The Medina Valley SA BEST team provided the attached notebook to all teams at SA BEST in 2002, and to all teams at Texas BEST in 2002. The pictures in the back of the notebook, referenced in the table of contents, were removed to decrease the file size.

Note that this notebook was prepared based on the 2002 SA BEST requirements. The current SA BEST requirements are different, so please review the current requirements as you prepare your notebook.

SA BEST

Design Documentation for
"The Collector"
A Robot
to Satisfy the Requirements of Warp X

Prepared for

SA BEST

Prepared by

Medina Valley Robotics Club

Interdimensional Robotic Services (IRS)

October 2002

Executive Summary

This document describes the Medina Valley Robotics Club's concept promotion activities for the school and community, design and fabrication of the "The Collector" using the engineering process, using available technology including web-site design, and development of this notebook for the San Antonio Boosting Engineering, Science, and Technology (SA BEST) competition *Warp X* held October 24, 2002.

BEST is an intense six-week robotics competition for high schools. This competition is designed to promote math and science and to encourage those students to pursue technology-based careers. For, this year's game, the objective was to design a robot to go back in time by traversing a micro black hole and retrieving a number of game pieces from previous games.

This document will continue to evolve as the final design and fabrication of "The Collector" continues up until game day. At game day Medina Valley Robotics will provide a single CD that contains a PDF version of the final document along with an electronic version of the WebPages to each of the schools participating in the contest.

TABLE OF CONTENTS

1 Resources

Medina Valley Robotics used a wide variety of resources to accomplish the objectives of this year's task. In addition to being able to play the game well and compete against the other teams, promotion of the engineering process was extremely important. Resources were as close to home as family support providing transportation to and from activities and as widespread as including World Wide Web searches for information. When combined, the resources and support for the club are enormous.

1.1 Medina Valley Robotics Club

The Medina Valley Robotics is a school club that operates on a year around basis. Our club consists of students of all grades (9-12), teachers covering different subjects, mentors with different technical and professional backgrounds, and parents. Each of these supported the club through direct participation and behind-the-scenes activities. Photographs and a brief biography for the team members can be found in Appendix B.

Students

The primary purpose of the game is an engineering, science, and technology competition *for* the students. To that end, students are primarily responsible for designing, constructing, testing, documenting, and operating the robot. Because of the organization present from the Medina Valley Robotics Club, this year's management responsibility fell heavily on the students, including the following key personnel.

- President Josh Reynolds - Josh is the leader of the club who gives direction and presents ideas to the club. He orchestrates and conducts meetings and provides insight to past games.
- Vice President William Knight - William is in charge of member-mentor relations, as well as keeping members and mentors informed of when and where the meetings are and on the current happenings.
- Archivist/Treasurer Tim DeLeon - Tim keeps minutes of the meetings and holds onto the important documents. He is also the treasurer for the club and keeps track of the income of the club, reporting it as necessary.
- Webmaster Matthew Chestnut - Matt is in charge of the website which he updates in a timely manner.
- Reporter Jordon Gonzales - Jordon is in charge of relaying information to the public. He writes our newsletter and distributes it to our sponsors, members, and mentors. He is also responsible for the poster placement around our school campuses.

Teachers

The club's sponsoring teachers were responsible for scheduling meeting times and locations, providing access to necessary equipment, and interfacing with school officials to obtain authorization, ample funding and equipment to accomplish the club's tasks. This year there were three teacher/sponsors working in the program, Mr. and Mrs. Bollinger and Mr. William Davis. Many other teachers provide support by attending some of the club meetings, providing ideas and access to their rooms and/or equipment for the club use.

Mentors

Professional knowledge and expertise is brought into the arena via the mentors who are primarily responsible for guiding the students in all of their endeavors throughout the competition. The mentors are responsible for constructing a mock playing field from the diagrams provided in the game packet, which we have set up on a stage. Mr. Weber and Mr. Pomerening are both engineers and their advice helped majorly. They also helped out in transportation, supervision, and Mr. Weber let us use his workshop in the construction of our field and robot (brave man). Mrs. Reynolds and Mrs. Weber provide the driving force for all the spirit related activities.

Parents

Without the parents the club would not be a success. They provide support and allow there students to participate in an activity that is both time consuming and demanding from a education and emotional level. Support includes but is not limited to Taxi service, moral support, food to fuel the body and mind, and financial support as necessary.

1.2 Medina Valley ISD

Medina Valley Independent School District's motto is to challenge its students with an educational environment designed to inspire excellence, promote creative thought, achieve maximum potential, and instill responsible behavior and attitudes. As the years that we've been involved with SA BEST pass, the school district has become increasingly supportive of the club.

Medina Valley Independent School District encompasses 296 square miles; 286 in Medina County and 10 in Bexar County and provides the educational facilities and resources to meet the needs of approximately 2,900 students on six campuses. It is currently classified as a 4A UIL district. The district was formed in 1959 by the consolidation of the schools in Castroville and LaCoste. Approximately 60 percent of the district's enrollment stems from residences outside of LaCoste and Castroville.

Medina Valley High School is a school of about 980 students and is growing at a fairly stable rate. Student population ranges from wealthy ranching families to less-advantaged minorities, in about a 50-50 mix. Medina Valley Robotics Club has had to compete with football, the national sport of Texas, band, and ROTC activities that have often conflicted with the time demands placed upon us by the SA BEST schedule. This has proved a challenge, but we've so far been able to balance these activities with our own.

This year there are three teacher/sponsors working in the program:

- Mr. David Bollinger
- Mrs. Susie Bollinger
- Mr. William Davis.

Each has had their turn in providing work and meeting space, as well as arranging transportation and other district related tasks. Many other teachers supported us by attending some of the club meetings, providing ideas and access to their rooms and/or equipment for the club use. As part of their support the teachers allowed the club use of the reproduction facilities to provide copies of the documentation developed by the club.

Facilities were provided by the school district included places to meet, Mr. Bollinger's and Mr. Davis's class room. Hallways were used a test facilities for a variety of experiments including the determination of robot speed as a function of wheel diameter and driver capabilities. The school district also provided space for the club to set up a practice field and keep it intact. This is no small task because of the shortage of space in most schools. The stage in the secondary cafeteria was wrested from a book storage facility for use in setting up the stage. Because of the design of the field for this year's game it was necessary to have a permanent site. For this years program the majority of the actual robot construction was performed at the workshop of one of the mentors rather than in the school shops.

One aspect of the schools district's participation is providing transportation for the students to activities. During this year's competition as school bus was provided for both Kick-off and Game Day activities.

There is money in the school districts budget for the Medina Valley Robotics Club. Typically the club relies on funds raised by the club directly from sponsors and other fund raising activities to get is through the SA BEST competition. This includes construction of the necessary portions of the playing field, purchase of spirit items, and other miscellaneous items. If we are successful and advance onto the competition at Texas A&M we then rely on the schools funds to meet the expenses of this activity. School funds are also used to purchase items for the long-term growth of the club such as a controller and associated hardware.

1.3 Castroville Texas and Local Sponsors

Medina Valley High School is located in the historic town of Castroville, TX. Castroville, the "Little Alsace" of Texas, is located on the Medina River and U.S. Highway 90 twenty-five miles west of San Antonio in eastern Medina County. The town was named for its founder, Henri Castro. In 1844 Castro set out from San Antonio with his colonists, mostly Catholic Alsatian farmers, to decide upon a site for settlement. The company chose a level, park-like area near a sharp bend of the Medina River covered with pecan trees. Castro patterned his town after European villages with small town lots surrounded by individual farming plots. By 1856 Castroville supported three large stores, a brewery, and a water-powered gristmill. The community raised corn, cattle, horses, hogs, and poultry, and sold produce to the military posts in the area.

It is an area rich in German, French, and Spanish heritage with many structures dating from the 1850's. Many of the structures erected in Castroville's earliest days continue to house people and businesses 150 years later. Castroville has been recognized as a national and a Texas historic district. Many of the ninety-seven Historical American buildings in Castroville can be seen on a walking tour; they include the Landmark Inn State Historic Site, the St. Louis Catholic and the Zion Lutheran churches, the Moye Formation Center, the Tarde Hotel, and Henri Castro's original homestead.

Both Castroville and LaCoste, the major towns, offer the advantage of a small rural community with the convenience of major shopping centers only a short drive away. The economy of Medina County is centered on farming and ranching operations. The area is experiencing increased growth due to its proximity to San Antonio. Numerous subdivisions have recently emerged as a result of this growth. The citizens of Medina County play a very active role in the community and promote educational initiatives, civic betterment, and economic development.

The sponsors are either businesses or individuals who show their support for Medina Valley robotics through donations. Most businesses provide simple monetary donations, but others contribute with newspaper interviews, website hosting, etc. In return for their support, we advertise these businesses on the website, robot, and other ways. In addition they are provided with copies of the Medina Valley Robotics Newsletter to keep them informed of the activities of the club. Some of our regular sponsors are Holt Truck Division, True Value Hardware, and the United Methodist Women's Group in Castroville. Every year we have new sponsors, mostly small businesses, but some larger companies. At the end of this year's game the club will provide them with a letter identifying the accomplishments of the club and thank them for their support. Additional details of this year's sponsors can be found in Appendix F.

Our Webmaster has been the focal point with the club for sponsor activities. He coordinates the "sponsor runs", where he tries to get as many sponsors as possible as he can in a given region. He is also responsible for inclusion of their names on the web page.

1.4 SA BEST and BEST Robotics Inc.

Without the support of the many volunteers within SA BEST on a local level and BEST Robotics Inc. on a regional level this program would not exist. The mentors and volunteers who helped out with everything were a large aid to BEST and Medina Valley Robotics. Not much could have been done without them.

Interaction with SA BEST occurred during kickoff, demo day and game day activities. During kickoff they provided us with the introduction to the game and the kit materials from which to construct the robot. Information of the differences between the requirements of the local hub and the regional game were provided. During the course of the program contact was through their website www.sabest.org that provided updates on schedules and links to other information. Team information was tracked on this site. During demo day we got a chance to view some of the ideas that other teams had come up with to accomplish the task. Game day activities are the culmination of all the efforts of all the teams and the volunteers that make sure it comes off. Median Valley Robotics would like to thank SA BEST for the effort that it puts into this program.

