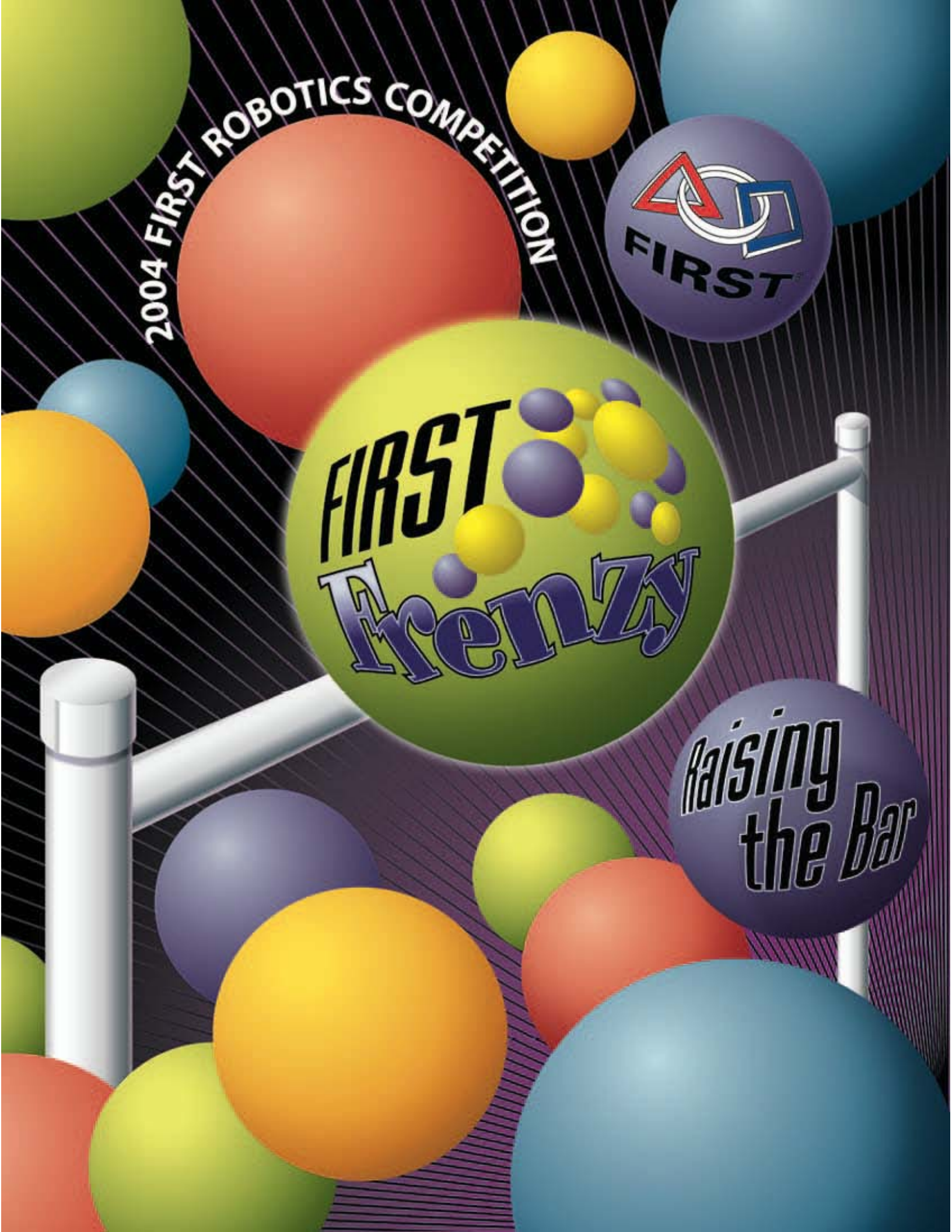
2004 FIRST ROBOTICS COMPETITION
FIRST
FIRST
Frenzy
Raising
the Bar

2004 FIRST ROBOTICS COMPETITION

FIRST FRENZY: Raising the Bar

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1 INTRODUCTION

1.1 WHAT IS THE FIRST ROBOTICS COMPETITION?

The FIRST Robotics Competition is an exciting program that pairs teams, sponsors, colleges, and technical professionals with high school students to develop their solution to a prescribed engineering challenge in a competitive game environment. The program has resulted in life-changing, career-molding experiences for its participants. It is also a lot of fun.

In 2004, our reach will expand to over 23,000 students representing approximately 930 teams. These teams will come from almost every state in the U.S., as well as from Brazil, Canada, Great Britain, and Mexico. FIRST has truly become an international program and is continuously growing. These teams will participate in 26 Regional Competitions and the annual Championship Event. The competitions combine the practical application of science and technology with the fun, intense energy, and excitement of a championship sporting event.

This year's challenge will be presented at the 2004 Competition Kickoff on January 10, 2004. All teams will be shown this year's game field for the first time and will receive a kit of parts and the game rules and regulations. The Kit of Parts will include motors, sensors, shafts, bearings, and other materials that teams can use in the design and construction of their robots. They will also receive a new, enhanced multi-channel radio control system and a 12V battery power supply. The kit is meant to provide a level starting point for all teams. The game rules also indicate additional items teams can purchase. When you bring dedicated, enthusiastic students, teachers, engineers, and other professionals together, they will produce a wide range of amazing machines that are competition ready in six weeks of construction time.

1.2 GRACIOUS PROFESSIONALISM, A FIRST CREDO

Dr. Woodie Flowers, FIRST National Advisor, asks and provides his view regarding the question, "Why do FIRST folks talk so much about that phrase?"

Quoting Dr. Flowers, "Obviously it would not make sense to endorse "asinine professionalism" or "gracious incompetence." It is, however, completely consistent with the FIRST spirit to encourage doing high quality, well informed work in a manner that leaves everyone feeling valued. Gracious professionalism seems to be a good descriptor for part of the ethos of FIRST. It is part of what makes FIRST different and wonderful.

Gracious professionalism has purposefully been left somewhat undefined because it can and should mean different things to each of us. We can, however, outline some of its possible meanings. Gracious attitudes and behaviors are win-win. Gracious folks respect others and let that respect show in their actions. Professionals possess special knowledge and are trusted by society to use that knowledge responsibly. Thus, gracious professionals make a valued contribution in a manner pleasing to others and to themselves.

In FIRST, one of the most straightforward interpretations of gracious professionalism is that we learn and compete like crazy, but treat one another with respect and kindness in the process. We try to avoid leaving anyone feeling like they are losers. No chest thumping barbarian tough talk, but no sticky sweet platitudes either. Knowledge, pride and empathy comfortably blended.

Understanding that gracious professionalism works is not rocket science. It is, however, missing in too many activities. At FIRST, it is alive and well. Please help us take care of it.

In the long run, gracious professionalism is part of pursuing a meaningful life. If one becomes a professional, and uses knowledge in a gracious manner, everyone wins. One can add to society and enjoy the satisfaction of knowing that you have acted with integrity and sensitivity. That's good stuff!"

1.3 THE 2004 GAME – *"FIRST FRENZY: Raising the Bar"*

Teams will become frenzied as they strategize on whether their robots will negotiate IR beacons during the Autonomous Period, herd small balls to Ball Corrals, cap large balls on goals, move mobile goals, climb steps or attempt to hang from the Pull-Up Bar. The object of the game is for teams' robots to trigger the Ball Release during the first 15 seconds, collect balls and feed them to the Human Players who will throw them into the goals. Robots will try to cap the goals with large balls to double the point value contained in that goal and attempt to end the match hanging from the center Pull-Up Bar. The final score is the result of adding small ball points in the goals, doubling the points for goals that are capped, and adding 50 points for any robot that is hanging from the bar.

Each match will feature two-team alliances playing from opposite ends of the playing field. The robots from each of the four teams will be placed in starting positions straddling the white lines on the carpet in front of the drivers. The robots will be allowed 15 seconds to function autonomously, without driver control of any kind, to race to the Ball Tees, remove the balls and activate the Ball Release mechanism at their end of the field. After the "Autonomous Period," the robots will be under complete control of their drivers for the remaining 1 minute and 45 seconds of the match. If the Ball Release is not activated during the Autonomous Period, it will automatically activate at the 45-second mark of the match.

