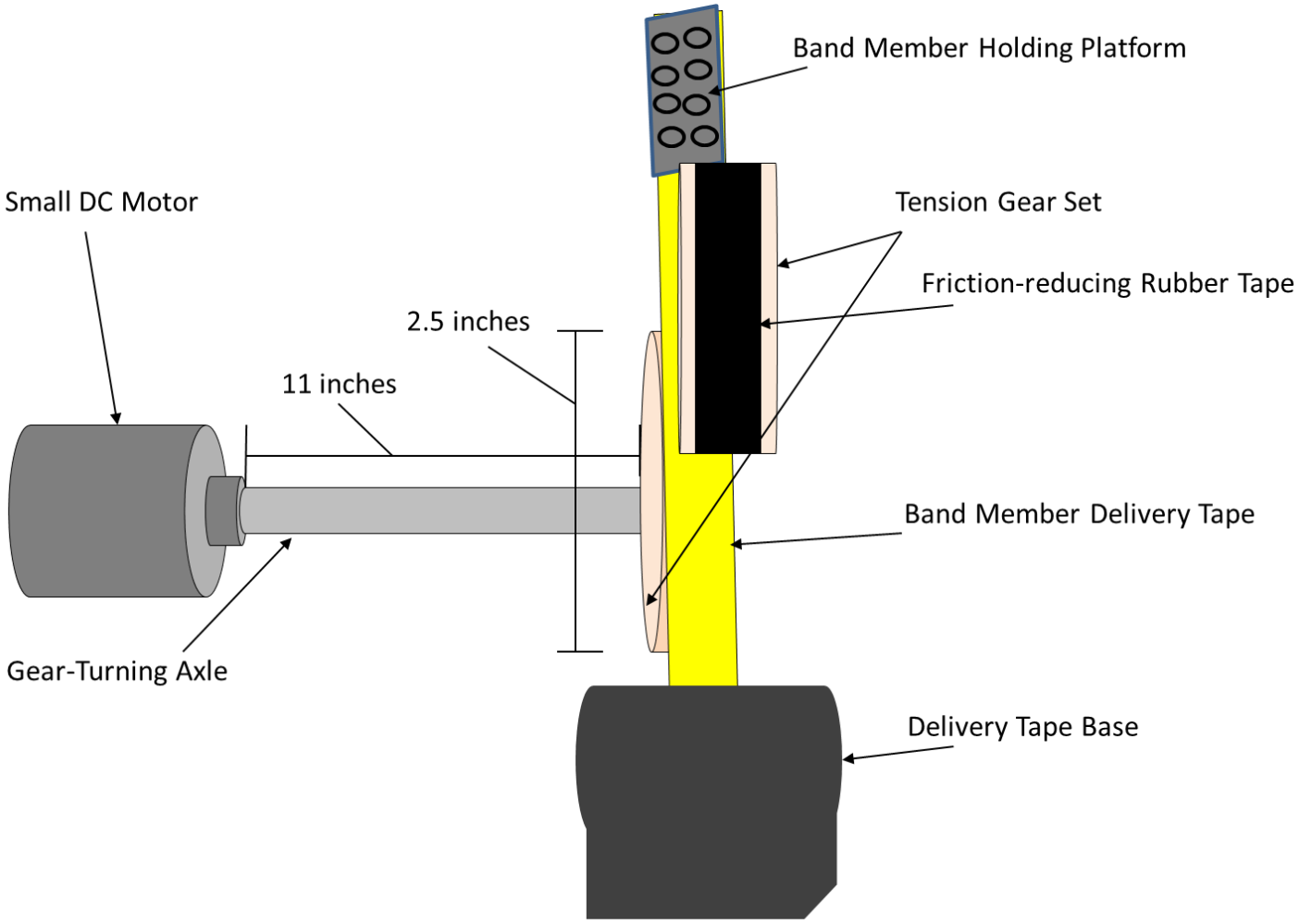
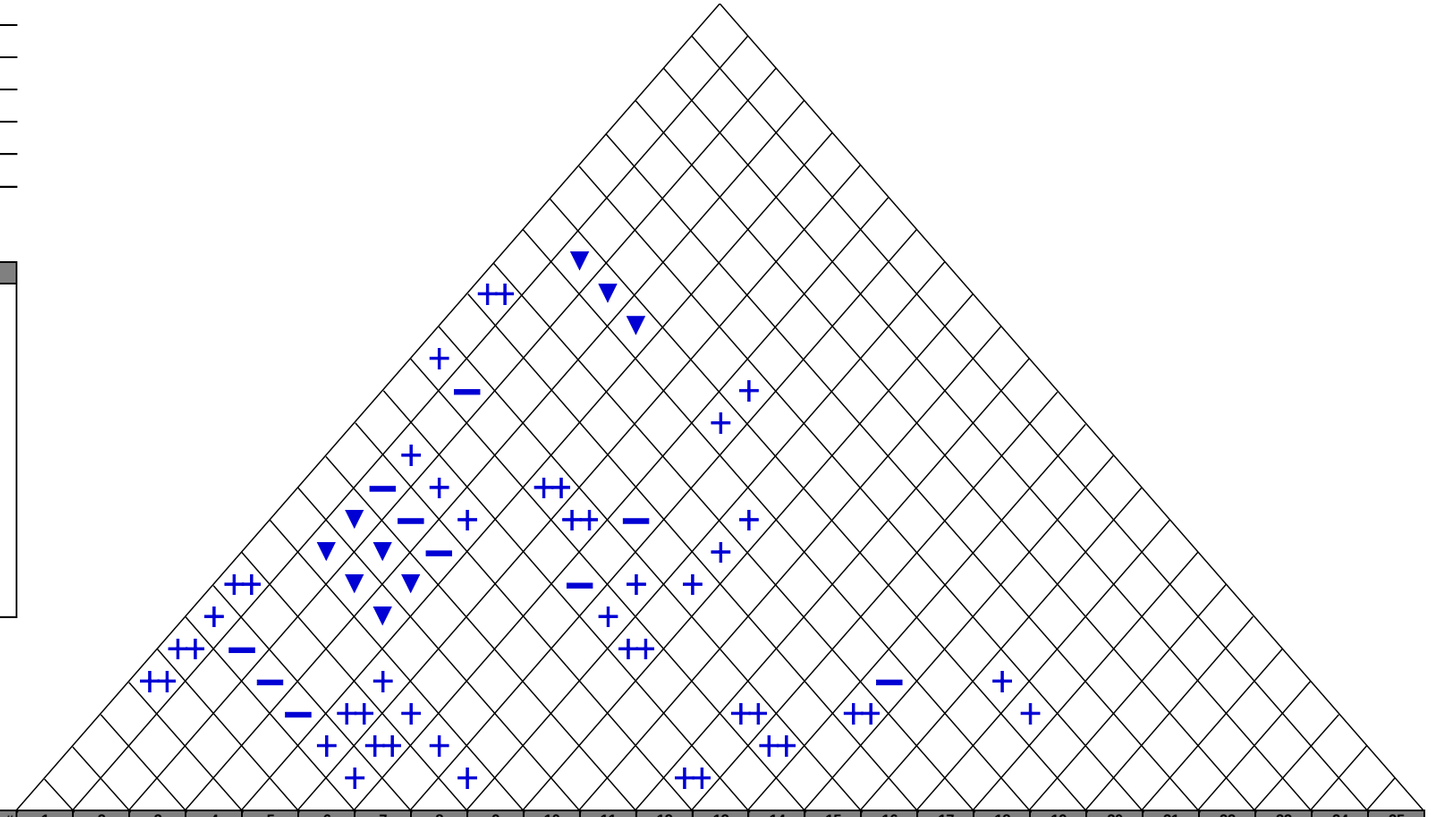