The BEST game this year, Warp X, is one of the most challenging games ever created even for some of the veteran players. Medina Valley Robotics had to come up with a robot that is capable of handling six different scoring options in addition to being able to quickly move about the field Questions that we had about the field during the design process were quickly and well answered by the QA pages, provided by BEST Robotics Inc. On this page we could view previously asked questions of the field and rules. Of course rules are important on any of the BEST games and knowing them just as important. So this page has provided us with knowledge that we needed to design a rule compliant robot.

Everything provided by BEST Robotics Inc. was excellent. The actual game itself provides us with knowledge needed to succeed in life. The QA page helps us learn the rules and with this we will hopefully have an effective robot capable of accomplishing all our assigned tasks.

1.5 Communications and Meetings

Here at Medina Valley Robotics, it is essential to have communication among club members, the school community, and members of the community. The communications among the members is important to insure that the lessons learned from one meeting are transferred to all parties to be integrated into subsequent activities and to insure that they get where they want to be, especially with the short time fuse of this program. The members had to be able to talk to each other efficiently so data from tests could be related to designs and prototypes. In addition to transfer of information, communications was necessary in the recruitment process. Members of the previous years along with the teachers and mentors talked up Medina Valley Robotics and the BEST program to try and recruit people. The school announcements were another method to recruit new members. Because of its importance this responsibility was one of the major tasks of the Vice President of Medina Valley Robotics.

Communications between Student Members

One of the major methods of communication between the members during the school day was word of mouth. Either the officers or teachers generated a message that was transferred between members in an ever-growing circle. Because of the variety of grade levels it was not always possible to insure that all the members received these messages. To ensure a more global distribution school announcements informing the entire school about the schedule for the weekly meetings were given over the PA system. These messages had to be planned ahead of time because the required approval by the school administration. This is not always a foolproof method because of the noise levels in some of the classrooms.

After school hours phone calls were an important form of communications between the members. A list of the club member's name, phone number, and E-mail address was generated early on in the program and provided for everyone's use.

The vast majority of communications occurred during the club meetings that were regularly held three times a week. These were very effective means of communications because the majority of interested parties were present and the feedback was instantaneous. The President of Medina Valley Robotics was responsible to insure that the meetings were run in an efficient manner and all the work required got done in a timely manner.

Communication between Teachers and Mentors

Because of the differences in location communication between the teachers and mentors was primarily via E-Mail. This allowed for quick transfer of information as well as files. This was supplemented by phone calls and discussions at the club meetings.

Communications with School and Community

As identified above the club used school announcements as a form of communications. One of the objectives of these was to informing the entire school about the schedule for the weekly meetings and to recruit new members. Information about the activities of the club and planned requirements for facilities and equipment were transferred to the school administration through the teacher sponsors. Information was also included in the school calendar that was published by the cheerleading squad.

The Medina Valley Robotics Newsletter was our main form of communication with the community as a whole. The newsletter was a new idea presented by one of our members, who went on to develop the format and publish then during the program. In the newsletter, readers were informed about activities of the club, status of the robot, website status, information about the next meetings, and mentors words of wisdom. Samples of the newsletter are given in Appendix D.

All these forms of communications, but did any of them turn out successful? Yes, all of these methods of communications were quite successful to help us recruit people, sponsors as well as to transfer information. These skills helped us get the job done, from the robot to the notebook. We not only helped the club in these areas, but we were also able to promote the Medina Valley Robotics itself along with the BEST organization.

Club Meetings

The club meetings were the primary method for transfer of information and the decision making process. The President, who first established an agenda, ran the meetings. Decisions were made based on input from all the members and action items identified. In addition to a discussion of business concerns most of the meetings also included working sessions to address design and fabrication of the robot and other club related activities. Agendas from past meeting were looked over to find out what may have been missed, or what has not been finished. Other items were also brought up that the club members might need to be reminded of. The following agenda items were included in the meetings:

- General Discussion – Talk about upcoming/important items such as demos, spirit items, t-shirt design, buttons designs, team names, and mottos.
- Getting Started – Talk about what needs to be done and how to get them started.
- Action Items – Includes working on robot, working on notebook, building a field, gathering supplies, practice driving, and generally anything with an action verb in it.

Some examples of the minutes from the meetings are given below.

Medina Valley Robotics Meeting 5/23/02

Discussion of having a Summer Schedule, or not having one

Alternative given includes researching a hovercraft or a general discussion of engineering basics. Presentations on engineering principles were chosen.

Summer Meeting Dates: Weekday afternoons Wed. 6-7:30/8:00 o'clock every week. Starting on June 12. The location for first summer meeting will be at Sammy's.

Medina Valley Robotics Meeting 6/12/02

Brainstormed on communication for next year. The primary outcome was the need for a phone list and the idea of a Newsletter.

Next meeting was to be held on June 20th at the regional park.

Medina Valley Robotics Meeting 6/20/02

Mr. Weber presented a demonstration on levers. He had fabricated a lever mechanism with a spring scale. The relationship between force and the distance from the pivot point was discussed.

The next meeting will be held at Medina Valley Methodist Church.

Medina Valley Robotics Meeting 8/8/02

The technical discussion was on gears based on information provided by Mr. Pomerening that he extracted from a website.

Gears – Wheels with teeth that have several uses include transfer of power from one shaft to another.

Driver – Main powered gear, i.e. the one attached to motor.

Follower – Second gear moved only by other gear.

Idler – A third gear between the driver and follower to keep rotation the same direction.

Crown Gears – Designed for changing axes.

Ratio – The comparison of the "size" of two gears in terms of the number of teeth or diameter. Can be used to convert speed to power and vice-versa.

Example: If the Ratio is 5:1, for 1 rotation of the 5 gear the 1 gear makes 5 rotations.

Example: Gear A (driver) is 10, Gear B (idler) is 5, Gear C (follower) is 50

Ratio A:B=10:5 or 2:1

Ratio B:C=5:50 or 1:10

Thus Ratio A:C=2:10 or 1:5 or 10:50 with rotation in same direction.

Pulley – A circular device that is grooved on the outside edge to accommodate a "Belt" to drive another pulley.

2 Robot Design and Development

One of the major goals of this competition is to teach the principals of the engineering/scientific process. In laymen's terms the process includes the following steps: (1) Plan, (2) Do, (3) Check, and (4) Act.

Analyzing the Game and Brainstorming- To solve any problem, one must first analyze all the known information, such as the game rules, robot constraints, and playing field layout. The club studied the game rules, the game floor design, and robot constraints to determine the best strategies for development of the robot. Consideration of how points are scored, the maximum number of points obtainable (if all can be made), what other teams may or may not be trying to do, surface textures of game floors and obstacles, and special interests were analyzed. After analyzing the requirements, we came up with several ideas and suggestions (brainstorming) on how we could solve the problem. After analyzing the requirements, the club broke up into two smaller working groups to brainstorm ideas on robot scoring mechanisms and mobility (wheel) design. These sessions were held during a meeting at Southwest Research Institute immediately following the Kick-off. They were further developed during the first week of the competition and were written down without regard to kit materials. After all ideas have been gathered and documented, they were scrutinized for validity, complexity, compatibility (between designs), and effectiveness to solve the problem.

Prototyping Designs - The ideas were further developed and cardboard mock-ups created to test whether or not the ideas were viable. We eliminated many ideas, modified some and improved others during this testing and re-designing stage of the prototypes until we settled on a final viable solution for "The Collector". Prototypes were initially sketches on paper that were quickly used to create cardboard models to demonstrate proportions and mechanics of the designs. In some cases the designs evolved to actual kit materials, such as the PVC pipe for the arm, directly without the intermediate step of a cardboard model. After evaluating the sketches and cardboard designs, the most viable solutions were constructed of plywood so that the design could be tested.

Testing Designs - Walkthrough testing was performed so that only the most viable solutions were modeled. The cardboard and plywood prototypes were tested on a mock-up of the playing field. The final implemented design was tested on the game playing field at Demo

Day as well as on our own playing field. The following factors were considered during these tests:

- Soundness of the design (Was the design be sturdy?)
- Effectiveness of the design (How well does it accomplish the goal?)
- Speed of the design (How fast/slow was the platform? How fast/slow are the mechanisms?)
- Complexity of the design (Can the design be implemented with the parts provided?)

Final Design and Fabrication – Based on the results of the prototype testing a final design was arrived at and the fabrication process completed. We further modified some designs and improved others until a final viable solution for "The Collector" emerged. Construction of the final product was not the end of the process. It was necessary to go through the steps of the engineering process multiple times based on results of performance testing and resulting design modifications. The process will be repeated until game day arrives.

All work groups documented their daily activities to include accomplishments, action items to be done for the next meeting, and lessons learned. These daily notes were provided to the Archivist for formal documentation into the club records and finally into this notebook.

2.1 Game Requirements

At kickoff, the teams were presented with a detailed game task description. The following information was extracted from the official rules of the game.

This year's game incorporates the items of many previous games because of the micro black hole that opened up inside of the BEST archives, sending 10 years worth of game pieces back in time. Details of the previous games are provided in Appendix B along with a summary of Medina Valley Robotics participation in these games. The teams mission was to build a robot capable of crossing through the micro black hole and over the threshold of time to retrieve the lost game pieces including bumble balls, dynamite sticks, alien pods, rings, and noodles and shut off the electrical breakers.

The outside boundary of the playing field is defined by two 12' by 24' sections with a 2-foot neutral zone spanned by the black hole. A circular black hole (platform is 16.75" high disk, 6' in diameter and rotates clockwise at approximately 5 rpm) separates the two sides of the field. Two ramps provide access to the black hole on the driver side of the field and a ramp 5' wide provides access to the spotter side of the field.

Game pieces on the spotter side of the field, include dynamite sticks, aliens pods, rings, paddle switches and bumble balls. Wormholes at the openings of each of the front two rows of tubes of the MTCVs can be used to transport the smaller game pieces (alien pods and dynamite) back to the present. The larger game pieces (rings and bumble balls) must be brought back through the black hole by a robot. The candles, for ring scoring, and bumble-ball grid are on the starting-side of the field. Noodles must be removed from the back rows of the MTCVs. Once removed, they should find their own way back to the present time. The difficulty is because of the wide variety of shapes and sizes of the game pieces. This does not include the three other fantastic teams that BEST has paired us up with that are also trying to earn points with BEST.