This year's game requires excellent coordination between the robots and very accurate Human Players. With multiple ways to score points, it will be necessary to track your score as well as your opponent's score and make critical decisions near the end of the match. There will surely be a frenzy of activity as the clock winds down.

2 COMMUNICATION

2.1 OVERVIEW

This section provides teams with necessary information for contacting FIRST staff, using the FIRST logo, and other information regarding such topics as the Yearbook Page.

A form for all of your team information can be found at
http://www.usfirst.org/2004comp/yourteaminfoform.pdf

2.2 FIRST - CONTACT INFORMATION

You can reach FIRST via phone, fax, mail, and e-mail, or get information from our website. The office is open Monday through Friday from 8:30 a.m. to 5:00pm, EST. *Be sure to provide your team number.* Refer to the sections below for the appropriate help resource.

Phone Extensions: ***Press the # key, then the extension number.***

Mailing Address: FIRST 200 Bedford Street Manchester, NH 03101	Team Support e-mail frcteams@usfirst.org	Phone: (800) 871-8326 or (603) 666-3906 Fax: (603) 666-3907

2.3 GETTING ANSWERS TO YOUR QUESTIONS

First will utilize an on-line Manual, starting in 2004, including a web-based question and answer system.

To submit a question to FIRST, you will have to log in with a password. Each team can obtain its password within its team record in the Team Information System (TIMS).

To ask a question, you will have to specify the section of the Manual for which you need clarification. Teams will be able to view questions and answers sorted by date or Manual section. (The Game, The Robot, etc.)

Access the question and answer system at http//www.usfirst.org/robotics/2004/qa.htm

2.4 TEAM SUPPORT

The Operations, Team Support system is ready to help your team. Please use the information below to contact one of our staff members with regard to administrative concerns. Please bear in mind that our program requires many requests in writing, so e-mailing may be your best resource.

We ask that you do not copy multiple persons about the same problem as we are a small group and try very hard to avoid duplicating efforts. We try very hard to answer questions or requests within one working day.

2.4.1 E-mails and Subject Lines

This may be the best way to get a quick answer to your question. E-mails save money, time, and provide information for a researched, more accurate answer. Include your team number and short reference in the subject line, please. E-mail detailed questions or concerns to frcteams@usfirst.org.

2.4.2 Phone/Competition Questions

Call 603-666-3906 or 800-871-8326, Phone Option 1 on the phone menu, for help and answers to questions regarding administrative or team concerns. If you leave a voice mail, make it short and detailed and include your team number, name, e-mail address, and phone number. Team Support will research the question and return your call or send you an e-mailed answer.

2.5 TEAM INFORMATION MANAGEMENT SYSTEM (TIMS)

The Team Information Management System (TIMS) is the on-line way to register and provide information as the season progresses. When teams use the system properly, the system provides FIRST with up-to-date:

- Team names
- Team Contact information for important, individual team messages and FIRST e-mail blasts
- Team Partner (Sponsor) information
- Event attendance information for each team (Kickoff, Events, Team Socials, and Forums)
- Team Yearbook Pages
- Team's FedEx or UPS shipping account number

This system also provides information to teams about:

a. Teams willing to mentor other teams
b. Teams wanting mentoring
c. Team website links

2.5.1 Main Contact and TIMS

Your adult Main Contact is responsible for accessing TIMS, our registration and on-line information update system, keeping the information current and providing necessary information by the set deadlines. The Main Contact for your team has the password and logon ID to enter the system and make necessary additions and changes as they occur.

2.5.2 Team Contacts Provide Internal Information

Each team contact is responsible for informing the Main Contact of changes and additions to his/her record.

2.5.3 "Off Season" and Current Contact Information

If your phone numbers and addresses are incorrect, you will not receive information or materials. This is especially crucial during school vacations. Be sure to provide the Main Contact with a secondary address, home and cell phone numbers, and e-mail addresses so we can reach you during the event travel season, vacations, school weather closures, and/or the summer.

If any of the contacts leaves the team, either replace his/her information with new contact information, or delete the contact from the system.

2.5.4 Team Name for the Competition Scoreboard

Once you have established your team partners (sponsors), remember to adjust your twenty-one (21)-letter maximum "short team name." Whatever you put in this field will appear on the scoreboard at each event. Remember….sponsors like and expect the recognition.

2.6 FIRST WEBSITE

Visit FIRST at its World Wide Website at http://www.usfirst.org to access periodic rules updates, check deadlines and dates, find event information, and find answers to administrative concerns.

2.6.1 Team Website Links

The website also provides links to home pages. FRC teams set these up. If you have a team-related web page, you can post it via our Team Information Management System (TIMS) as part of the registration/maintenance process.

Remember to keep your website up-to-date, especially if you would like consideration for the Website Award.

2.6.2 Team Updates

Team Updates provide rules updates and other important information about parts, administrative reminders, or deadlines. Check for Team Updates often, especially on *Tuesdays and Fridays*.

Teams often put someone in charge of printing Team Updates, passing them to relevant team subdivisions. To find them on the FIRST Robotics website, do the following:

- Click the "Documents and Updates" button on the left side of the page
- Choose "2004 Competition Documents"
- Choose "Team Updates"

2.7 EVENT-SPECIFIC LOCATION/SHIPPING/DRAYAGE INFORMATION

We post specific information pertaining to Regional and Championship events on the website regarding site directions, team socials, and shipping and drayage. You will be able to download this information for the events you plan to attend. To find this information, do the following:

On the FIRST Robotics page, click on Regional Events or Championship, then click on "Site Info" when you find the relevant event.

Provide information to the proper subdivision(s) of your team:

a. Print the document

b. Distribute the document to relevant team members

c. Place it in your FRC Manual behind your "Events" tab

2.8 CONTROL SYSTEM-SPEED CONTROLLERS: INNOVATION FIRST, INC.

Contact Innovation First, Inc. for help with items such as: Operator Interface, Robot Controller, Radios, Speed Controllers, and Relay Modules.

Phone: (903) 454-1978.

E-mail: To contact them via e-mail, visit the website: http://www.innovationfirst.com

2.9 ENGINEERING

Phone: 603-666-3906 or 800-871-8326, phone Option 2.

Contact Engineering for technical issues, playing field construction information, and game rules.

Please do *NOT* contact FIRST Robotics if you are having technical problems with the Innovation First components. See above for Innovation First contact information.

2.10 MENTORING & TEAM ORGANIZATION

Sign up to mentor or receive mentoring through our on-line Registration / Team Information Management System (TIMS). Use the event map on the website for mentoring information and connections.

2.11 PROVIDING CORPORATE SPONSORSHIP TO FIRST

Please contact Dia Stolnitz, Director of Development, for information. 800-871-8326, Ext. # 406 or dia@usfirst.org.

2.12 NEW - HOTEL INFORMATION - THE THS COMPANY

Please review instructions on the website, http://www.usfirst.org, before you attempt to reserve rooms for your team. Each FIRST team must designate one person as the Team Travel Coordinator to manage this process.

The THS Company will handle the FIRST recommended hotel reservations.

The THS Company
306 High Street
Hackettstown, NJ 07840
888 536 TEAM
http://www.thsweb.com

2.13 USING THE FIRST LOGO

We encourage teams to develop and promote team identity. It is a great way to help FIRST judges, announcers, and audiences recognize your team at the competitions, and it is also a way to help you create a "buzz" about your team in your community.

You have incredibly creative opportunities in terms of designing your own identity. Every year we see great examples of how teams "brand" their efforts with websites, incredible team logos on robots, t-shirts, hats, banners, fliers, and giveaways.