Figure 7: Band Member Extension System

Title: Final Project House of Quality
Author: Team 8
Date:
Notes:

Legend		
Θ	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
−	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	



Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▼	▼	▼	▼	▲	▲	x	▲	▼	▲	▲	▲	▼	▼	▲	x	▼	▲	▲	▲	▲				

Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats") \ Quality Characteristics (a.k.a. "Functional Requirements" or "How s")	# of moving parts	Length of footprint	Width of footprint	Height of device	Supplied Voltage	Supplied Ampaerage	Number of Tasks performed	Speed of individual tasks	# of sensors	Range of collection system	Range of removal system	% of lightweight materials used	% of heavy materials used	Length of coding	Power of propulsion system	Number of logic Mechanisms used	Total operation time	# of logic inputs	Range of Delivery system	# of Original Design Components	Number of color patterns
1	9	7.7	10.0	Operate Autonomously					▲	▲	▲		O					Θ		Θ		O		▲	
2	9	6.2	8.0	All functions performed < 30 sec	O							Θ	▲			▲	O				Θ			▲	
3	9	7.7	10.0	Fits within 12x24x18 in box		Θ	Θ	Θ						▲	▲										
4	9	6.2	8.0	Activated by sensing of button					▲	▲										Θ		Θ			
5	9	6.2	8.0	Dissmiss Hecklers	▲	▲	▲	▲				▲	O		Θ										
6	3	5.4	7.0	Keep Crowd Rocking	▲			O				▲	▲		O										
7	9	6.2	8.0	Collect merchandise	▲							▲	O	Θ											
8	9	4.6	6.0	Uses electro-mechanical design	O	O	O	O	Θ	Θ			▲	O	O	O	O								
9	9	3.1	4.0	Program with small number of lines	O				▲	▲	Θ	O	O	▲	▲			Θ		Θ		O			
10	9	0.8	1.0	Efficent use of energy					Θ	Θ			O										O		
11	9	3.8	5.0	Convenient size for transportation		O	O	O								Θ	Θ								
12	9	5.4	7.0	Device is capable of movement	O				▲	▲						Θ	Θ		Θ						
13	9	5.4	7.0	Make it to the Main Stage	O								O									Θ			
14	9	4.6	6.0	Collect Festival Pins	O								O	Θ											
15	3	4.6	6.0	Does not damage nearby Robots	▲								▲	▲	▲	O	O						▲		
16	9	3.8	5.0	Contains original design components	▲											O	O			O				Θ	▲
17	9	3.8	5.0	Design is aesthically pleasing												▲	▲								Θ
18	3	5.4	7.0	No damage to rented out components	▲			O	O	O		▲				▲	▲	▲		▲		▲	▲		
19	3	3.1	4.0	Low cost to assemble	O	▲	▲	▲					▲			O			▲	▲			▲		▲
20	3	2.3	3.0	Contains small # of electrical devices	O						O						O				O	O			
21	9	3.8	5.0	Low number of components	Θ	▲	▲	▲			▲			O	O			O		▲					
22																									
23																									
24																									
25																									

Competitive Analysis (0=Worst, 5=Best)

Row #	Our Company	Competitor 1	Competitor 2	Competitor 3	Competitor 4	Competitor 5
1						
2						
3						
4						
5						
6						
7						
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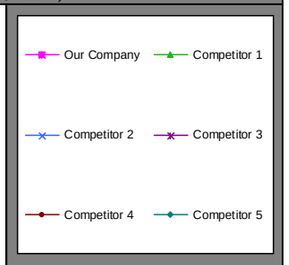


Target or Limit Value																									
Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)																									
Max Relationship Value in Column	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9				
Weight / Importance	170.0	107.7	107.7	140.0	86.9	86.9	46.2	87.7	157.7	137.7	112.3	146.9	156.9	113.8	51.5	176.2	62.3	100.0	61.5	50.8	41.5				
Relative Weight	7.7	4.9	4.9	6.4	3.9	3.9	2.1	4.0	7.2	6.3	5.1	6.7	7.1	5.2	2.3	8.0	2.8	4.5	2.8	2.3	1.9				