The table below shows the scoring opportunities for each team:

Scoring Opportunity	**Per Item Points**	**Total Points**
Flipping Paddle	10 pts	10 pts
Noodle Extraction	10 pts	50 pts
Dynamite Insertion	10 pts	70 pts
Alien Pods Insertion	10 pts	
Rings 1st Level (bottom) 2nd Level (middle) 3rd Level (top)	20 pts 30 pts 40 pts	90 pts
Bumble Ball	50 pts	50 pts

To accomplish all the objectives in the three minute time interval seems unlikely. Therefore each team will select the method that if feels most likely to allow it to win the competition. An ingenious and difficult game, we can hardly wait to get started on retrieving the game pieces against the teams from the rest of the universe.

2.2 Supplies

Each team receives an identical box of consumable parts, fasteners, and constructions materials, returnable parts that may be used without modification, and team supplied parts that can be used as seen fit. A radio controller, four motors, associated electronics, and wiring is provided to provide power to drive the robot and operate any mechanisms necessary. What the team decides to use out of this defines the product. In the real world, a new product must be built within a budget. In the game world, the machine can be built only with kit parts.

The consumable products including the printer are the parts that control the shape and function of the robot. Typically a team will use less than 10% of the products supplied. It is possible to mold the vast majority of the consumable product into any shape required. Glue, brackets, and any sort of nuts, bolts, and washers are important because of the support and stability that they provide for holding our robot firmly together. Wood is a good building material because it can be processed with a minimum set of tools and skills. We built the Robot's skeletal structure from it. PVC is another good building material because it is lightweight, bendable, and strong and can be used for many things on the robot such as the arm and skids. The thin sheets can be bent into the appropriate shapes using care. Medina Valley Robotics often uses it for motor mounts since it can be formed into a solid support structure. Fabrication of parts from the thicker metal stock is more difficult and we typically supply a machinist with the part and drawings necessary to fabricate the necessary parts. The hubs for the drive wheels are made from this material.

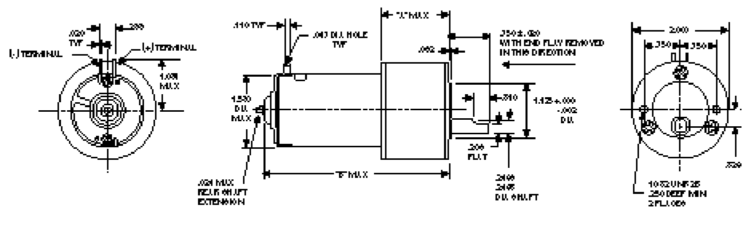
The following table is a shortened list of the consumables provided and how Medina Valley Robotics used them in the construction of "The Collector".

Description	How was this part used on "The Collector"
¼", 3/8", and ½" plywood	Body and wheels
¼" hardwood dowel	*
½", ¾", and 1" Schedule 40 PVC pipe	Skids, arm and arm support components
½", ¾", and 1" PVC 90 degree elbows (slip)	*
1"X4" #2 whitewood	Body motor/axle support
½", ¾", and 1" PVC Tee (slip)	Arm bearing
4"PVC pipe	*
Regular PVC cement	*
Corner angle brackets w/screws	*
Hinges	*
Hose clamp	*
¾" metal pipe hangar tape, 24 gauge	Battery holder, misc. support
Extension spring for heavy doors	*
18 gauge, 2 conductor, unshielded cable	Motor and switch wiring
Snap-Plug Terminals, insulated, male	Motor extension wiring
Vinyl electric tape, ¾"	Wire insulation
11" natural cable tie	Speed controller support hangers
¾" nylon sticky back Velcro (hook and loop)	*
all purpose duct tape, 2"	Lots of places too numerous to state
Neon Twine (#18 twisted Nylon Seine Twine)	*
Loctite	Set screws on wheel hubs and gear drive pulley for arm
carpenter's wood glue	Body assembly
5 minute epoxy	*
Aluminum grid for 5 gallon bucket	Bumble ball trap ramp
¼"-20 and 3/8"-16 threaded rod	*
¼"-20 and 3/8"-16 hex nuts	*
#4-40, #8-32, #10-32 machine screw	General construction and attachment
#4-40, #8-32, #10-32 machine screw nuts	General construction and attachment
#8 X 1 sheet metal screws	General fastening in construction
#4 and #6 wood screws	Body, electronics components, etc
#8, #10, ¼", and 3/8" washer	General construction
Wood screw thread eyebolts	*
Mini Snap Acting Switches, 10 amps	Arm control motor w/servo actuation
Piano wire	Ring stops and arm guide
¼" polyproplene sheet	*
1/8" polycarbonate sheet	Receiver attachment base
0.5" Thick Aluminum Bar Stock	Wheel hubs

0.063” Aluminum sheet	Motor support/mounts
bicycle inner tube (26”X 1.5”-2.0”)	Wheel treads and arm nose
60x65” Universal Brake cable w/housing	Bumble Ball actuator
Printer	Arm gear attachment to arm
Large and Small cogs	Arm position control
Cogged belt (Loop)	Arm position control
Other Parts?	To fix whatever breaks

* Indicates a part not used (yet)

Without the returnable parts it would not be possible to produce a functional robot. The controller and motors allow for the drives to control the robot so that it can perform its intended function. This year’s robot uses the two large motors for the drive wheels. The speed controllers allow for proportional control, ie high speed as well as fine control for small positioning motions. A single smaller motor is used for ring scoring arm. When integrated with the centering mechanism for the candle this mechanism allows for relatively easy capture and scoring of the rings. There are plans to integrate the second smaller motor into the robot to allow for capture of the bumble balls, if time permits. It would be interesting to try and develop and autonomous robot but that is beyond the capabilities of most teams in terms of hardware, software, and technical expertise. To make a long story short the returnable parts, IT MAKES THE ROBOT WORK!



ROTATION (SEE CHART, OPPOSITE PAGE) VIEWED FROM SHAFT END WITH POSITIVE VOLTAGE ON (+) TERMINAL. REVERSE POLARITY FOR OPPOSITE ROTATION

Because Medina Valley Robotics has been involved in the program so long is has collected a supply of pieces and parts from previous games kits. These are used in the fabrication of the prototypes and development of secondary robots. It is important to control the production of the final product to insure that only this year’s kit material is used. Both the students and mentors carefully control distribution of parts to the groups building various components. Care is also taken to insure that returnable parts are used and mounted in a manner that insures that they will not be damaged.

One a part is constructed it is also necessary to control it to insure that it remains functional and can be integrated into the final robot. All team members are instructed on the proper handling of materials to insure that their integrity is maintained.

In terms of safety, tools are used by the students only under supervision of mentors what are knowledgeable in their use. This includes both hand tools and power tools. In some cases the mentors operate the tools to produce items required by the students. For example the students will draw cut lines on the plywood and the mentor will use a radial arm saw to cut the parts out. It is the hope that during the course of the program the students will obtain enough experience to safely operate the majority of tools required.

2.3 Planning

Last year after the competition was over the activities of the club continued. We had numerous activities including recruitment, engineering lessons, demos, election of officers, and writing a constitution.

Our recruiting session was not over until BEST started up for 2002. To recruit we employed a wide range of techniques to interest people in Medina Valley Robotics and to promote the BEST concept. Several of our techniques were posters, PA announcements, demos, hand-held signs, and walking around shouting out phrases about what Medina Valley Robotics is and how cool it is. Before the school year started this year team members set up a display at freshman orientation “Fish Camp” to attract new members. After the school year started we began to meet and continue recruiting new members and sponsors. After kickoff we had announcements letting team members and potential team members know about the time and location of meetings.

We also held elections for officers to replace the seniors who held positions and were graduating. These elections were vital because they determine who is in charge of club operations, keeping the robot stored and safe, public relations, recruitment, and more. At the same time we voted on our constitution, which provides the framework for the operation of the club.

Over the summer and at the start of the school year we had engineering lessons that covered the basic and partially advances aspects of engineering such as torque, motors, batteries, remote controls, servos, and more. At these meetings we also thought up several game problems and how to overcome them, such as climbing, swimming, and flying (yes, flying). These were fun experiences and good ways to practice for the upcoming games. This also helped to retain members because the activities constantly challenged and engage their mental skills.

One of the experiments run was a time and motion study to identify the influence of different size wheels on the speed of the robot. The chassis for the robot for Pandemonium in the Smithsonian was simplified and a variety of wheel sizes collected from pervious years. The robot was run down the hallway over a defined distance and the time for a trip was recorded. The tests were run with wooden wheels on tile and carpet and wheels with rubber treads. For the test run three different wheel diameters were used, see the following table. These test were conducted over several meetings. Each test configuration consisted of multiple drivers with multiple runs. The data was an average of the results from these multiple runs. This was an attempt to eliminate variability do to driver skill and timing.

Wheel Circumference (inches)	Distance Traveled (inches)	Time (seconds)	Revolution per Minute	Comments
18.8	126	12	33.5	Rubber wheels on tile.
28.8	126	6	41.2	Wooden wheels on carpet.
32.6	126	5.7	40.7	Wooden wheels on carpet.

It should be noted that for this experiment the distance traveled was set. The time for the largest diameter wheels was very short and it is possible that it was not measured accurately.

The big question that arose for this testing was why the revolutions for the smallest diameter wheel were lower than those for the other wheels. Based on a 7.2 volts battery in comparison to the 12 volt operational parameters identified for the motor the speed should consistently be around 40 rpm. The only logical explanation provided was that because of the rubber on the wheels the amount of torque transmitted to the ground was greater and the torque limited the speed of revolution. The suggestion was also forwarded to do an additional experiment with a wheel, motor, and string. This would likely get rid of the torque questions. Follow-up on this experiment was never completed. Note that the tests with the wooden wheels were done on a carpeted surface because of slippage noted when power was initially supplied to the wheels. Another lesson learned was that for the larger diameter wheels the time was influenced by the reaction time of the driver.

This meeting concluded with a short discussion of the Scientific/Engineering Method that includes:

- Hypothesis (Plan)
- Gather data (Do)
- Experiment (Check)
- Conclude (Act)

In the meeting just prior to kickoff the following items were discussed.