These branding activities are a wonderful way to include students from art, communications, computer, and language arts classes in your team effort. As you manage your own promotion, you may want to incorporate the FIRST logo in what you do. Because our mark is registered, both name and the geometric logo, we have a few guidelines for you to follow when using the FIRST logo:

Positive Promotion:	Use our logo in a manner that is positive and promotes FIRST.
Unmodified:	Use the FIRST logo without modification. This means that you will use our name and the circle, square, and triangle as you see it on our website or letterhead. You can use it in red, blue, and white, or in black and white.
Modification Permission:	If you have an interest in modifying our logo, do that only when you receive our permission. FIRST is happy to talk with you about modifications after you submit a written request letting us know why you want to modify the logo; how you plan to do it, and where you plan to apply it. Send an e-mail request to Ken Freitas, kfreitas@usfirst.org, Marketing and Promotion.
Advertising Use Approval:	All Teams and sponsors must obtain approval from FIRST prior to incorporating our logo in any advertising. E-mail requests to Ken Freitas for approval, by e-mail kfreitas@usfirst.org or by phone at 800-871-8326 #410.

2.14 JUDGES' YEARBOOK PAGE

The Yearbook Page is a team overview page. Complete the Yearbook Page via the TIMS before the deadline**.** We compile these pages in books for the Judges for each event.

FIRST will post the Yearbook Page instructions and format in mid-February..

2.14.1 NEW - Description of Potential Inclusions

To prepare for this project, you may want to gather information about your team, such as:

- Team's City, State, Country
- Team website address
- Number of years involved
- Names of the Student Leader and Main Contact
- Affiliation - Sponsor
- Team Budget for the year
- Number of female and male students, engineers and technicians, teachers, parents
- How many freshman, sophomores, juniors, seniors
- FIRST events you will attend
- Previous FIRST awards/year won

Another portion of the Yearbook Page could include short, written descriptions of:

- Team History
- Team Goals
- FIRST impact on the team/community
- Community Description
- Team Strengths
- Most significant challenge the team overcame
- Robot game and strategy
- Most competitive for which awards
- Funding sources
- Reasons for public awareness of your team

2.14.2 Purpose

The Yearbook Page submission is a tool that:

- Provides a common starting point for judging each team
- Helps provide judges with some insight into each team's workings, history, and robot
- Makes the judging more efficient
- Provides team data for FIRST and its archives

2.14.3 Requirements

Insert a single photo in the designated spot. The requested digital picture of the robot, or the team and robot, provides a visual recollection for the judges as well as a picture we can archive on disc to use for media coverage and the awards ceremony at the Competitions.

The Main Contact for each team will receive instructions and required format for filling out the form via the website. To ensure proper archiving, carefully follow the specific guidelines.

2.14.4 Submission Deadline

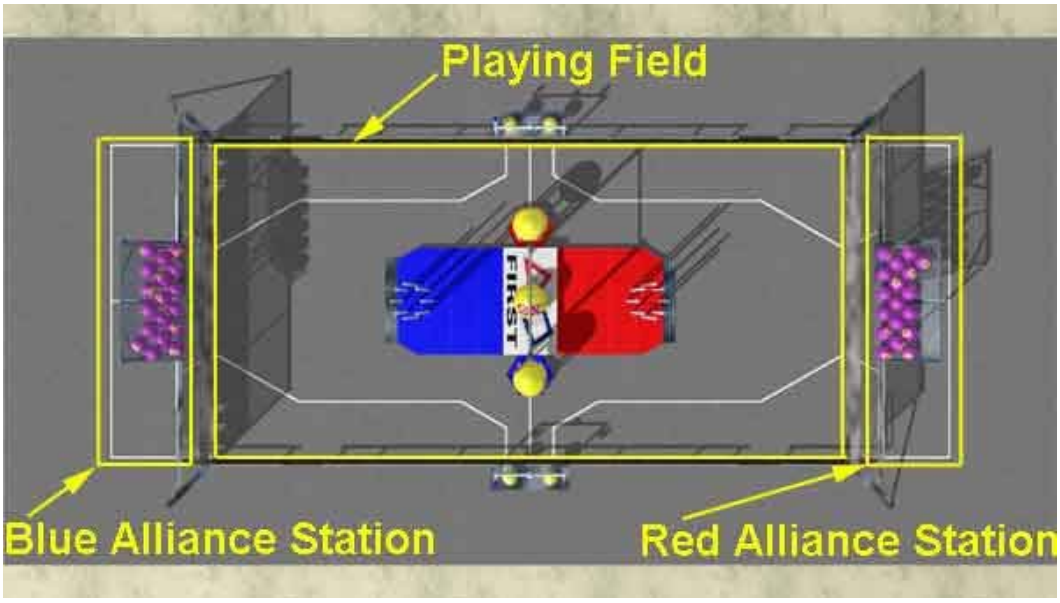
Midnight, Eastern Time, February 26, 2004.

2.15 HOW TO VOLUNTEER FOR FIRST

Each Competition event depends on an abundance of volunteers with a broad spectrum of talents to support operating needs and competition demands. If you have time, we can use your help. Please use our website for information about volunteering and on-line signup.

3 THE ARENA

3.1 OVERVIEW



The Playing Field is a rectangular area in which the Robots compete. The Red and Blue Alliance Stations are rectangular areas, each consisting of two (2) Team Zones, which are located outside of the ends of the Playing Field. The two teams that make up each Alliance play the game from these stations.

The specifications below are for the FIRST playing fields used in competition. These fields are welded aluminum, which are built to withstand rigorous play and damage from frequent shipping. Specifications and drawings for low cost versions of the field components are available on the FIRST website at http://www.usfirst.org/robotics/doc_updt.htm ("2004 Low Cost Field – Layout 1, 2, 3, & 4")

3.1.1 Dimensions and Tolerances

All official dimensions are on the following drawings:

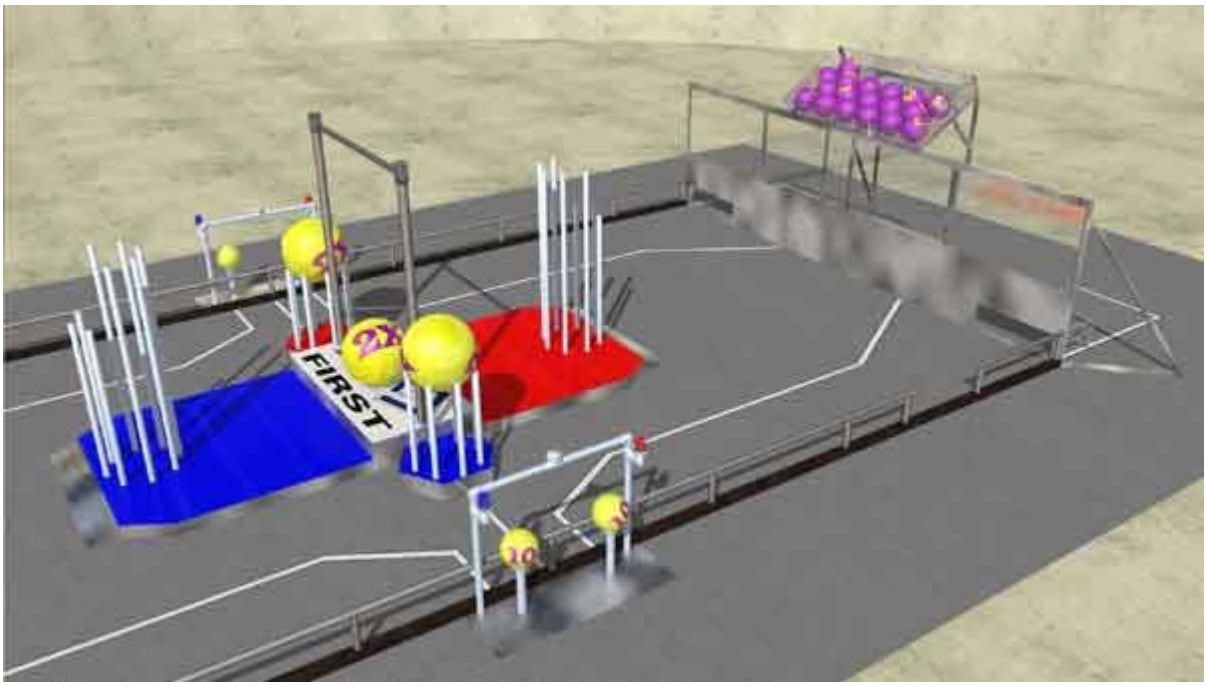
- 2004 Arena Layout and Marking
- 2004 Field Elements - Center Structure - Part A
- 2004 Field Elements - Center Structure - Part B
- 2004 Field Elements - Center Structure - Part C
- 2004 Field Elements - Mobile Goal
- 2004 Field Elements - Ball Release, Ball Chute
- 2004 Field Elements - Tees / Corral / Paddle