Figure 8: Festival International Contest House of Quality

Good

Table 2: Festival International Contest Specification Sheet

		For: Festival International de Acadien Contest Design	Issued: 3/26/16	
			Page 1 of 1	
Changes	D/W	Requirements	Responsibility	Source
		Geometry		
3/26/2016	D	Fits within 12x24x18 inches	Design Team	Contest rules
3/26/2016	W	Fits within 11x23x17 inches	Design Team	Contest rules
4/17/2016	D	Must be at least one inch away from Crowd pin at all times	Design Team	Design Team/Contest rules
4/17/2016	W	Must be at least two inches away from Crowd pin at all times	Design Team	Design Team/Contest rules
4/17/2016	D	Must be initially 8 inches from Crowd, Heckler pins	Design Team	Contest rules
4/17/2016	D	Must be initially 21 inches (approx.) from Merchandise Revenue	Design Team	Contest rules
4/17/2016	D	Must not initially cross over 2x2' start zone	Design Team	Contset rules
		Kinematics		
4/6/2016	W	Average straight line velocity of .05 m/s	Quinn	Design Team
4/6/2016	D	Average straight line velocity of .01 m/s	Quinn	Design Team
4/7/2016	W	Average projectile velocity of .2 m/s	Mat	Design Team
4/7/2016	D	Maximum component rotation < 175 degrees	Design Team	Design Limitations
4/7/2016	W	Maximum component rotation < 150 degrees	Design Team	Design Limitations
		Operation		
3/26/2016	D	Operates < 30 sec	Design Team	Contest rules
4/4/2016	W	Operates <25 sec	Quinn	Contest rules
3/26/2016	W	Motors must not be running for > 25 sec at a time	Matthew	Design Team
3/26/2016	W	Code must contain < 150 lines	Matthew	Design Team
3/26/2016	D	Keeps crowd pin standing	Design Team	Contest rules/Design Team
3/27/2016	W	Collect All Festival Pins	Design Team	Contest rules/Design Team
3/27/2016	W	Delivers All Objects to Main Stage	Design Team	Contest rules/Design Team
3/27/2016	D	Delivers All Objects to Secondary Stage	Design Team	Contest rules/Design Team
3/26/2016	W	Collects all three merchandise sponges	Design Team	Contest rules/Design Team
3/27/2016	W	Collects at least two merchandise sponges	Design Team	Contest rules/Design Team
5/2/2016	D	Dismiss All Hecklers	Design Team	Contest rules/Design Team
		Materials		
4/6/2016	W	Must use wood no more than .75" thick	Mat	Design Team
4/6/2016	D	Must use screws no larger than 3/8"	Mat	Design Team
4/3/2016	D	No store-bought actuators	Matthew	Contest rules
4/6/2016	W	No hot glue used	Mat	Design Team
4/3/2016	W	Must make use of at least one original design idea	Quinn	Design Judges
		Energy		
3/26/2016	W	Two individual Power Sources	Quinn	Design Team
4/17/2016	D	Must have at least one Power Source	Matthew	Contest rules
3/26/2016	D	No more than one Arduino Redboard	Matthew	Contest rules
3/27/2016	D	Minimum 5 V Power Supply	Mat	Design Team/ Design Limitations
4/17/2016	D	Must contain no stored energy pre-activation	Matthew	Contest rules
		Dynamics		
4/4/2016	W	Able to move at least 30ft	Quinn	Design Team
3/26/2016	W	Able to survive force of 5 N	Mat	Design Team
3/26/2016	W	Weighs less than 10 lbs	Matthew	Design Team
3/26/2016	D	Weighs less than 20 lbs	Mat	Design Team
		Cost		
3/26/2016	D	Cost less than 100$	Quinn	Design Team
3/26/2016	W	Cost less than 50$	Quinn	Design Team
		Quality Control		
4/6/2016	D	Minimum of 30 vehicle tests	Design Team	Design Team
4/6/2016	W	Minimum of 50 vehicle tests	Design Team	Design Team
4/17/2016	D	Wear/ Damage check every two days	Mat	Design Team
4/17/2016	W	Wear/ Damage check every day	Mat	Design Team
		Signals		
4/6/2016	D	Must activate from one push-button press	Design Team	Contest rules
4/17/2016	D	Must be able to connect to track pushbutton	Design Team	Contest rules
		Safety		
4/6/2016	D	Must contain no wood-piercing elements	Design Team	Contest rules
4/6/2016	D	Must contain no plastic-piercing elements	Design Team	Contest rules
4/17/2016	D	Must not damage track	Design Team	Contest rules
		Transportation		
4/6/2016	D	Vehicle must be transported to site no less than 2 hours before	Mat	Design Team
4/6/2016	W	Vehicle must be transported to site no less than 3 hours before	Mat	Design Team
		Aesthetics		
4/6/2016	W	Vehicle must contain at least 2 color patterns	Matthew	Design Judges
4/6/2016	D	Vehicle must contain at least 1 color pattern	Matthew	Design Judges

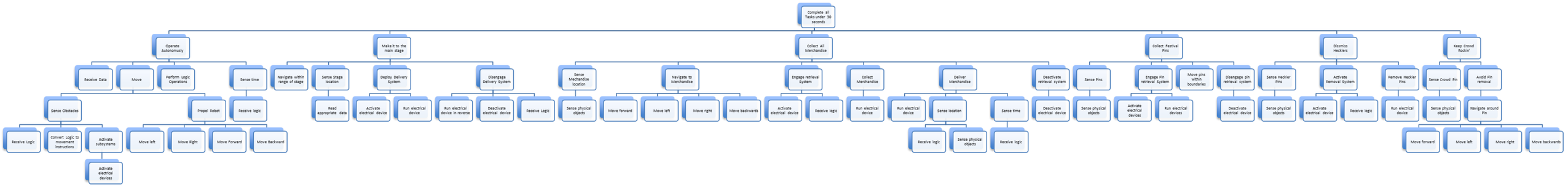


Figure 9: Festival International Contest Function Tree

Why the extra space?