- Responsibilities @ K.O. Day
- In dress Code
- Must follow all school rules
- Stay in designated areas
- Check field and notice details
- Bring pen/ pencil and notepad
- Everyone must have notes
- Attend Meeting @ SWRI until 5:00-6:00 pm
- Be @ School by 10:45 for transportation to St. Mary's University

In the kickoff at St. Mary University we learned what the game was, what the field was like, what objects can be used to score, and how to score. Seeing the field and a functional robot proved to be useful. The ideas began to flow during discussions at St. Mary's University. In a meeting at Southwest Research Institute immediately following the kickoff we continued to develop the ideas. We split up into two groups. In the group discussions more ideas were generated that could written down. Everything was throwing g onto the table, wheel design, chassis configurations, arm designs, etc. With the robot design, we were concentrating on scoring the most points in least amount of time and how to outmaneuver the other robots. Things that initially seemed totally useless sometimes turned out to be the better design. We then started to draw the ideas for some designs and discussing the pros and cons of the design. We never eliminated an idea until the later stages. Kickoff was a fun and new experience for the entire club.

2.4 Team Strategy

Because of the wide variety of scoring options, it is necessary to develop different strategies for scoring using a variety of procedures. This included both offensive and defensive strategies. While analyzing the game, the club discussed the time required to accomplish various tasks and what score would be required to advance. The club must adapt to the capabilities of all the robots on the field and the abilities of the drivers. Careful notes taken during the preliminary rounds will allow for changes to the strategies during the afternoon session.

We have identified five scoring possibilities: (1) Bumble Ball retrieval and placement, (2) shut-off the Electrical Breakers, (3) Noodle Extraction, (4) Dynamite and Alien Pod capture and insertion, and (5) Ring retrieval and placement. We then decided on which mechanism would be most profitable. Two groups were born from two different viewpoints.

- Jenovah: The group's strategy was to go over the ramp through the black hole, hit the electrical breaker, grab three rings, capture a bumble ball on the way back through the black hole, score the rings on the candle, block off other teams from coming down the ramp, prevent other teams from scoring their rings and bumble balls.
- Warp: The strategy for this group was to do as many things as possible in the time limit. The focus was the bumble balls and using a arm to do anything else, in essence, to widen our options in case we are not able to do a certain task (i.e. the rings are blocked or someone has take all the alien pods and dynamite.)

In order to make it even, the senior club members came up with the opposing team, the EDT (Evil Dream Team). This is what they are and what we need to watch out for.

- Thief – The robot that steals your rings, bumble ball, and anything it can get its little manipulator on.
- Mimic – The robot that uses the exact same strategy as you but is faster.
- Omni – God of the robots. This robot can do anything and everything and is extremely good at it.

This was implemented by use of a previous year robot chassis and motors and controllers owned by the club. In addition specific items were removed from the field of play to eliminate the possibility of acquiring them. Other obstacles were thrown in the path of the robot. With these in mind and the fear of God in our hearts, we started to devise ways to combat them by using multiple strategies.

2.5 Prototype and Preliminary Design Review

The design of the robot was a long and drawn out decision process. After designs and support documentations were discussed with the whole group construction of the prototypes began. Certain ideas were eliminated from the robot because it was not physically possible to construct the parts within the constraints of the game. Modifications necessary to make to robot perform at its peak efficiency were made as necessary. For example the initial wooden bumble ball collector was too small to consistently capture the bumble ball and allow for the insertion of energy absorbing materials. The box was rebuilt and testing continued.

Construction of actual parts for the robot was from supplied kit materials. Where necessary, where multiple designs were developed, the kit materials were supplemented with replacements materials with identical properties. Each of the elements was tested as a unit before it was integrated into the final product. For example the ring score mechanism was fabricated. Testing was performed using a cardboard box for the body of the robot. The mechanism was manually positioned and the arm operated using a battery with controls. This is where all the tweaking and messing around took place.

Our plan was to score using the rings and the bumble balls using the most efficient way. This is because we tried to think of all the combinations of scoring to see which one is the fastest, efficient and gives you the most points. We also decided to abandon all other ways of scoring because of the need for extreme precise driving and the fact that not as many points would be awarded. It is likely that other teams will choose a similar path so we need to be better.

2.5.1 Platform

With the platform of the robot, a balance in size between large for stability and small for agility. The larger the robot in wheelbase the more stable it is going over the threshold of time. The height of the center of gravity had to be considered, higher means higher probability of tipping over. This was proven out is some trials on the game field. The smaller the wheel base the easier it is to maneuver the robot around obstacles. This was especially important for capture and scoring of the rings as well movement on the black hole. The location of the center of gravity also dictated the direction that the robot had to go up and down the ramps. It was determined during testing that the wells had to follow the robot up the ramp such that the majority of the weight was on the wheels. This allowed for sufficient traction to allow the robot to climb the ramp. If the wheel go up first they have a tendency to slip, even on the rough surface, because of the lack of downward force. This is because the amount of friction is directly proportional to the weight on the wheels.

The platform was built from plywood supplied in the kit. Plywood has good strength to weight ratio and is easily modified. It was also possible to easily make attachments to the plywood base. The overall size of the platform was driven by the requirements of the bumble ball collection system. The box structure was connected together with glue and screws. The wheel motors were attached to a short section of 1" x 4" wood and then this assembly was attached to the platform body. This allowed for quick adjustment of the overall height of the robot above the surface of the playing field. The overall design of the platform was very stable and allowed for easy adaptation to all the components mounted on it.

The final weight of the robot was less than 16 pounds, including the weight of the battery and all electronics.. This was well below the upper limit of 24 pounds and allowed for good use of the limited power supply.

2.5.2 Wheels

The wheels are probably the most crucial part to a robot. Without them, your more than likely not going to move. But it takes a perfect wheel to make a great robot. Our goal for the mobility of the robot was pure speed based on time and motion studies. Some limited consideration of maneuverability was required to position the robot to score the rings. Use of a centering device for the candle eliminated some of the driver ability concerns. In addition the motor controllers are proportional that allow for fine control of motion of the large motors. The Club considered these traits to be an essential part of a successful robot.

When you watch the robot move, you take in a strong consideration of the wheels. You begin to ask many questions such as, "Is the robot fast enough? Does it have enough power? How is the traction? Are the wheels to heavy?" and so on and so on.

Many different wheel designs and sizes were explored for the robot. We discovered that when we have a wheel that is too big, we lost power going up the ramp and in most cases we never make it up. The motor has insufficient torque to drive the robot up the ramp. Then with the smaller wheels, we lost speed but gained more torque. In figuring out what size we wanted the wheels to be: 14", 12", 10", 8", and 6" were considered. The club first calculated the speed based on motor speed and the wheel diameter. Sample wheels were then fabricated and tests run to determine the best option. These tests were run under controlled conditions to determine the overall speed and control. During these tests it was determined that the larger motor turned at a speed of approximately 40 rpm under simulated game conditions. After we tested different wheel sizes we decided to try and stay within the range of 7 to 9 inches in diameter for the best combination of torque and speed. This design has proven successful in the past because bigger wheels go faster than smaller wheels. Previous Medina Valley robots used smaller powered wheels to provide more torque to climb obstacles.

The club explored several different types of wheels; ridged, treaded, and free spinning. We also decided to use rubber lacing for the drive wheels to give the most traction up and down the ramps and along with the carpeted floor. We considered wheel designs used by Medina Valley Robotics in previous competitions as well as some new ideas and voted on treaded wheels with notches to get over the PVS, for precise movements.

In addition to the preliminary test lessons were learned from practice on the game field. If you ask me if the robot is fast enough, I'd tell you that you're crazy. Nothing is ever fast enough no matter how you look at it, and when we finally think something is fast enough, along comes another robot that is faster. Hopefully we will learn on game day what the capabilities of the other robots are to judge or changes. So as I see it, we have a shot with its speed, but remember, there will always be something faster.

The speed is not that bad, but it is not my main concern. My focus is in its traction. When you watch it go up and down the ramp, you can notice it sort of stutter at the point of separation from the ramp to the pinnacle of the field. Now I know its always going to have a little trouble going up the ramp, sometimes a little trouble can go a long way. If the traction is not good enough, we could easily roll down the ramp, or even get stuck. Hopefully we will be able to adjust for this prior to game day.

Next is the power. Who doesn't want more power, huh? I believe it contains good power, but good just is not good enough. To me, adding more power will add a notch of speed, which could, at one point, save us. It could help us get that extra ring to push us over the hump. The problem is how to get more power from a motor with limited capabilities and only a 7.2-volt battery. To me, we pretty much have a good set of wheels. They are big, light weight, and contain okay traction. To me, I feel we would have a better chance of winning though, if we add that extra bit of power.

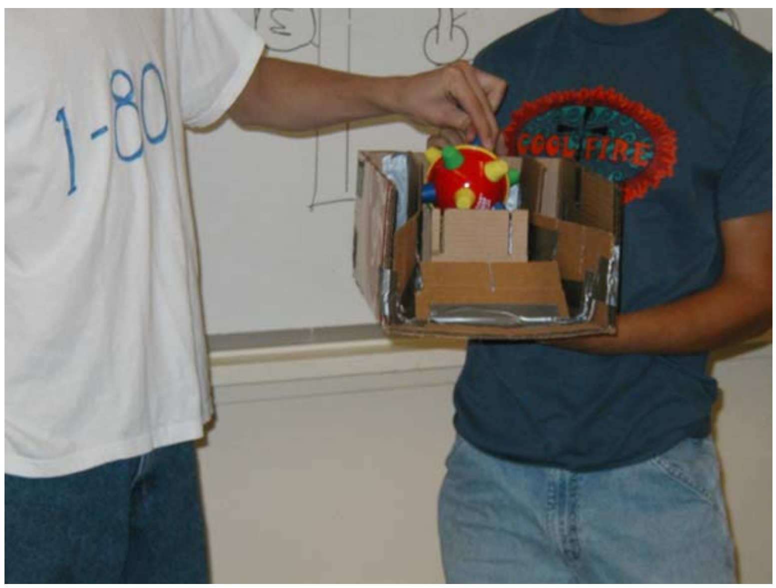
The previous discussion was for the drive wheels. It was determined that the best option for the other supports were skids made out of PVC that was formed to the proper configuration. The skids slide easily of the carpet and will ride up over the PVC pipe as necessary. The skid design was such that it attached to the sidewalls of the bumble ball funnel. The height of the skids can be adjusted to accommodate changes in height of the drive wheels. They can also be adjusted to insure that the robot runs true and one skid does not drag more than another. For the design the skids are effective.