As indicated on the drawings, all dimensions are +/- 1 inch. Where surfaces are indicated as flush, there may be variations either direction of as much a 1/4 inch. This is not considered abnormal and is part of the game challenge. The reasons for these variations are numerous; different arenas are manufactured at different sites, set up by different volunteers, and undergo different temperature extremes. Volunteers and FIRST staff at each competition site will do their best to make the Arena and its elements as close to nominal as reasonably possible.

The balls are made of rubber and are expected to undergo a lot of robot and person handling. They are likely to become misshapen and may become ovular instead of round. Because of a variety of environmental conditions at various competition sites, their resilience and elasticity are expected to vary. Because of these reasons, balls will be inflated at each site to their stated 13" dimension measured at their Equator (the manufacturing seam of the ball). Since misshapen balls are expected, they are considered to be part of the game challenge.

3.2 PLAYING FIELD

Note: The official Playing Field description, layout, dimensions and parts list are contained in the"2004 Arena Layout and Marking" Drawing. Diagrams and dimensions below are for summary purposes only.



3.2.1 Boundaries and Markings

The carpeted Playing Field is 48 feet by 24 feet, bounded by two Walls and a Guardrail System.

The Guardrail System is a 20-inch high horizontal pipe with vertical supports mounted on a 3" aluminum angle. A 3/16" stranded steel cable runs through the vertical supports mid way between the angle aluminum and the top pipe.

The Wall is 7 feet high: a 3-foot high base of diamond plate with a 4-foot high transparent acrylic top.

In each quadrant of the Playing Field, there is a two-inch-wide white line of gaffer's tape on the Playing Field carpet running from the Wall to the Ball Tee Station.

There is a 2-inch white line running across midfield.

3.2.2 Center Structure

Note: The official Center Structure layout, dimensions and parts list are contained in "2004 Field Elements - Center Structure" Drawings. Diagrams and dimensions below are for summary purposes only.

3.2.2.1 Upper Deck & Pull-up Bar

The Upper Deck is a stationary 4' x 8' x 12" platform at midfield; the surface is polycarbonate; the sides are diamond plate.

A Pull-up Bar, made of 2.375 inch galvanized steel pipe, spans and rises from the Upper Deck; its height is 10 feet from the carpet to the top of the bar.

3.2.2.2 Lower Decks and Stationary Goals

The Lower Decks are stationary, 6-sided polygons measuring 8' x 8' x 6", the surface is Red or Blue textured HPDE, and the sides are diamond plate.

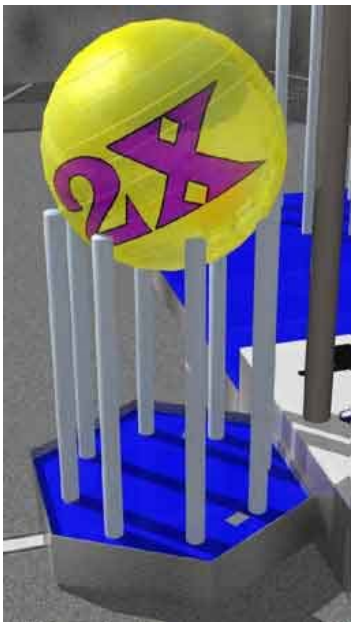
The end contains a ful- width diamond-plate staircase of three 1.5-inch rise by 3 inch run steps.

Each Lower Deck contains a 28" diameter octagonal Stationary Goal formed by 2" PVC Posts at each apex.

The five Goal Posts closest to the Upper Deck are 8'; the other three are 6', measured from the carpet to the top of the pole.

3.2.3 Mobile Goals

Note: The official Mobile Goal, layout, dimensions and parts list are contained in "2004 Field Elements - Mobile Goal" Drawing. Diagrams and dimensions below are for summary purposes only.



The Mobile Goal is a 36"x 36"hexagon mounted on casters, with either a red or blue textured HDPE surface and diamond plate sides. It contains a 28" diameter octagonal Basket formed by one 2" PVC Post at each apex.

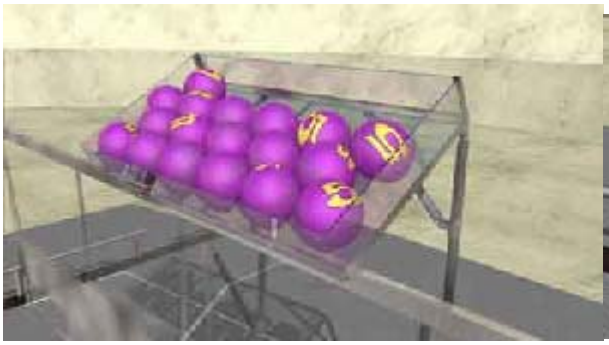
Each Mobile Goal Post is 4 feet high as measured from the carpeted surface of the Playing Field.

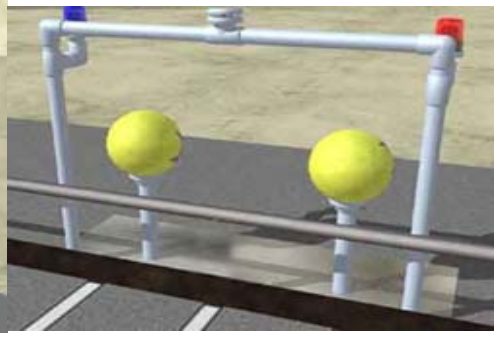
The Mobile Goal weighs approximately 112.5 pounds.

3.2.4 Ball Delivery System

Note: The official Ball Delivery System, dimensions and parts list are contained in "2004 Field Elements - Ball Release, Ball Chute" and " 2004 Field Elements - Tees / Corral / Paddle" Drawings. Diagrams and dimensions below are for summary purposes only.

The Ball Delivery System is an automated part of the Field Control consisting of a Ball Release, Ball Tees, and Field Control.





The Ball Release stores eighteen (18) Small Balls and is mounted above each Alliance Station.

A framed Ball Tee Station is located on each side of the Playing Field at the midpoint. Each Ball Tee Station contains two Tees to support the Bonus Balls. Each Ball Tee is associated with its nearest Ball Release.

Red and Blue lights mounted on the Tee Station indicate when a Bonus Ball has been removed during the Autonomous Period.

3.2.5 IR Beacons

Centered on the top of each Tee Frame is a light beacon that continuously emits an infrared signal across the playing field during a match. Each beacon emits at the same IR frequency, but sends pulse trains of different pulse widths. These signals are detectable by robot-mounted IR receivers that are tuned to the beacons' frequency. The receivers provide direct input to the robot's control system when they sense an IR signal.

FIRST has supplied appropriate code that allows teams to program their robot's controller to make decisions based on a received signal and discriminate between the two Tee locations. Thus teams may create mechanisms on their robots to locate and track a beacon during the autonomous period. The Kit contains four IR receivers and materials needed to build a beacon.

3.2.6 Ball Chute

Note: The official Ball Delivery System, dimensions and parts list are contained in "2004 Field Elements - Ball Release, Ball Chute" drawings. Diagrams and dimensions below are for summary purposes only.

Located in each corner of the Playing Field is a Ball Chute to allow the robots to pass Small Balls through the Wall from the Playing Field into the Ball Corral (described below) within each Team Zone. The dimensions of the Ball Chute are 48"wide and 16" tall.