Table 3: Festival International Contest Morphological Chart

Good

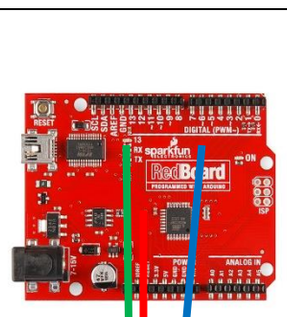
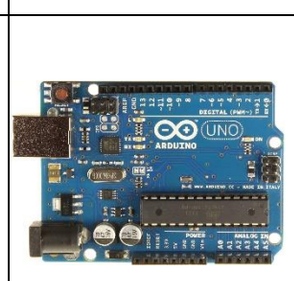
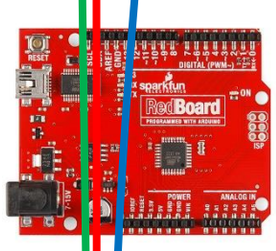
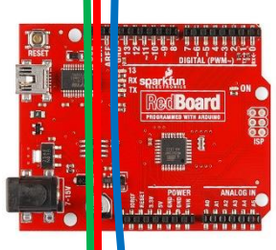
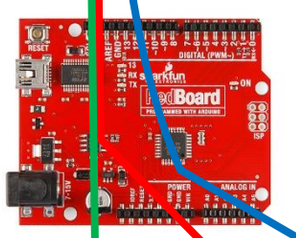
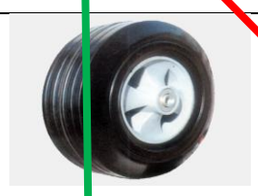
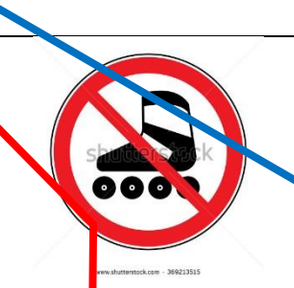
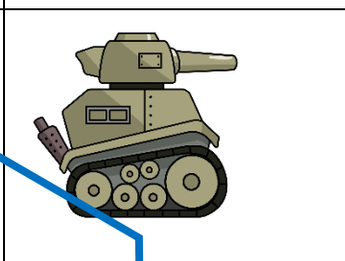
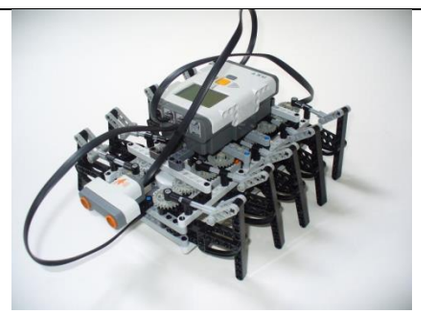
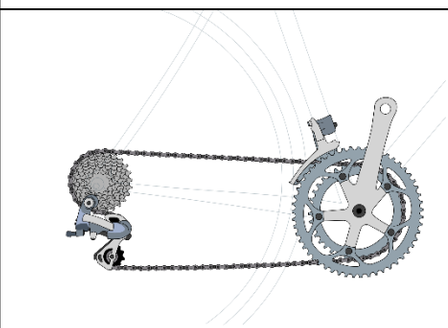
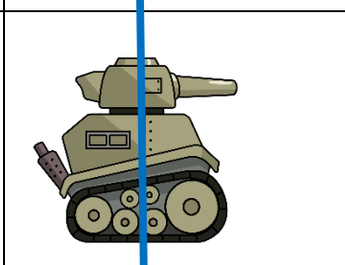
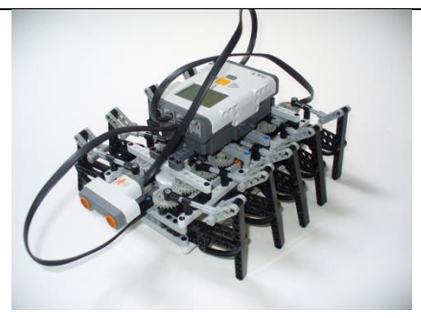
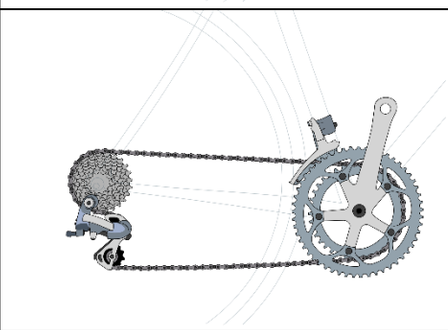
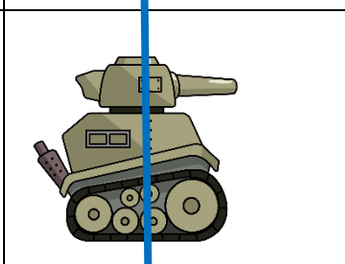
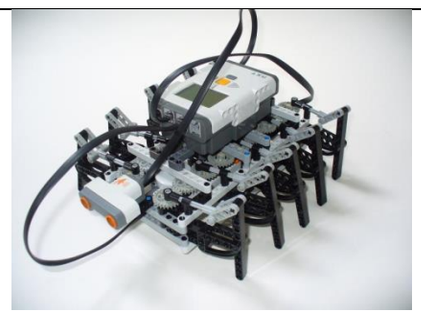
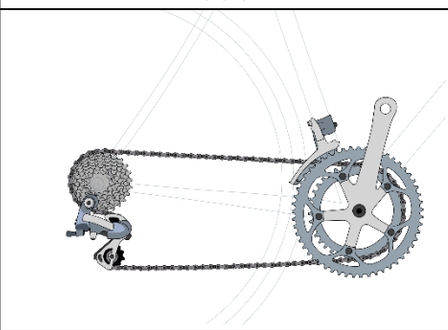
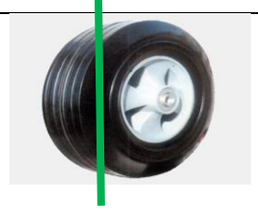
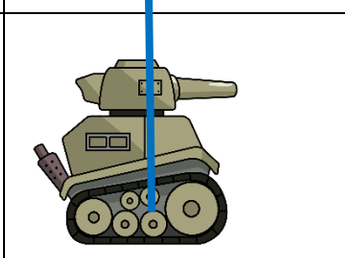
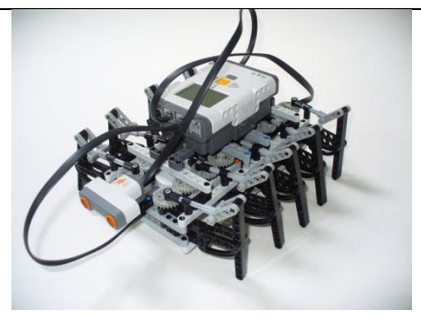
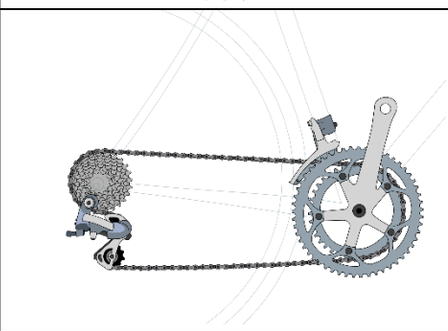