2.5.3 Scoring Mechanisms

Bumble Ball

Our plan was to get the bumble ball in a box on the bottom of the robot using a passive capture system. First we made a cardboard mockup that we attached to the bottom of a chassis. The box was located at the rear of the vehicle in the middle. We then thought about how we were going to get the bumble ball into the box. One of the mentors said something about funneling the ball to the box. This got us started and be made a cardboard mockup of the funnel as well. We were also wondering about how we were going to stop the bumble ball from going back out the front of the robot. So we put one way going spring loaded flaps inside the funnel. Once we finished with the cardboard mockup, one of the club members then built a wooden mockup, without the spring-loaded flaps. We were able to capture an active bumble ball by pushing the wood mockup over the bouncing bumble ball. Several trials convinced us that we would be able to capture a single bumble ball. In the containment box, we put an insulator to help absorb all the bumble balls power.

The passive design of the bumble ball collection system was based on having the bottom of the robot 1 inch above the playing surface. Because of the need for ground clearance going up and down the ramp it was necessary to raise this height to 2 inches. Numerous trials demonstrated that it was not possible to capture the bumble ball in the box with it this high. Trials were run with thin aluminum flaps taped to the skids. This method did not prove successful.

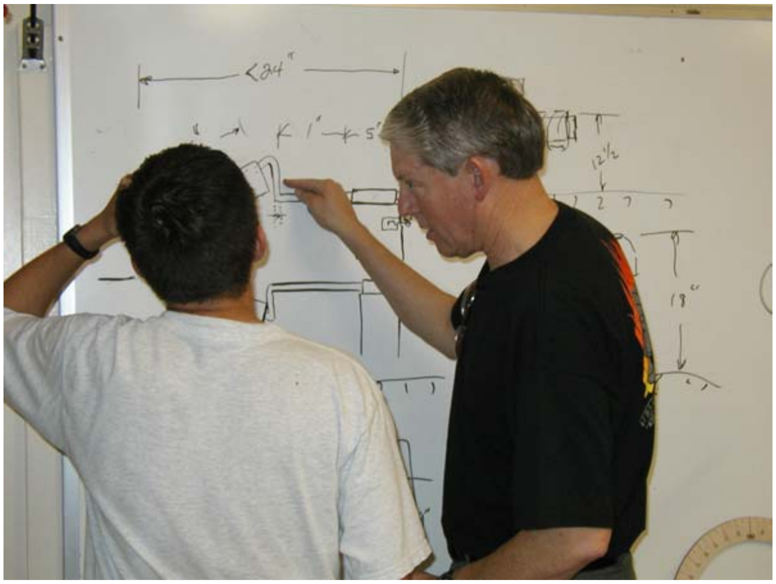


Since there was still one motor available it was decided to motorize the trap. A hinged flap was placed at the lip of the catch box. The front edge of this flap was attached to a lever on the fourth motor using a section of the brake cable (at least that is the idea that has not been implemented yet). In the raised position the flap will clear the ground and allow for easy transition over obstacles. The flap is lowered to capture the bumble ball. When the bumble ball is inside the body of the robot the flap is raised driving the ball into the catch box. We hope that this method is successful, even though is has not been demonstrated to date.

The system is designed to capture a single bumble ball. It should accommodate up to two balls but the added weight may cause difficulties getting up the ramps.

Ring Score

With our strategy, we decided to try and score with the rings. We designed a hook that rotates in circular motions to pick up the rings and when rotated, allowed the rings to slide off the hook and onto the candle. This hook was also designed to hold up to 3 rings at a time to obtain the maximum score.



The original design of the ring capture mechanism was generated by one of the students. After he sketched it out on paper it looked like a very good idea. A prototype was quickly fabricated out of PVC. This was used of preliminary testing to determine the proper angle to both capture and score the rings. The geometry of the various components is critical to allow the mechanism to be low enough to capture the rings and still be high enough to score the rings of the candle.

Tests were also run to determine what angle was necessary for the rings to slide off the arm onto the candle. It was determined, based on the number of rings on the arm that the angle required varied from 13 to 17 degrees. The slippery nature of the PVC pipe helped this out. In addition any motion of the arm or robot body will start the rings to slide. Information on the necessary angle was incorporated into the design.

The final design was then fabricated. The major arm element is PVC pipe that has been formed through heat to the proper shape. The capture end is flattened to allow it to pass easily between the support board and the ID of the rings. A metal hook with tape is placed on the end to aid capture. A larger diameter PVC pipe with bearings motion supports the drive end of the arm. Bearings are used to insure that there is limited motion of the drive end relative to the drive motor. A square metal rod from the printer is used as the primary power transmission part. This is firmly attached to the PVC arm. The larger diameter gear supplied in the returnable kit is the attached to the metal drive rod. The small diameter gear supplied in the returnable kit was attached to the shaft of the small motor. The motor was in turn mounted to the chassis of the robot. The looped belt for the gears was used to transmit power from the motor to the arm. These items were new to the kit and proved extremely useful in the fabrication of the robot.

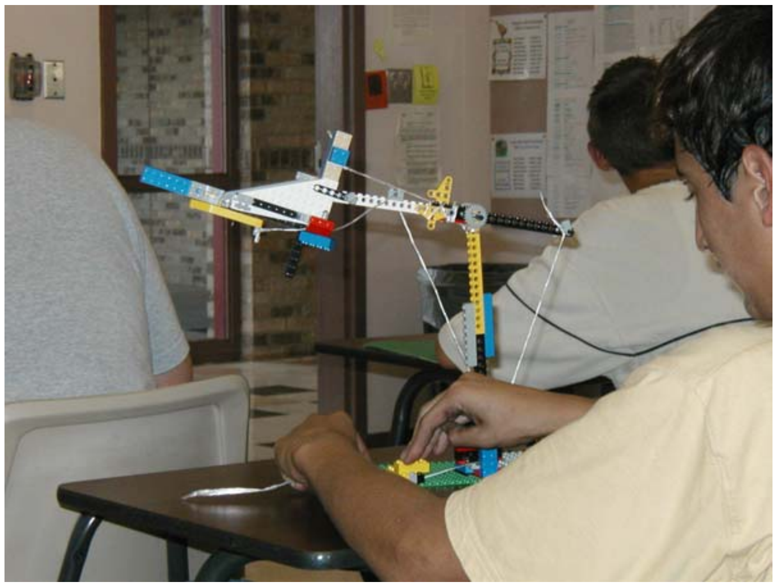
During initial testing several modifications were made to the arm design. The angle of the arm was adjusted to allow the proper range of motion. The location of the arm on the platform was adjusted up and down to be in the correct position. One problem encountered during testing on the game field was interference of the wheels with the rings. As the robot went up the ramp the wheels tended to drive the rings off the arm. Modification of the placement of the wheels was made and the interference was eliminated.

Since this is the primary scoring mechanism for the robot it is hope that it performs as designed and we can win the competition.

Scoop

The scooping arm is meant to pick up alien pods, dynamite sticks, and the noodles. To do this we designed the scooping arm to capture the alien pods and dynamite sticks from the bin and drop them into the MTCV at one time. Hooks were added to the bottom of the scoop to capture the noodles and allow them to be extracted from the MCTV. In order to get the height need for the noodles we have designed a multi-sectional arm that starts in a compact position and folds out.

Our goal was to get all the noodles effectively. To do this, we first calculated the angle we needed of a jointed arm to get the height necessary to pull out the noodles without causing strain on the robot. Our calculations showed us that we needed to reach a height of four feet. Since our arm needed to fit in a 2-foot cube at the start of the match we decided that we had to build an segmented arm. Our design consisted of two pieces of wood connected by a joint. These pieces of wood started out bent but once the match began the arms would be pulled straight by a motor using a string and pulley mechanism. Once straight the arm would lock in this position via a hook that captures a dowel on the opposing piece of wood. Integrating the parts into a working mechanism proved difficult and time consuming. We have still not reached a product that could be used on the robot.



Now that the arm is able to reach the height we needed the actual 'grabber" which would pick up the noodles. We figured claws would be the simplest and most effective way to extract the noodles. Since the bucket was wide enough and at the end of the arm we decided that this is where our hooks would go. We would have five hooks for all five noodles. The hooks were basically scissors with one blade being stationary. The hooks had one segment that moved because it had a string tied to it. The other end of the string was tied to a set point on the robot. As the arm moved up the string would pull the movable segment off the bucket until it eventually met the stationary segment. These two pieces would enclose the noodle and would hold onto it while the arm moves up, thus removing the noodle. To drop the noodles all we would need to do is lower the arm and springs would reset the claws.

The initial design also considered using the hooks to capture the rings using a spear motion through the opening between the rings and the wood. After this, we could raise the arm then lower it once we reach our candle we were then lower the arm causing the ring to slip off the hook and onto the candle.

In theory this is an elegant design because it can perform all the tasks. The difficulty was developing a design that was within the capabilities of the motors to drive and was stable on the robot platform. Because of the complexity this design is still in the prototype stage and will not likely be used on the game day robot.

Breaker Switching

We did decide to use our robot itself to run into the switch mechanism to score the ten points and the tiebreaker if needed. This was an afterthought and still needs to be demonstrated in practice.

2.5.4 Testing

"The Collector" has gone through a series of test to demonstrate its ability to perform the tasks. Initial tests were performed with the prototype parts, either in the cardboard state or fabricated out of scrap materials. Lessons learned were then integrated into the subsequent design phases. Subsequent test were performed with the final design as individual parts and integrated onto the robot. The following identifies some of the lessons learned form the first rail run of "The Collector" on the game field. In additions to lessons learned the students identified changes that could be made to the robot. Some of the changes were implemented because they were vital to the performance of the robot. Other changes were made because they were easy. Some of the changes were not made because of the time involved to implement them. We needed to make sure that the changes that were made did not require retaining of the drivers. Since game day is sill a week away I am sure that additional testing will be performed and modifications made to the robot.

Summary of lessons learned from 1st trial on game field.