3.3 SCORING OBJECTS

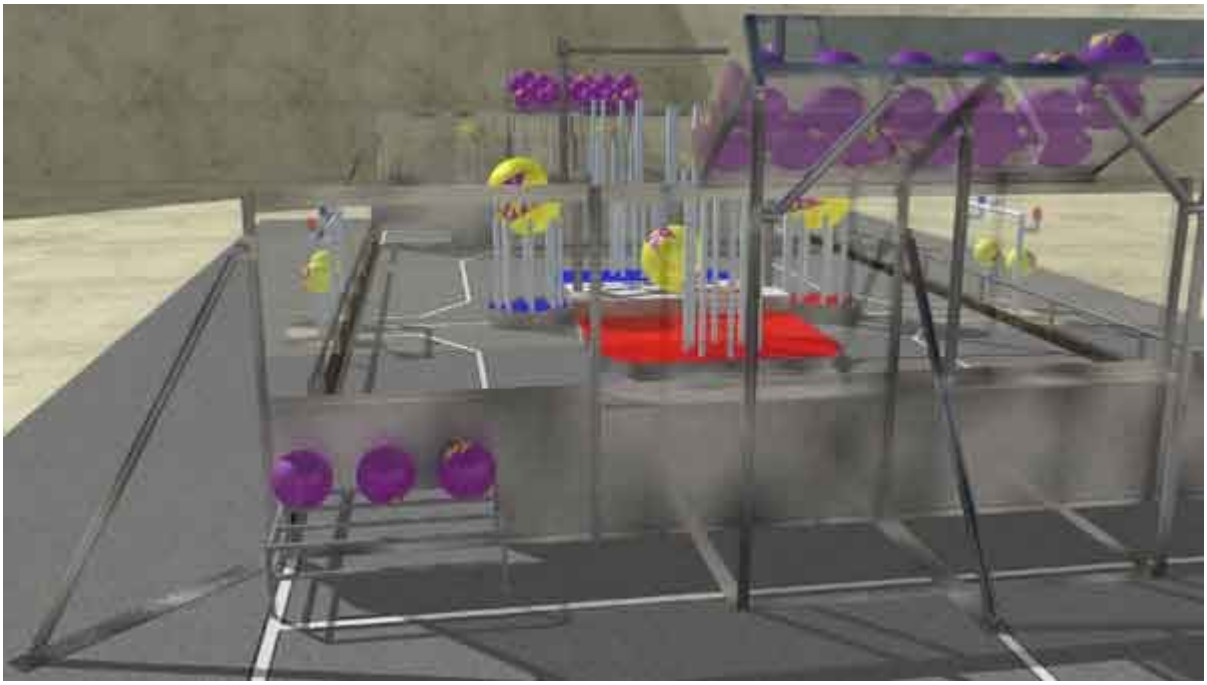
Small Balls are purple, 13-inch diameter, rubber balls with a yellow "5" point value on one side.

Bonus Balls are yellow, 13-inch diameter, rubber balls with purple "10" point value on one side.

Large Balls are yellow, 34-inch diameter, rubber balls inflated to 30-inch diameter with a purple "2X" on one side.

3.4 ALLIANCE STATIONS

Each Alliance Station is 8' x 24', split into two mirror image 8'x12' Team Zones.



(The Ball Release supports are for illustration purposes only. The actual support system may be different.)

3.4.1 Boundaries and Markings

Each Team Zone shares the Wall with the Playing Field and has its outer and rear edges marked with tape on the carpet. The Team Zones share the downrigger support for the Ball Release as a common side from the center of the Wall.

Three feet behind the Shelf is a white-taped line on the carpet named the Starting Line.

3.4.2 Shelf

Attached to the Wall, at a height of 3 feet, is a 42” wide by 9.5” deep diamond plate shelf to support the Team's Robot Controls. Attached to each shelf is a competition port cable for connecting the Operator Interface to the Field Control for power and communications. Two feet above the Shelf, on the center Wall pole, is a pocket to support the Operator Interface Radio.

3.4.3 Ball Corral

Note: The official Ball Corral dimensions and parts list are contained in "2004 Field Elements –Tees / Corral / Paddle” drawing. Diagrams and dimensions below are for summary purposes only.

Each Team Zone contains a 4'w x 30"d x 16"h Ball Corral abutting the Ball Chute. It is constructed of one-inch square aluminum with two crossbars on top and sidebars. The side facing the Shelf has no side bar.

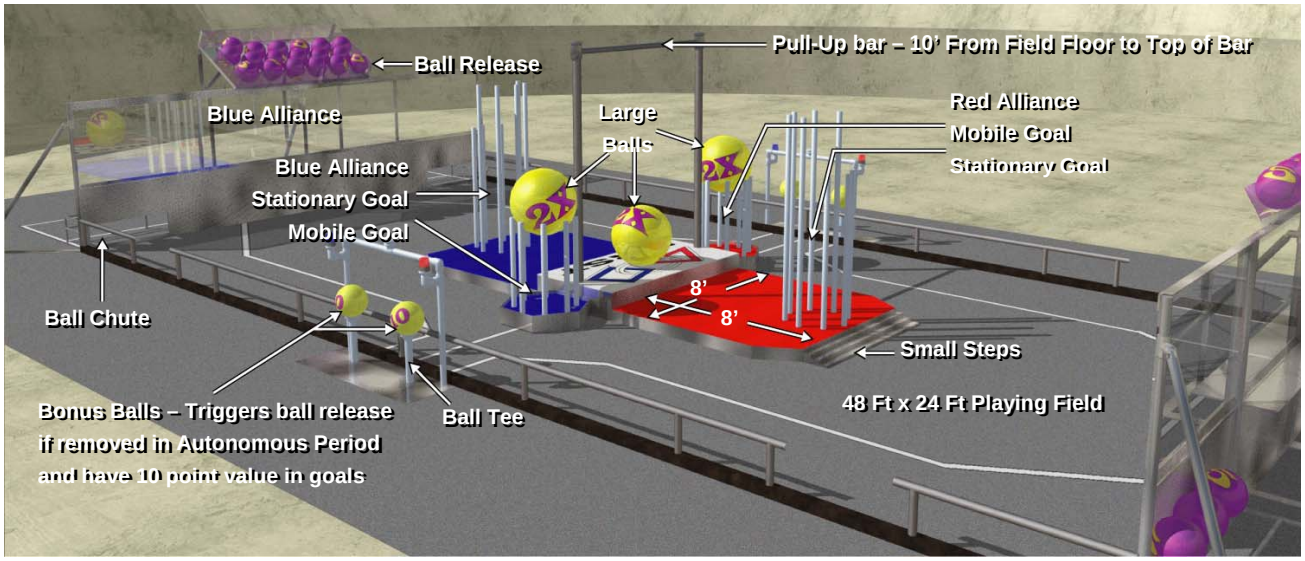
A Paddle will sit on top of and extend into the Corral to aid in clearing balls from the Ball Corral. The Paddle is made of a 36-inch long piece of PVC pipe with a clear polycarbonate square stop at mid length and a clear rectangular piece of polycarbonate at the bottom.

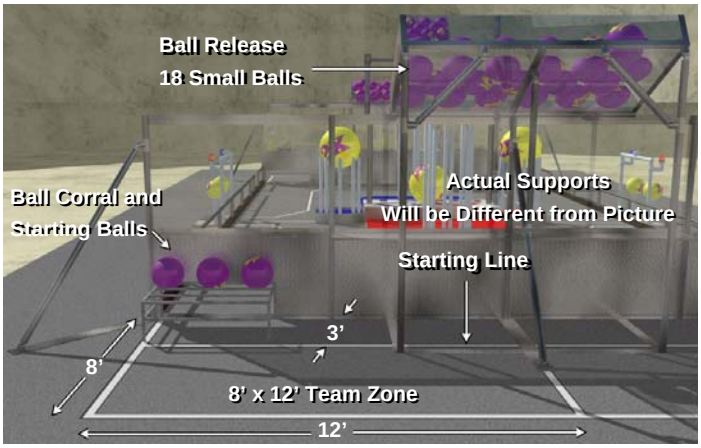
4 THE GAME

4.1 GAME OVERVIEW

The object of the game is to attain a higher score than your opponent alliance by delivering balls into goals, capping goals with larger balls, and/or having robots hanging from the Pull-Up Bar at the end of the round of competition. The point values for each of those actions are explained below.