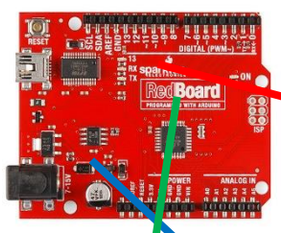
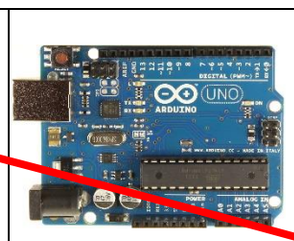
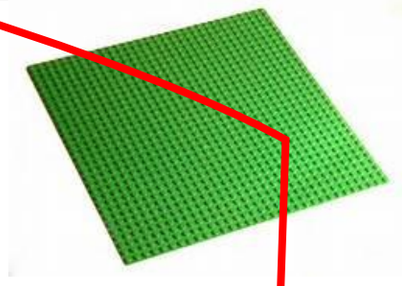
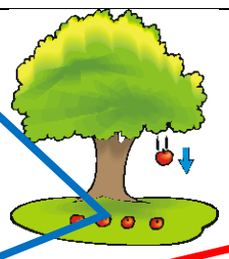
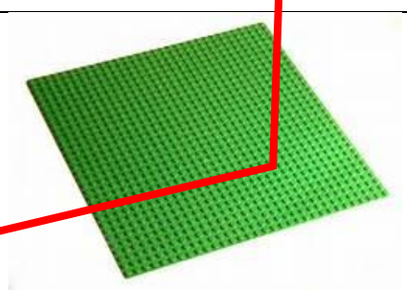
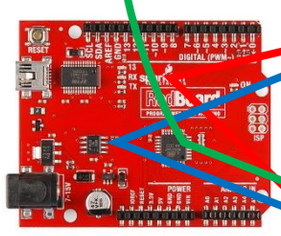
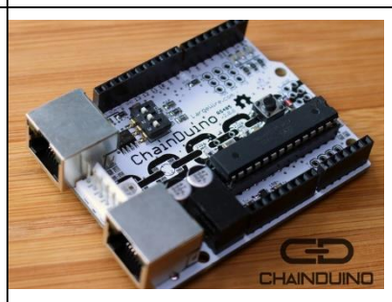
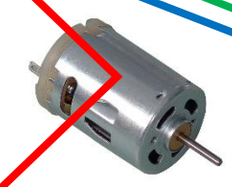
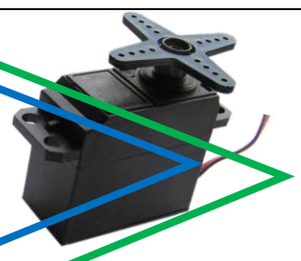
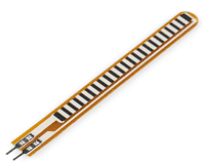
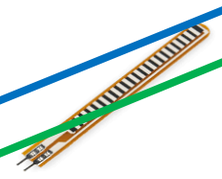
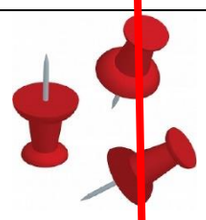
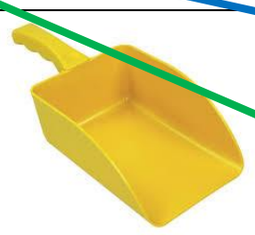
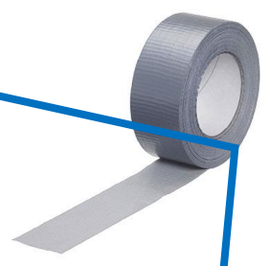
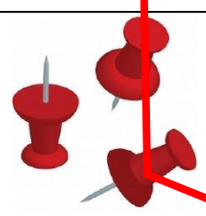
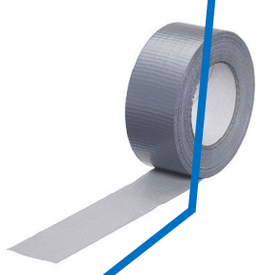
Final Project Morphological Chart	Idea 1	Idea 2	Idea 3	Idea 4	Idea 5
Receive Data					
Read Sensor Data					
Convert Logic to movement instructions					
Activate electrical devices					
Move left					
Move right					
Move forward					
Move backward					