- Wheel motor controls are proportional and you do not have to hit the stops. Small movement can result in precise control.
- The robot was sluggish and jerky.
- There is a tendency for the robot to tip over going up and down the ramp.
- Might need fenders to prevent wheels from getting caught on ramp edges.
- The arm was inaccurate.
- It takes too long to capture the rings and will not allow us to score them.
- Problems with getting three rings back up the ramp because of interference with drive wheels.
- The bumble ball capture failed miserably.
- Drivers will require a lot of practice to become proficient.

Proposed Modification to Robot

- Make the overall platform smaller for easier navigation and turning. (Complete redesign/build, test, and debug. Two weeks to implement)

- Put the larger wheels on for testing. (Easy to implement. One day to change, test/observe. May have been done on Wednesday, 10/16)
- Adjust the cg to increase stability. (Easy fix, move motors. One day to implement)
- Move the wheels back (motors on other side of wood) to decrease possibility of tipover. (Same as item above)
- Put more weight on skid side to move CG for better stability. (See items above)
- Put more of a point of arm to allow easier ring capture. (Try first on test piece of PVC to verify steps to achieve desired shape. Implementation, if shaping possible, should be one day)
- Adjust the angle of the arm more to capture the rings better and allow them to slide off easier. (Angle of arm is physically determined based on differential between ring and candle heights. Slope is minimum to allow rings to slide. Adjustment to angle changes geometry that drives the differential needed. Redesign may address problem. Design, prototyping/build, and test estimated two to three days.)
- Move the rod in the arm back some to allow for more room for the rings. (Need more information. If this is a clearance problem, a slight wheel move may correct. One day.)
- Notch to guide robot to candle. It may be possible to move the skids to make scoring easier as well as serve as a guide. (Easy to implement. One day)
- Add powered screen ramp between skids to be raised when bumble ball is between skids. Need servo mounted with single wire attachment to hinged screen. Need screen, purchased, or use one we have now. Design, build, test. Two days)

2.6 Game Robot and Final Design Review

With game day one week away the design of "The Collector" will change some. The robot as it exists today in shown below. All the verification checks, field fit, and function checks have not been completed. Time constraints did not allow for full development of the game robot as was originally planned.

The most important part of this next week will be driver practice. Modifications will be carefully controlled to insure that they do not degrade the performance of the drivers.

3 Supporting Tasks

Working groups consisting of students and at least one mentor and/or teacher were established to manage club activities during this competition.

We had numerous Robot Design groups that varied from time to time. Initially there were two groups that look at the overall design of two distinct robots. The hope was to fabricate both and pair them off in a competition to determine what was best. Time constraints did not allow this to happen. Subsequent groups included those for wheel design, capture mechanisms for the bumble ball and basic platform, ring capture and score, and a scoop and arm for alien pods, dynamite sticks, and noodles. These groups are responsible for documenting their daily activities and providing that documentation to the Notebook Committee.

The Recruiting group consisted of all students and was chaired by Sponsoring Teacher. This committee was responsible for recruiting students, fund raising and finding club sponsors.

The Web Page group was responsible for updating the web page.

The Notebook group consisted of all students and was responsible for documenting daily activities, preparing the notebook, interviewing club members, and providing necessary information to the Web Page group.

The Spirit group was responsible for club uniform design (including the T-shirt), coordinating spirit activities and inviting everyone under the sun to

3.1 Notebook

This document is a critical component of demonstration of the use of the engineering process. It was developed to identify the individual involved in the program and the work that they have accomplished of the last year. The club members agreed upon the overall structure of the document during one of the early meetings following kickoff. All members of the club provided inputs to various sections of this document. These inputs were then integrated into the documents by one of the mentors. Because of the complexity of the document and its electronic size some difficulties were encountered in its production. This was mostly driven by the quirks of MS Word that limited full integration of pictures with captions into the text portion of the document. Therefore it is necessary for the reader to refer back to the appendices for pictures and drawings.

Updated copies of this document will be distributed to other teams on game day to provide them with a model that has proven successful in the past. This will mean that in the future Medina Valley Robotics will have to continue to push the state of the art and improve if it wants to stay on the top. The intent is to help strengthen the SA BEST hub until in becomes the dominant force in BEST Inc.

3.2 Spirit

The objective of the spirits activities was to promote BEST, SA BEST, and Medina Valley Robotics to the community, civic groups and schools. In addition it was found necessary to reeve up the club during times of stress. All club members, mentors, parents, and other interested parties were involved in this activity. Although it took a back seat to the actual robot construction it was worked on throughout the entire period to insure that things came together.

To accomplish the goals the engineering process was applied to the spirit activities. Ideas were tossed out at brainstorming sessions and club meetings. Club members browsed spirit catalogs and other related publications for ideas. Web sites were visited for availability and prices. Club members and mentors worked together to construct various spirit items. Mentors tracked down supplies and ordered construction items as needed. The following is a portion of one of the meeting minutes were the spirit items were discussed.

> Medina Valley Robotics Meeting 10/2/02 Agenda
>
> T-shirt Design: Discussion of placement of design on front or back. Text: Should include Medina Valley Robotics at either the pocket area or curved on top of logo. Final Idea: Design on back, team and students name on front. The shirt color voted in was black and white.
>
> Location of Sponsors Names included the following options Include: Along the sleeves. Around the shirt. On the shirttails. On sponsors buttons.
>
> Spirit Items identified as possibilities.
>
> - Buttons
> - Tattoos- Medina Valley Robotics or SA BEST
> - Pens and pencils
> - Magnets
> - Foam fingers
> - Clappers
> - Whistles
> - Chinese yoyos
> - Stickers-Medina Valley Best SA BEST
> - Cheap rings
> - Shoelaces

Additional details about specific spirit items are given in the following paragraphs.

The logo design was created by a club member and then refined and modified by the club during the "business" portion of meetings. It includes a stylized black hole and representations of all the game pieces flying around the black hole. The team name encircles the drawing.

The Club shirts are T-shirts with the Club's logo on the back. Individual names were placed on the front. The team name, IRS (Interdimensional Robotic Services), and the students name are in the pocket region. Pants are black and were worn by all students, mentors, and teachers during all club activities.

Buttons to wear and pass out at Game Day as well as at presentations and demos were made by the club members. The buttons were done in color and have our Club's logo and the Club's names. These provide mementos with persons the club has contacted.

Pens and pencils with Medina Valley Robotics imprinted on them. These provide another mementos with persons the club has contacted.

Bookmarks with club logo, club web address, and the school address have been produced. These are given primarily to elementary kids after a club demo. This serves as a reminder to the kids about BEST and helps to stir future interest in the Medina Valley Robotics Club.

Trinkets and/or noisemakers with Medina Valley Robotics on them will be provide to club members and the rest of the crowd on game day. This is one more thing to identify with the club and school.

Foam fingers with "Go Team!" have been fabricated for game day promotion of the Hub and team.

Characters from the game to "sit" in the stands with us on game day. The intent is to draw the attention of the crowd to Medina Valley Robotics.

Washable tattoo with SA BEST and Medina Valley Robotics for promotion of the hub and Medina Valley Robotics will be handed out at game day.

There was the potential for involvement in TV segment on a public access channel about BEST. The focal point for this activity was the SA Home Schoolers who would be responsible for final production of the video. The video will contain multiple segments each about 5 minutes long. Medina Valley Robotics was not able to actively participate in this activity because of the timing. They suggest delaying the production one month to allow for ample time to be spent obtaining a quality product. The status of the program is still open.

3.3 Website

The website's URL is http://www.mvbest.com. The index page contains a brief description of what BEST is and what our purpose is. It also has a navigation bar at the top with buttons that link to on-site pages and links at the bottom of the page to off-site sites. On the left of the screen are news updates and upcoming events. The left most button on the navigation bar links to a page with information on the current season. During competition season, this page contains links to pages with member and mentor pictures, game information, and a list of sponsors. The gallery button links to a page with various photo galleries of past activities and events. The history button links to a page containing a brief history of Medina Valley BEST. The schedule button links to a page containing two more links. One link goes to a calendar of the current month and the other link goes to another page with a calendar of the upcoming month.