FIRST FRENZY: Raising the Bar is played on a field initially set up as illustrated in the figures below. Two alliances comprised of two teams compete in each match.





4.2 PLAYING FIELD

The playing field construction and dimensions are detailed in the Arena Section of this manual.

4.3 THE GAME

4.3.1 Definitions

ROBOT – Anything (which has passed inspection) that a team places on the field prior to the start of a match.

SMALL – Balls that are inflated to approximately 13 inches in diameter.

LARGE – Balls that are inflated to approximately 30 inches in diameter.

COACH **–** A student or adult mentor designated as the team advisor during the match and identified as the person wearing a "COACH" pin.

DRIVER – A pre-college student team member responsible for operating and controlling the ROBOT.

HUMAN PLAYER – A pre-college student team member designated as the only team member permitted to throw SMALL balls onto the field.

SCORED – A SMALL ball is SCORED when it is contained within a goal or SUPPORTED only by the goal and/or other SCORED SMALL balls. A ball is not considered SCORED if it is touching a ROBOT of that alliance or is SUPPORTED by a structural part of the field other than the goal.

CAPPING – A LARGE ball is considered to be CAPPING a goal if it is SUPPORTED by the goal poles and/or SCORED SMALL Balls. A LARGE ball is not considered to be CAPPING a goal if it is touching an alliance ROBOT (of that goal's color) or is SUPPORTED by more than one goal or a structural part of the field.

SUPPORTED – If the "supporting object" is removed, the ball would not remain SCORED or CAPPED and/or the ROBOT would not remain HANGING.

GOALTENDING – A ROBOT cannot interfere with a SMALL ball on its downward flight toward a goal or within a goal.

HANGING – A ROBOT is considered HANGING from the Pull-Up Bar if it is directly SUPPORTED by the horizontal bar and is not touching the carpet, platforms, or goals.

AUTONOMOUS PERIOD - During this 15-second period, the ROBOTS operate and react only to sensor inputs and to commands programmed by the team into the onboard robot control system. Human control of the ROBOT will not be possible during this time. During this period, ROBOTS may perform any activities that would be permissible when operated under human control. All ROBOT operation and safety rules applicable during the operator control period are also applicable during this period.

BONUS BALL – A SMALL ball which, when SCORED, is worth ten points. Two BONUS BALLS, accessible by any team, are initially positioned on BALL TEES at each side of the field.

BALL TEE– A post which SUPPORTs the BONUS BALL at the start of the match. BALL TEES are associated with the ball release closest to each BALL TEE. If the BONUS BALL is removed from the BALL TEE during the AUTONOMOUS PERIOD, the ball release associated with that BALL TEE is activated.

STRADDLE – A ROBOT is considered STRADDLING the white line on the field if the ROBOT makes simultaneous contact with the playing field floor in at least one point on either side of the line.

4.3.2 Match Format

A match is 2 minutes long. At the start of the match, all HUMAN PLAYERS, DRIVERS and COACHES must stand on the Team Zone Starting Line, 3 feet away from their Driver's Station. An AUTONOMOUS PERIOD starts the match and lasts 15 seconds. Following the AUTONOMOUS PERIOD, the Driver Station controls will be activated and students may remotely control and operate their ROBOTS for the final 1 minute and 45 seconds of the match.

4.4 RULES

4.4.1 Scoring

<G01> A SCORED SMALL ball is worth the point value printed on the ball (5 or 10 points).

<G02> A LARGE ball CAPPING a goal doubles the SMALL balls SCORED within that goal.

<G03> A ROBOT HANGING from the Pull-Up Bar at the end of a match is worth 50 points.

4.4.2 Safety

<G04> If a ROBOT goes out-of-bounds (outside the playing field) to the point where it has to apply force to any out-of-bounds surface to rejoin play, its control system will be disabled and the ROBOT will be disabled. For purposes of this rule, the BONUS BALLS and BALL TEE are considered part of the playing field.

<G05> ROBOT mechanisms used to remove the BONUS BALLS may extend beyond the playing field border as long as they are within the vertical pipe structure surrounding the BALL TEES. If a BONUS BALL is removed from the BALL TEE by a ROBOT that violates this rule, a 25 point penalty will be deducted from that alliance's final score.

<G06> A ROBOT will be disabled if the ROBOT operation is deemed unsafe.

<G07> Two Emergency Stop (E-Stop) buttons are located in each alliance station, one for each team. Pressing an E-Stop button will cause the corresponding team's ROBOT to be disabled for the remainder of the match. The E-Stop buttons are intended for remote shut down during a match in the event of safety hazards and will not otherwise affect match scoring or duration.

<G08> Mechanisms which interact with the Pull-Up Bar are limited to a maximum tip velocity (relative to the ROBOT) of 10 feet per second.

<G09> Team members may not extend any part of their bodies into any part of the playing field, including the Ball Corral. Paddles will be provided to move balls from the Ball Corral into the Team Zone. Violating this rule will result in the disabling of the team's ROBOT and the team will be disqualified.

<G10> HUMAN PLAYERs cannot be aided by any object or ther person. Violating this rule will result in the disabling of the team's ROBOT and the team will be disqualified.

4.4.3 General Match Rules (GM)

<G11> At the beginning of a match, each ROBOT must not exceed a 30 inch by 36 inch footprint and must STRADDLE the white line on the playing field floor.

<G12> Each team will include one HUMAN PLAYER, two DRIVERS, and one COACH.

<G13> No team member may pass the Starting Line in their Team Zone until the conclusion of the AUTONOMOUS PERIOD. All team members must stay within their alliance's designated Team Zone during the match.

<G14> Team members may not touch any balls during the AUTONOMOUS PERIOD. HUMAN PLAYERS may use any balls in the Team Zone once the AUTONOMOUS PERIOD ends.

<G15> During the AUTONOMOUS PERIOD, the Ball Release will release an alliance's SMALL balls when a BONUS BALL is removed from either of that alliance's BALL TEEs. If the Ball Release is not activated during the AUTONOMOUS PERIOD, the balls will be released 45 seconds into the match. Teams may remove BONUS BALLs after the AUTONOMOUS PERIOD, however that action will not trigger the Ball Release. Each alliance Ball Release acts independently from the other alliance's Ball Release.

<G16> ROBOTS can only pass the SMALL balls into the Team Zone via the Ball Chute. Once balls have cleared the Ball Corral, any team member may pass SMALL balls to either HUMAN PLAYER on their alliance.

<G17> SMALL balls may only be SCORED by the HUMAN PLAYER's direct throw. If any other team member throws a SMALL ball into the field during a match, that team's ROBOT will be disabled and the team will be disqualified.

<G18> ROBOTS cannot SCORE or de-SCORE SMALL balls.

<G19> If an alliance ROBOT assists any SMALL ball into either of their goals, the referee will throw a red penalty flag and the alliance's final score will be decreased by twice the value of that SMALL ball.

<G20> ROBOTS cannot GOALTEND either the Mobile or Stationary Goals. If a ROBOT GOALTENDs or de-SCORES any SMALL ball, the referee will throw a green penalty flag and the opponent's final score will be increased by twice the value of that SMALL ball.

<G21> While a ROBOT is holding a LARGE Ball, that ball will be considered an extension of the ROBOT.

<G22> SMALL balls that leave the playing field or team zone are considered out of play and will not be deliberately returned to play.

<G23> Any LARGE balls that leave the playing field during a match will be returned to the playing field as soon as possible. The LARGE ball will be placed near the location where it exited the field as quickly as practical.