Table 3 (cont.): Festival International Contest Morphological Chart

Receive logic					
Contain Legos					
Prevent Legos from falling					
Read appropriate data					
Run electrical device					
Aim for stage					
Secure Merchandise					
Carry Merchandise					
Sense physical objects					
Deactivate electrical devices					

Red: “Bon Temps Machine”

Blue: “Average Joe Bot”

Green: “One-Wheel Drive Machine”

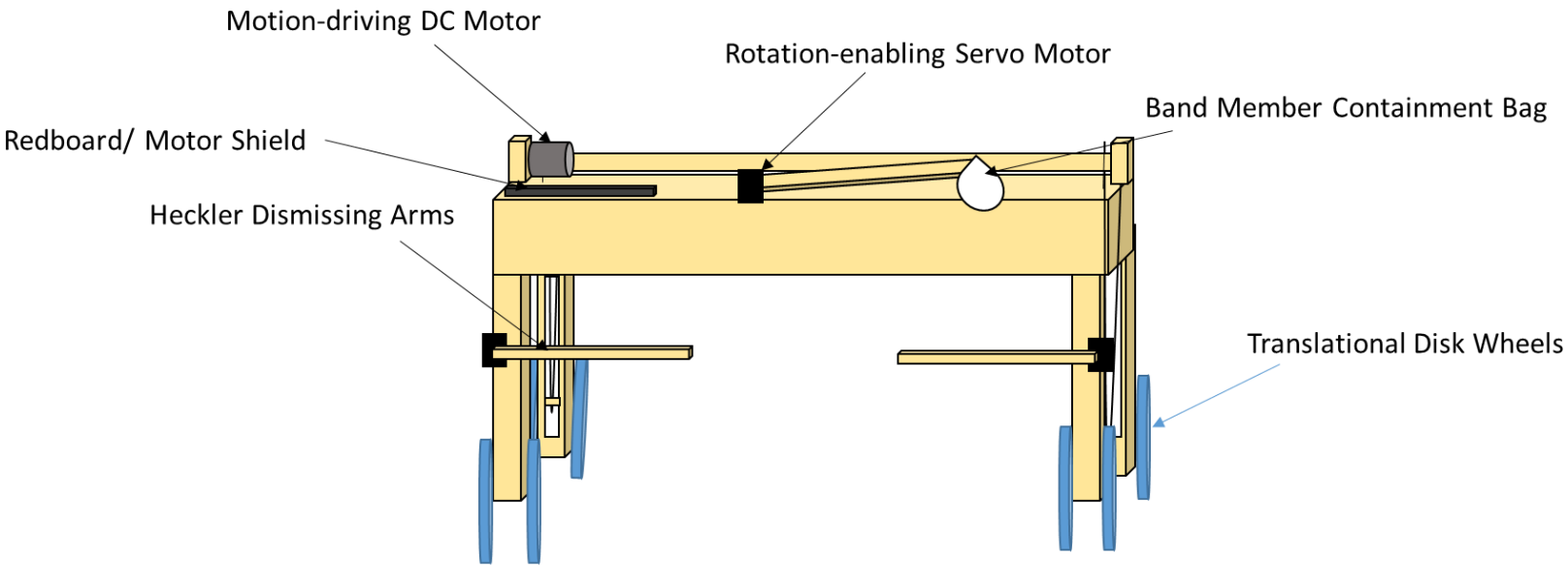


Figure 10: "Average Joe Bot" Design

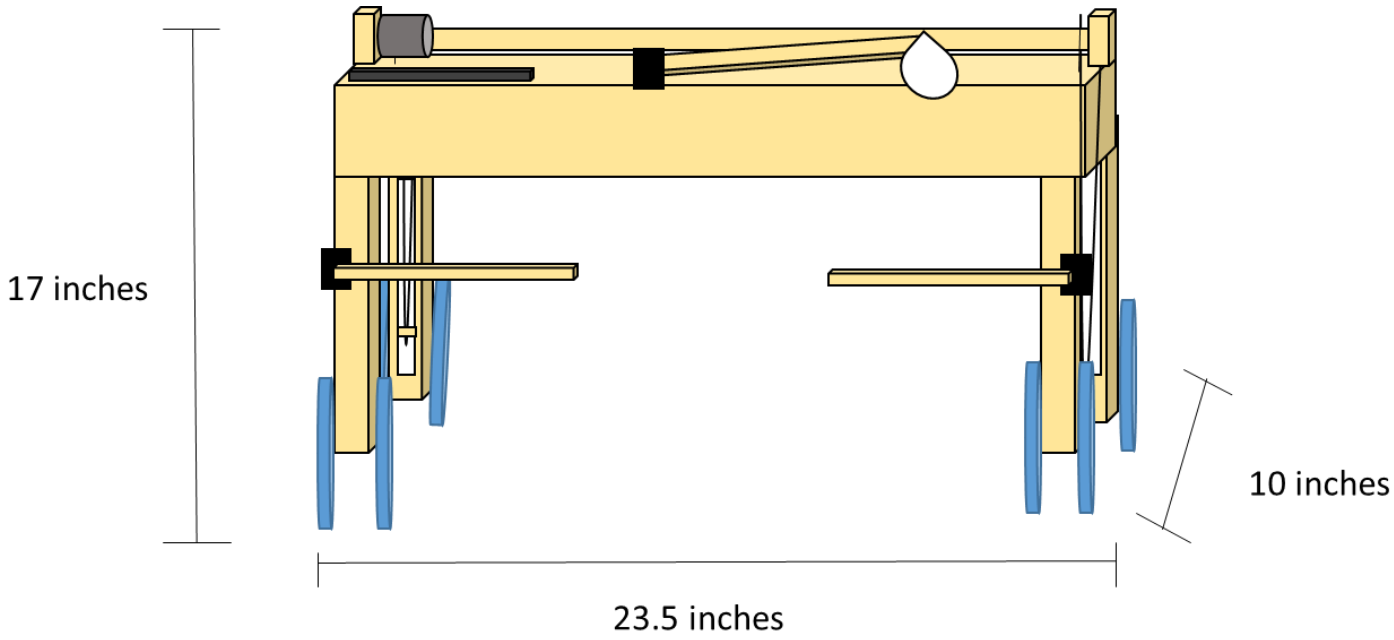


Figure 11: "Average Joe Bot" Design Dimensions

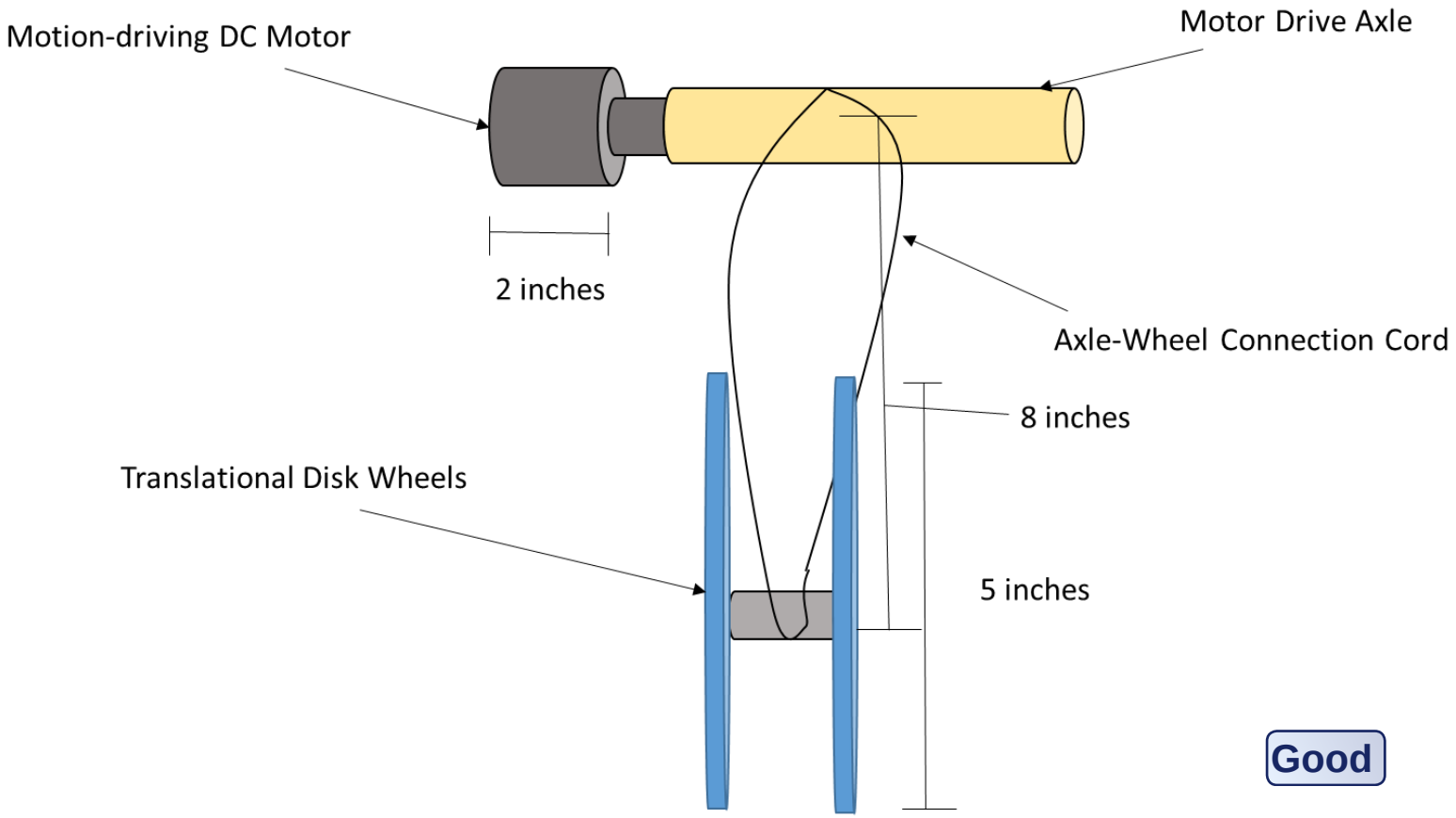


Figure 12: "Average Joe Bot" Design Motion Analysis