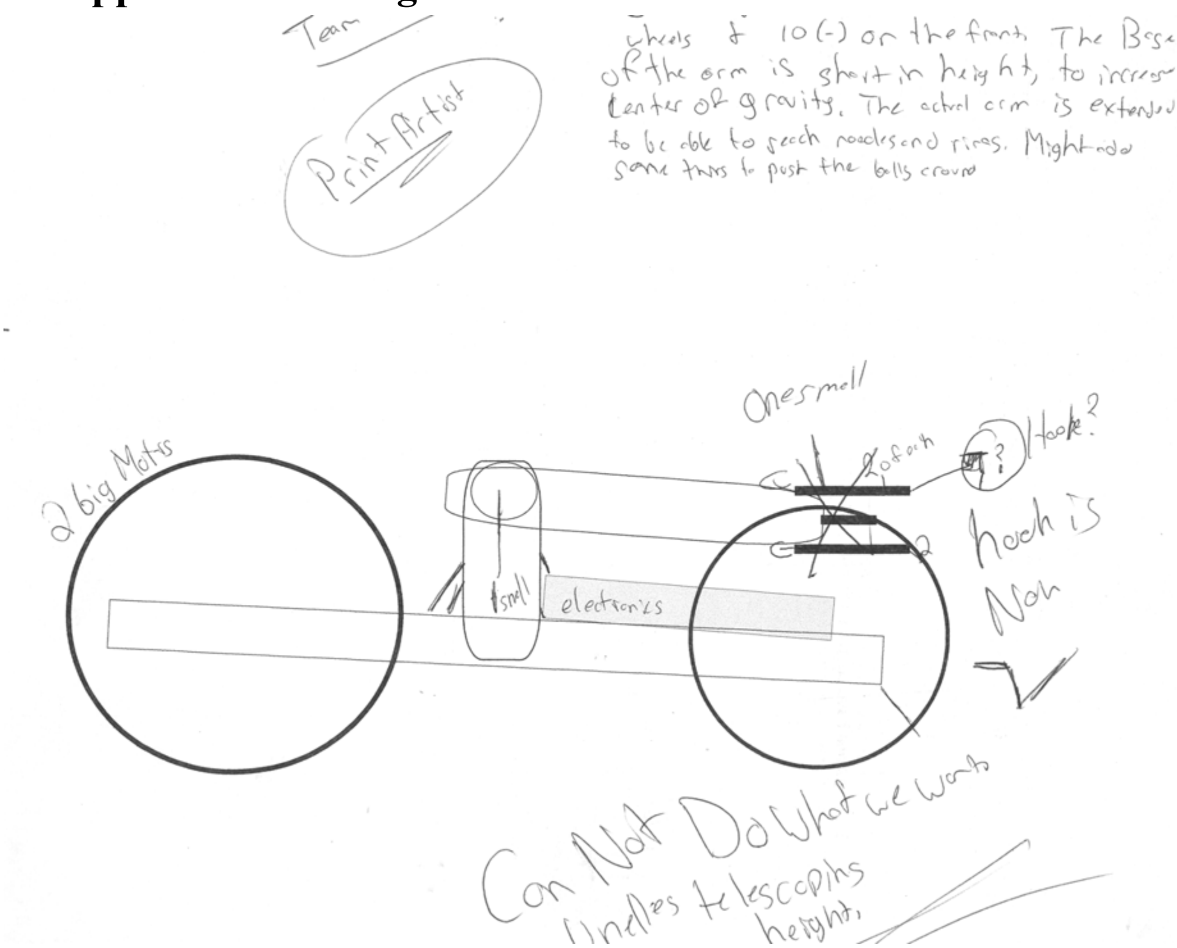
3.4 Newsletter

The purpose of the newsletter was to help promote the BEST and Medina Valley Robotics, to inform other people of the progress of the club, and provide information about the activities and objects of the club. Promoting BEST was a very specific and general task of the newsletter. We were trying to find ways of putting this information out to the general community. Finally, after several meetings, a mentor came up with a simple and basic idea to put the information into a newsletter. Jordon Gonzales ran with the idea and developed the format and basic content of the newsletter for Medina Valley Robotics. The basic idea was informing people of upcoming dates and activities.

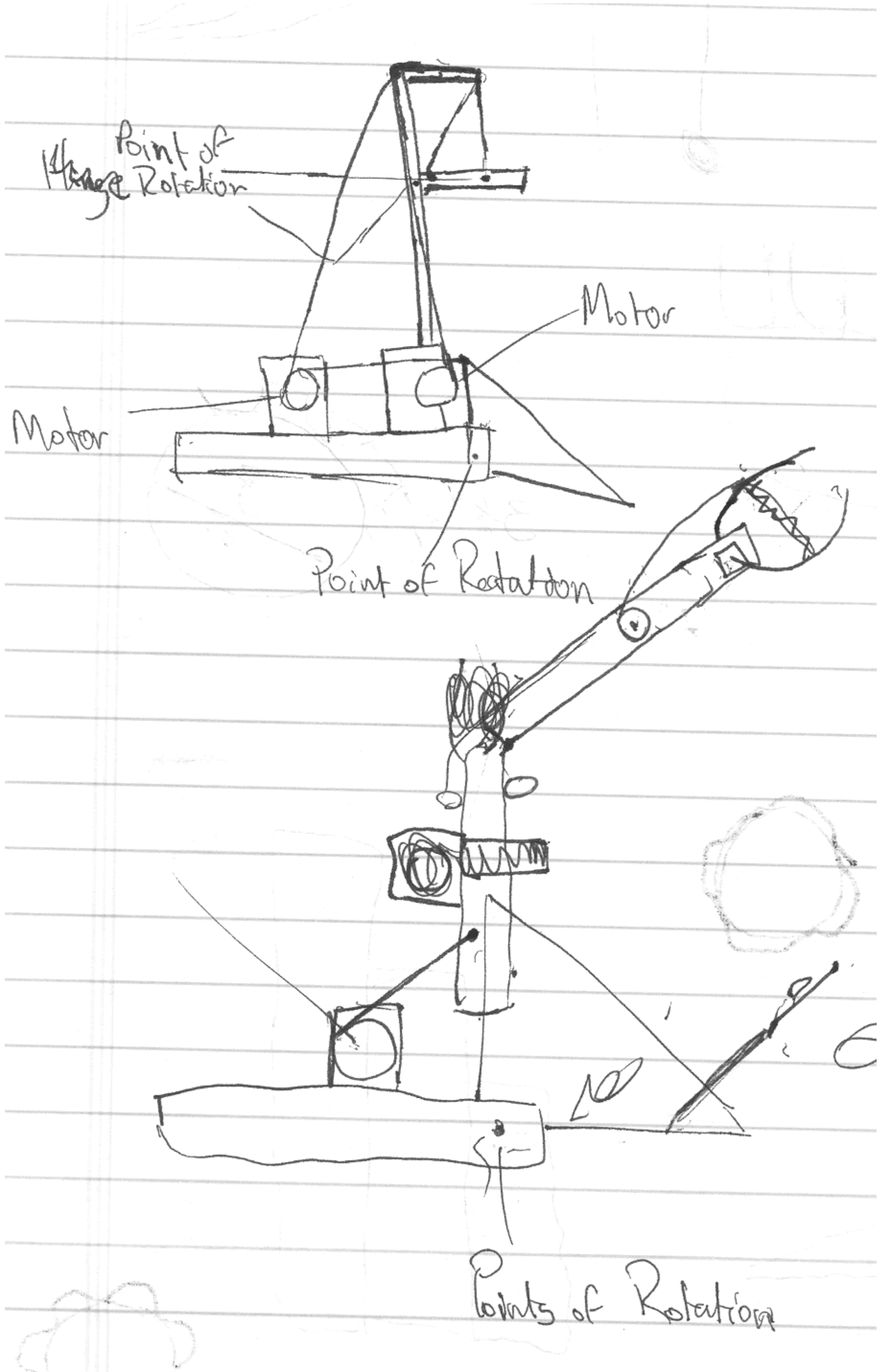
We decided over the summer to pass out the newsletter to our sponsors, administrators of the school, other teachers, students, members, and posted them in places of the school where they would be most seen. Many students did read these newsletters and comment about the newsletter. Our main objective for the newsletter, even though not completed, was quite successful. Many students of our school know very well what BEST is and stands for. It's just a matter of commitment to the club and organization. The newsletter also is a thank you for those who try so hard to keep this club going.

Samples of the newsletter are contained in Appendix D of this document.