<G24> ROBOTS can only grab a Mobile Goal by the top metal edge of the goal platform perimeter. No part of a ROBOT can extend under the base of the Mobile Goals. ROBOTS may never grab or attach to the poles. If a ROBOT grabs any other part of the Mobile Goal or extends under the base of the Mobile Goal, the referee will give one warning. If the referee decides that the team is disregarding that warning, the team's ROBOT will be disabled and the team will be disqualified.

<G25> If ROBOTS intentionally tip over any Mobile Goal or damage the poles of a Mobile or Stationary Goal, that team's ROBOT will be disabled and the team may be disqualified.

5 THE ROBOT

5.1 OVERVIEW

This section of the 2004 FIRST Robotics Competition Manual provides rules and requirements for the design and construction of the Robot.

This section also includes tips and guidelines for design and construction of some aspects of the Robot.

5.1.1 Other Important Documents

In addition to this section, there are other documents you should review before proceeding with the robot design process:

- *The Arena* and *The Game* sections of this manual
- *Shipping Deadlines* listed in the *Robot Transportation* section of this manual
- Instruction manuals for the *Robot Controller*, *Spike Relay modules*, and *Victor 884 Speed Controllers* which are provided by their manufacturer, Innovation First, Inc., and are available at: http://www.innovationfirst.com/firstrobotics/
- Information about the pneumatic components and ordering process are included in the 2004 FIRST Pneumatic Manual available at http://www.usfirst.org/

5.1.2 What is a FIRST Robot?

A FIRST robot is a remotely operated vehicle designed and built by a FIRST student Robotic Competition team to perform specific tasks when competing in "The Game." It is electrically powered by an on-board 12v battery, and utilizes various electrical, mechanical, and pneumatic systems in its operation. These systems employ sensors and feedback, and are controlled by a programmable on-board Robot Controller that communicates with the team's human operators via a two-way wireless modem. The robot may be operated in either an autonomous mode or under the direct control of its human operators via the wireless link.

The building of a robot involves the integration of several basic systems such as supporting structure, electrical, pneumatics, controls, etc. This section summarizes the electrical and pneumatic systems that are based on the parts provided in the Kit. Additional information about the Robot Controller, pneumatic devices, sensors, and other devices is also available in their respective manuals and specification sheets.

The minimum configuration that constitutes a FIRST Robot is 1) a structure; 2) a provided 12V battery, breaker, and fuses; 3) a provided Robot Controller and associated radio modem, 4) all four provided Team Color LEDs .

5.1.3 Safety

There are specific rules and limitations that apply to the design and construction of your robot. Most have been established to ensure that every FIRST robot has been designed in a safe manner. Please ensure that you are familiar with each of these safety rules before proceeding with robot design.

5.1.4 Getting Started

Before proceeding with your robot's actual design, there are several matters that teams should assess. The following are a few important points offered to help teams get started:

1. Evaluate The Game's physical challenges and identify those the robot will have to overcome.
   - Will it have to climb structures, pick and place items, push / pull goals, possess a low profile, extend its height, lift items, hang, etc.?
   - What are the game's implications regarding the robot's center of gravity?
   - Are there unique field surface characteristics that you should consider when determining robot driving mechanism tread design?
   - Are there any particular offensive / defensive capabilities the robot needs?
2. Review all items provided in the Kit of Parts and gain an understanding of their basic features. Note that there are also suppliers' data sheets for many of the components in the Kit.

3. Read all of The Robot section of this manual, and pay particular attention to the rules.
4. Look through the manuals provided for the Control System and pneumatic components.
5. Look over the specifications and technical notes provided for the various Kit components.

   Note: Pay particular attention to the torque/speed/current draw characteristics of the Kit's motors. Poor motor performance or failure may occur if employed transmission gear/sprocket ratios are not properly chosen to allow motors to operate within their preferred torque/speed/current ranges.
6. Note all safety requirements relating to the robot's design.
   - The locations and ratings of circuit breakers where indicated in the wiring diagrams
   - Any mandatory wire size requirements
   - Stored energy guidelines

5.2 ROBOT DESIGN AND CONSTRUCTION RULES

There are specific rules and limitations governing the design and construction of your robot. When reading the rules, use technical common sense (engineering thinking) rather than lawyer interpretation, and try to understand the reasoning behind a rule. **Any noncompliance with a robot design or construction rule must be rectified before a robot will be allowed to compete.**

5.2.1 Safety Rules

<R01> Energy used by FIRST Robotics Competition robots, i.e., stored at the start of a match, may come solely from:

- Electrical energy derived from the onboard 12V and 7.2V batteries
- Storage achieved by deformation of robot part
- Compressed air stored in the pneumatic system, but only supplied by the compressor included in the kit, and stored at a maximum pressure of 120 PSI only in the two Clippard Instruments tanks provided in the Kit
- A change in the altitude of the device's center of gravity

Teams must be very careful when incorporating springs or other items to store energy on their robot by means of part or material deformation**.** A robot may be rejected at inspection if, in the judgment of the inspector, such items are unsafe.

5.2.2 Robot Size Requirements

<R02> The ***maximum allowed size of the robot*** is 30 inches (76.20cm) wide by 36 inches (91.44cm) long by 60 inches (152.40cm) high.

<R03> The starting configuration of a robot immediately prior to being enabled by the Arena Controller at the beginning of a match is the basis upon which a robot will be inspected for compliance with the maximum allowed size. This configuration of the robot must fit within a FIRST Sizing Box that has the following inside surface dimensions: A flat, level rectangular base 30 inches x 36 inches, and a height of 60 inches. Other than resting on the floor of the Inspection Box, no part of the robot may touch the sides or top of the box during size inspection. The robot must be self-supporting while in the Sizing Box.

<R04> If a robot has been designed such that it may have more than one possible starting configuration, the largest possible configuration must be the one used during size inspection.

<R05> Once a match begins, robots may extend beyond the starting size under their own power. Any restraints (elastics bands, springs, etc.) that are used to maintain starting size must remain attached to the robot for the duration of the match.

5.2.3 NEW - Robot Weight Requirements

<R06> The maximum allowed weight **of all** robot configuration components combined is 130.0 pounds (58.97 kg). At the time of weigh in, the basic robot platform and any additional items that might be used in different configurations of the robot must be weighed together**.** Weight limit includes (one) 12V battery, control system, decorations, bumpers, and any other attached parts.

*Example: A team has decided to design its robot such that, before any given match, it may quickly change the configuration of the robot based on perceived strengths or weaknesses of an opponent team's robot. The team accomplished this by constructing its robot as a basic drive train platform plus two versions of a ball gripper, each gripper being a quick attach / detach device such that either one or the other gripper may be part of the robot at the beginning of a match. Their robot's platform weighs 120 lb, version A of the gripper weighs 6 lb, and version B weighs 8 lb. Although only one version will be on the robot during a match, both must be on the weight scale along with the robot platform during weigh in. This would result in a **rejection** of the robot because its total weight comes to 134 lb.*

5.2.4 Robot Visibility Requirements

<R07> *Robots must display their team number, sponsor and school names, and/or logos*. The judges, referees, and announcers must be able to easily identify robots by Team Number. Teams must display their Team Number in four locations at approximately 90-degree intervals around the side of the robot. ***The numerals must be at least 4 inches high, at least in 3/4 inch stroke width and in a contrasting color from its background***. *Team Numbers must be clearly visible from a distance of not less than 100 feet.*

<R08> Robots must use all four Team Color LEDs provided in the kit to display their alliance color (red or blue). Previous years rotating lights are not allowed. All four Team Color LEDs must be mounted on the robot such that their displayed color is visible over the entire 360 degree circle around the robot from a distance of at least 100 feet. Instructions for connecting the lights are provided in the Innovation First controller manual. The Robot Controller directly powers and controls the Team Color LEDs. The user has no control over the Team Color LEDs and no programming is required.