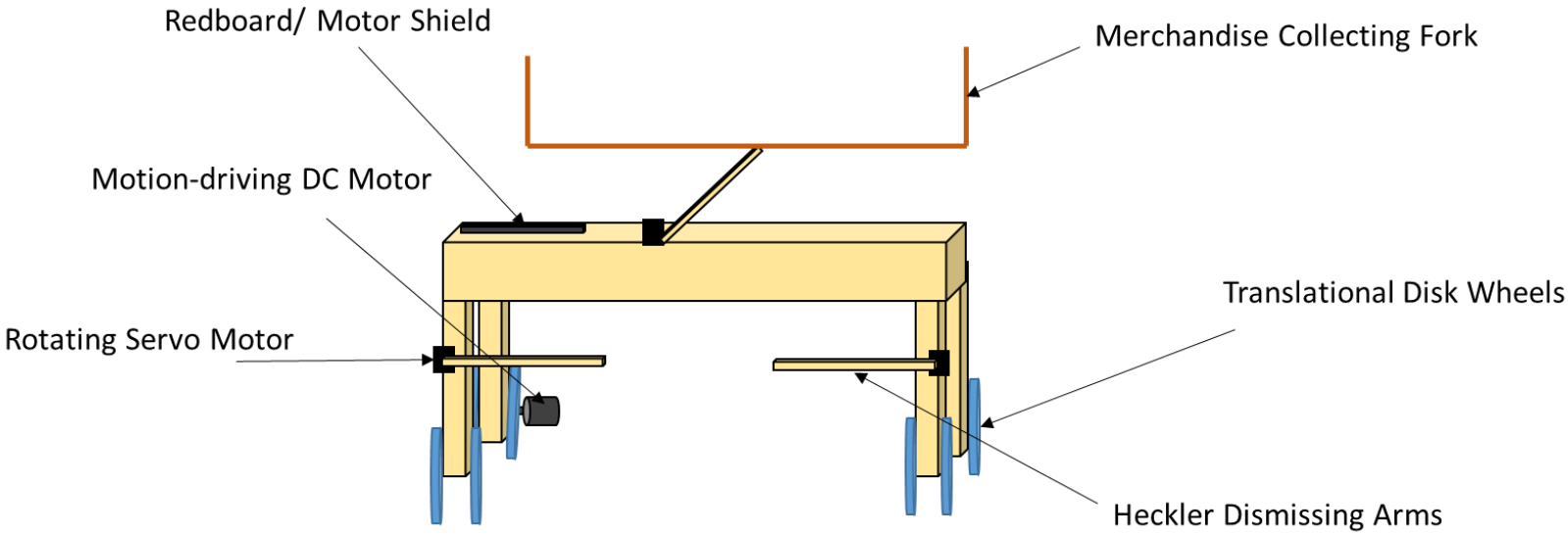


Figure 13: "One-Wheel Drive" Design

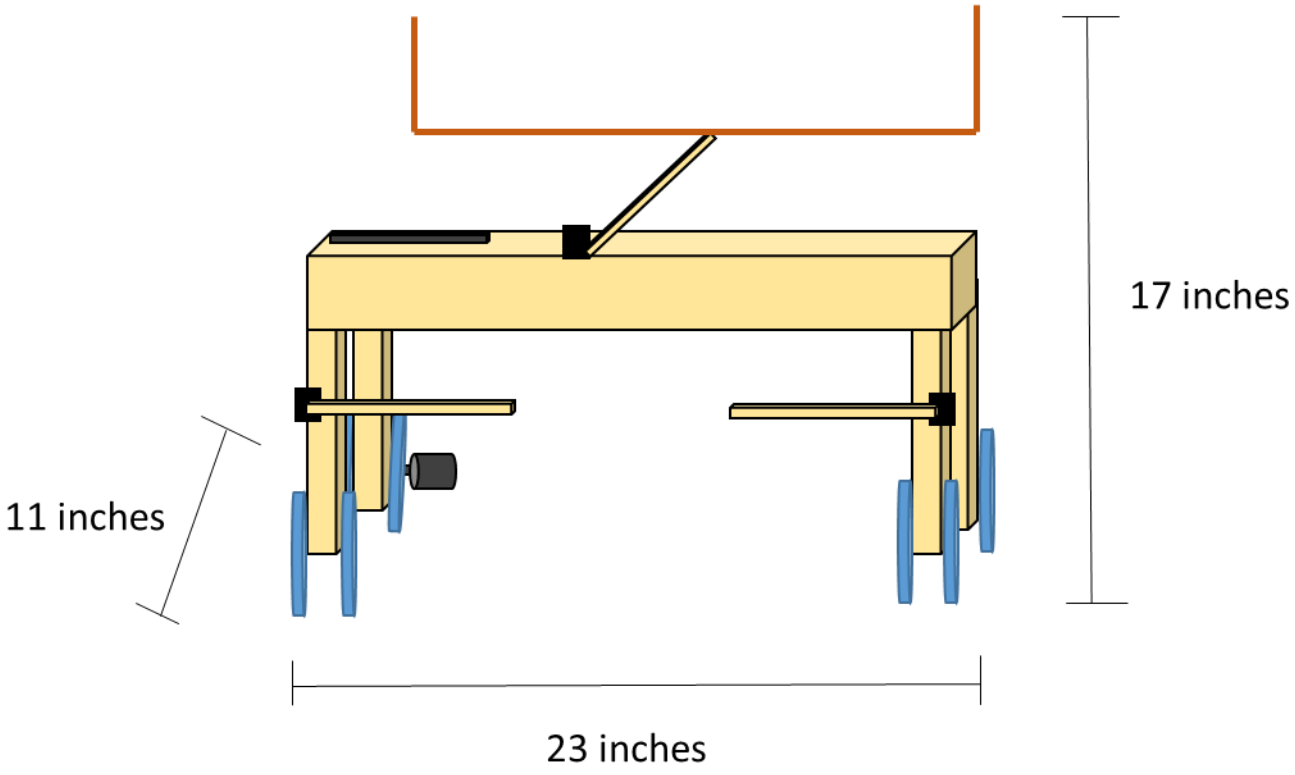
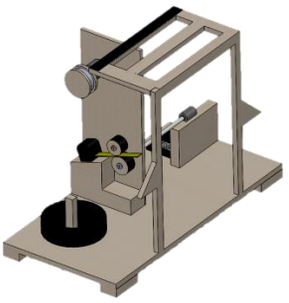
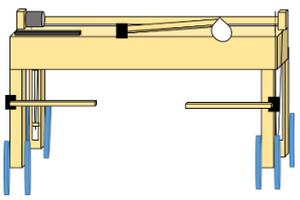
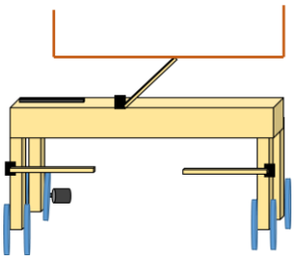


Figure 14: “One-Wheel Drive” Design Dimensions

Table 4: Festival International Contest Evaluation Matrix

	Importance			
Operate Autonomously	8	3	0	0
All functions performed < 30 sec	10	2	3	3
Fits within size restrictions	10	2	2	2
Activated by sensing of button	10	3	1	2
Dismiss Hecklers	8	3	1	1
Keep Crowd Rocking	8	2	2	3
Collect merchandise	8	4	0	2
Use electro-mechanical design	6	3	2	1
Program with small number of lines	4	4	1	1
Efficient use of energy	1	3	1	1
Convenient size for transportation	5	2	2	3
Device is capable of movement	7	3	1	1
Make it to the Main Stage	8	3	2	0
Collect Festival Pins	8	0	0	0
Does not damage nearby robots	6	3	3	3
Contains original design components	5	3	2	1
Design is aesthetically pleasing	5	3	2	2
No damage to rented out components	7	3	2	2
Low cost to assemble	4	2	2	3
Design is explained in low # of steps	3	3	2	2
Low number of components	5	2	2	2
Total:		354	210	226
Relative Total:		0.448	0.266	0.286

Ranking Scale:
0 - Unacceptable
1 - Tolerable
2 - Satisfactory
3 - Good
4 - Very Good