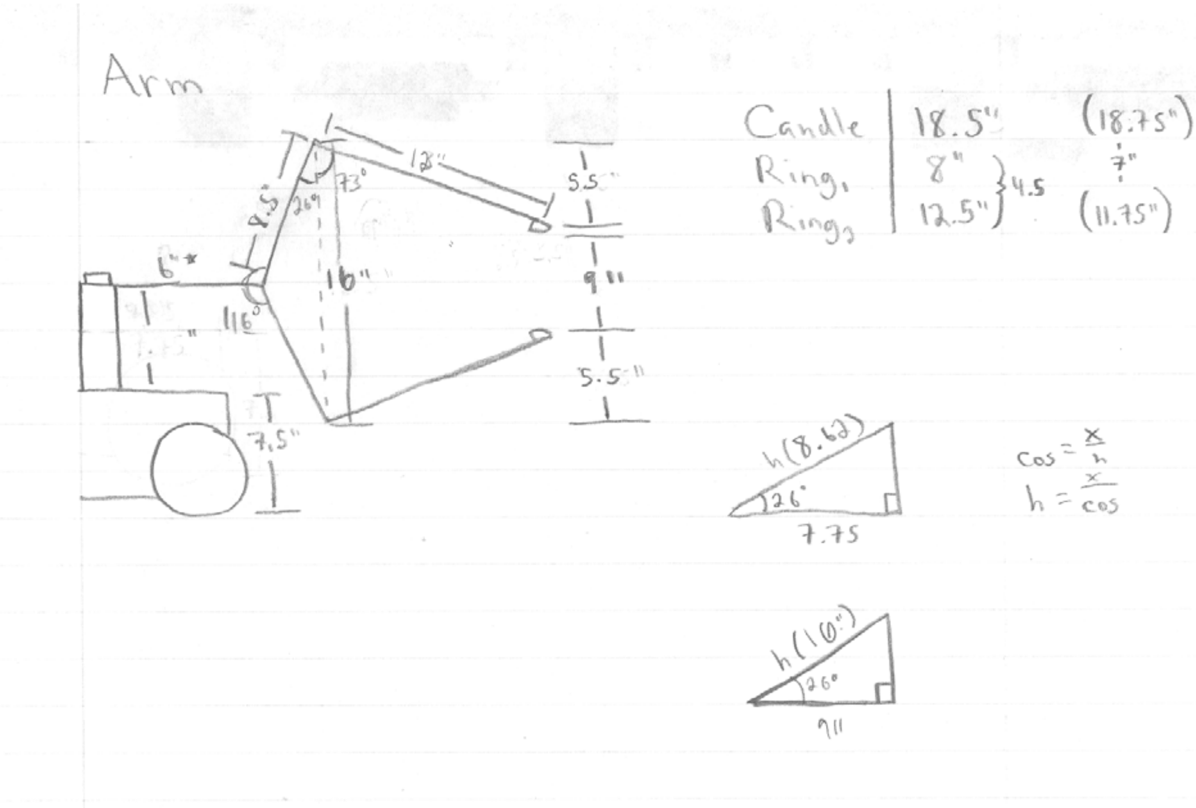
4 Appendix A – Design Details



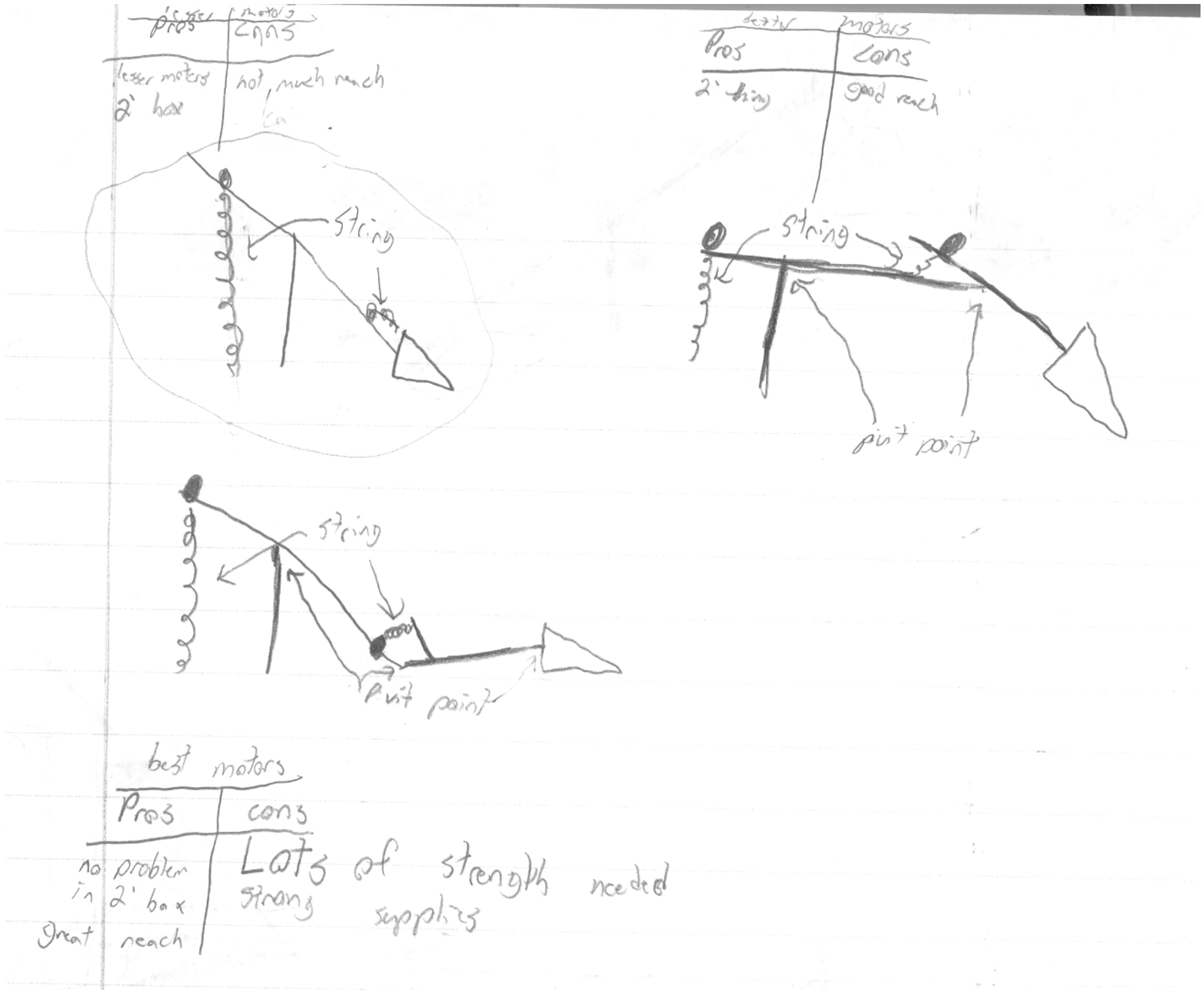
Robot Option



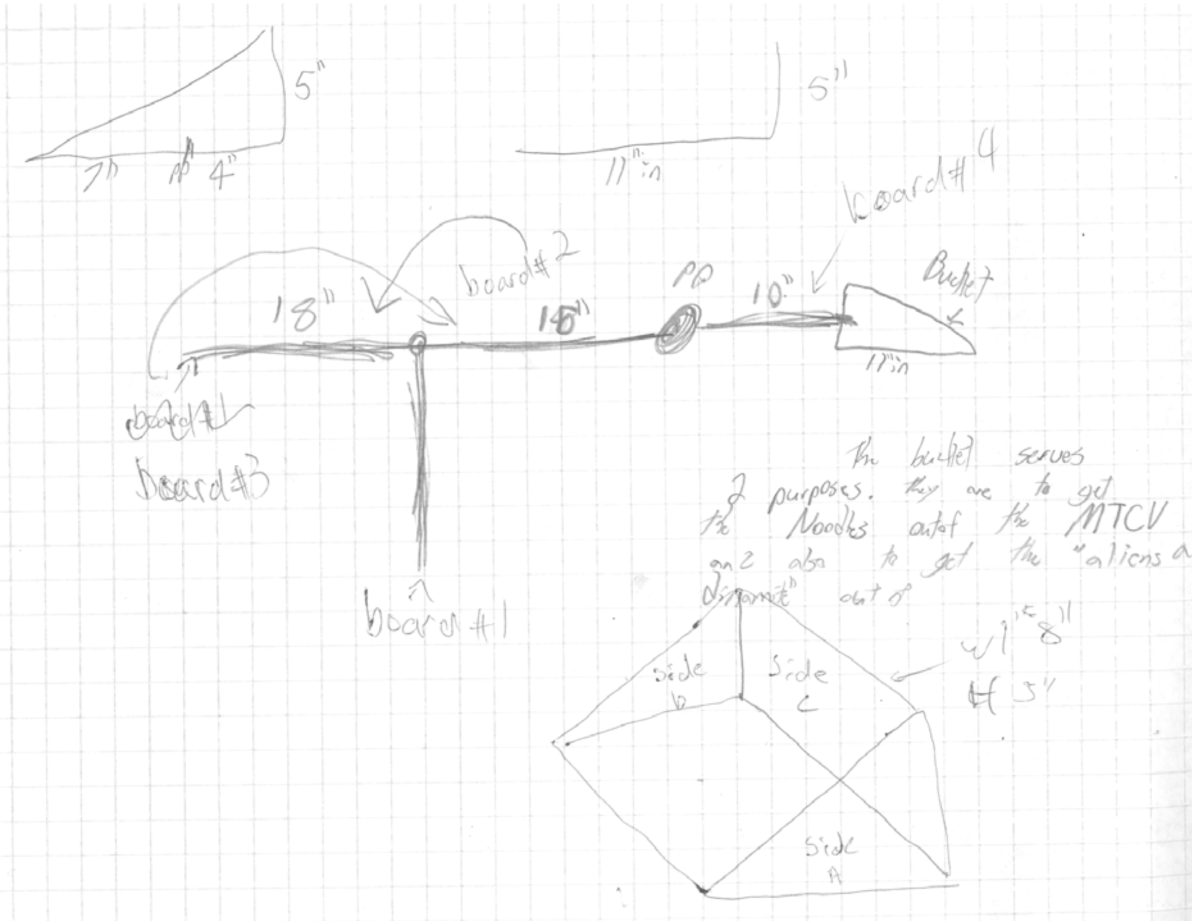
Design Option for Robot



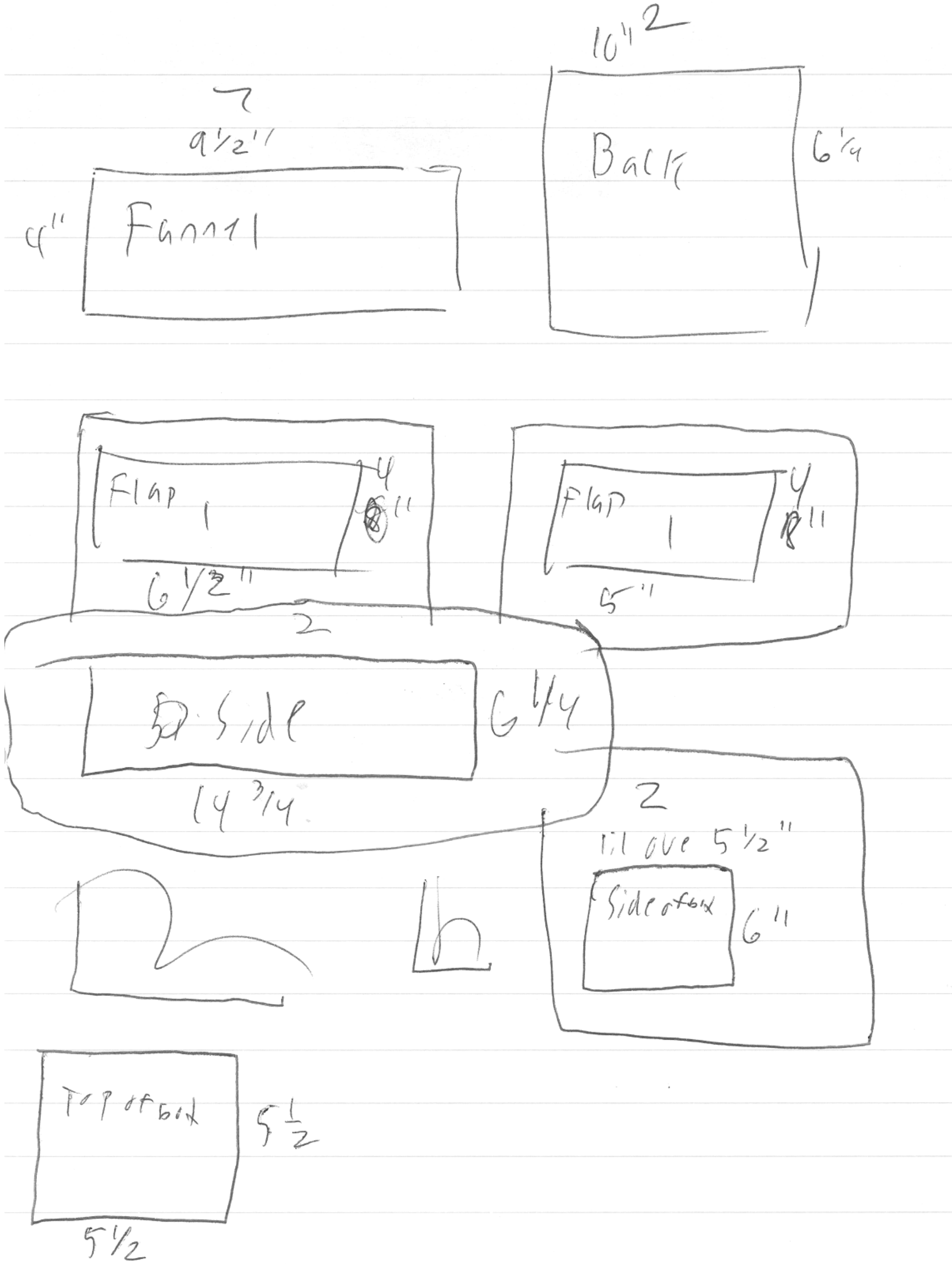
Ring Arm Design Parameters



Design Details for Scoop and Segmented Arm



Design Details for Size of Scoop and Arm



Cut Diagram for Bumble Ball Collection System