5.2.5 Design and Build Rules

<R09> Teams must fabricate and/or assemble all custom parts and assembled mechanisms on the robot by the 2004 team after the start of the Kick-off. Mechanisms from previous year's robots may not be used, however, individual off-the-shelf components from previous year's robots may be re-used to save the cost of re-purchase of these parts IF they meet ALL of the 2004 Additional Parts and Materials Rules.

- If you do use previous years' components, their costs must be included in the 2004 cost accounting, and applied to the overall cost limit.
- You may not use previous years' motors in addition to those provided in the 2004 Kit. You may use previous years' motors as direct replacements for those provided, however they must be the same identical motor as in the 2004 Kit.
- You may not use previous years Robot Controllers or Victor 883 Speed Controllers.

<R10> Teams are expected to design and build robots to withstand vigorous interaction with other robots. See The Game section of the manual.

<R11> Mechanisms or components that present an obvious risk of entanglement are not allowed.

<R12> No devices are permitted on the robot that will jam, or interfere with any sensors on competing robots. Teams shall not employ IR sources that could interfere with the IR beacons that are part of the 2004 playing field. FIRST will be monitoring the IR environment at all events with scanning devices to detect any attempted interference.

<R13> Robot wheels, tracks, and other parts intended to provide traction on the playing field ("traction devices") may be purchased or fabricated. In no case, will traction devices that damage the carpet or other playing surfaces be permitted. Traction devices may not have surface features such as metal, sandpaper, or hard plastic studs, cleats, or other attachments. Anchors, i.e. devices that are deployed/used to keep one's robot in one place and prevent if from being moved by another robot, cannot use metal in contact with the carpet or other playing surfaces to "stay put." Gaining traction by using adhesives or Velcro-like fastener material is not allowed.

<R14> Electrical tape is the only adhesive-backed tape that may be used on the robot. It may only be used as an electrical insulator.

<R15> Lubricants may be used only to reduce friction within the robot. Lubricants shall not be allowed to contaminate the playing field surfaces, balls, or other robots.

<R16> Raw materials may be machined or fabricated into custom parts.

<R17> In order to help reduce the impact forces that the robot will experience during collisions with other robots, teams may add external "bumpers" to the robot. If used, bumpers must satisfy the following constraints:

- Bumpers may extend outside the normal robot starting dimensions (in the horizontal plane) up to 4."
- Bumpers must be located in a region from 2" to 8" above the playing field surface.
- Bumpers must not cause the weight of the robot to exceed the weight limit.
- Bumpers must be removable in order to allow the robot starting size to be easily measured during robot inspection.
- Bumpers must remain attached to the robot for the duration of the match.
- Bumpers and any bumper mounts that extend beyond the robot starting size *may not contain "hard" materials* such as metal, wood, or hard plastics. The definition of "hard" is one of common sense, i.e., if you can punch it and not hurt your bare hand, it is ok.
- Adhesive-backed tape may not be used to fasten bumpers.

5.2.6 Electrical System Requirements

<R18> The only legal main source of electrical energy on the robot is one of the two 12v DC non-spillable lead acid battery provided in the Kit of Parts, or a spare of the same part number. The 7.2v "backup" battery is considered an integral part of the Robot Controller, and may not be used for any other purpose.

<R19> The 12v Battery may only be charged by a 6 Ampere rated battery charger between matches. When recharging Kit batteries, you may use the charger provided by FIRST or one with equivalent charging current.

<R20> The 12v battery must be wired directly to a quick connect / disconnect connector (provided in the kit) that in turn feeds power to the Main Power Disconnect Switch and Circuit Breaker Assembly.

- The breaker will automatically "trip" to the open state if a current in excess of its 120A rating passes through it for several seconds. It remains tripped until manually reset.
- The main disconnect switch is manually operated, and is used to totally shut down the robot's 12v electrical system. Then, the Robot Controller must be reset to shut down the 7.2v backup system.
- You must install the 120A circuit breaker in series with the positive terminal of the 12v battery such that all battery output flows through the breaker before being distributed to any electrical component on the robot. The breaker must be readily accessible for inspection and testing at each FIRST Robotics Competition event.

<R21> Power from the main breaker must be fed to the Maxi-style breaker panel, and either or both of the two current distribution blocks that provide power to individual branch circuits on the robot, each protected by an automatically resetting circuit breaker.

<R22> All electrical devices must be isolated from the Robot Frame; the robot structure may not be used to carry electrical current. The negative (return) wiring must be electrically isolated (floating) from the robot's frame. (This isolated ground arrangement is necessary due to polarity reversals that occur under certain operating conditions such as during motor direction reversals.)

<R23> The Robot Controller must manage all electrical operation of the robot.

5.2.7 Control System Rules

<R24> The control system is provided to allow wireless control of the robots. The Operator Interface, Robot Controller, Servos, Speed Controllers, Relay Modules, Radio Modems, Batteries, Battery Charger, AC Adapter, 9-pin cables, Maxi-style power distribution block, ATC breaker panels, circuit breakers, and fuses may not be tampered with, modified or adjusted in any way, (Tampering includes drilling, cutting, machining, gluing, rewiring, etc.) with the following exceptions:

- The dip switches on the Operator Interface may be set as appropriate.
- The user programmable code in the Robot Controller may be customized.
- The Speed Controllers may be calibrated as described in owner's manuals.

<R25> You must design your Robot to be operated by the wireless, programmable Innovation First 2004 Robot Control System.

<R26> Teams are responsible for any software bugs introduced into the Robot Controller's control program when using a custom program or for any unwanted or unanticipated robot behavior when using additional electronics.

<R27> The Robot Controller must be positioned within the robot so that its indicator lights may be seen during inspection and during operation in a match. This will greatly facilitate analysis in case of problems.

<R28> All circuit breakers must be accessible for inspection at each FIRST Robotics Competition event.

<R29> The terminals on the 12v battery must be insulated with electrical tape to reduce the risk of short circuits.

<R30> The team number settings on the Operator Interface must be set to the team number assigned to the team by FIRST, then the Robot Controller must be tethered to the Operator Interface to transfer the Team Number setting to the Robot Controller. This only needs to be done once after setting the Operator Interface.

<R31> A Relay Module must receive its power from a 20A circuit breaker, and may power no more than one motor or the compressor.

<R32> The Robot Controller, Relay Modules, 12Vdc LEDs, additional electronics, and muffin fans may be connected directly to 20A circuit breaker outputs. The Speed Controllers for the Globe motors, Fisher-Price motors, and the Van Door motor may be connected to 30A or 20A circuit breaker outputs. **Only the Speed Controllers for the Drill motors and CIM motors may be connected to the 40A Maxi Breaker Block outputs.**

<R33> The Drill motors, Fisher-Price motors, Globe motors, CIM motors, and Van Door motors may only be powered by the Speed Controllers. Do not connect these motors to the Relay Modules**.**

<R34> No more than one drill motor, CIM motor, Fisher-Price motor, Globe motor or Van Door motor may be powered by each Speed Controller

<R35> The Seat motor, Window motors, and 12Vdc LEDs may be powered by the Speed Controllers or the Relay Modules. Optionally, one Speed Controller may power two window motors.

<R36> The air compressor must be powered by a Spike Relay connected to a 20A breaker on the ATC breaker panel.

<R37> Do not connect 12Vdc power, Relay Module outputs, Speed Controller outputs, or PWM outputs to the analog or digital I/O on the Robot Controller.

<R38> You must connect all outputs from the sensors and additional electronics circuits used on the robot directly to the analog or digital I/O on the Robot Controller. ***Sensors may not be wired in series with their loads to directly control those loads***. The loads must be controlled by PWM signals sent by the Robot Controller to relays or speed controllers. It is acceptable to wire switches used as sensors in series or parallel with each other.

<R39> The 7.2V Robot Control backup battery must be connected to the controller as described in the controller's manual. The 7.2v battery must be charged to at least 7.0v before entering a match. Besides the EDU battery, any 7.2V NiCad battery pack can be used.

<R40> A remote reset and remote programming switch may be wired to the Robot Controller's RESET/PROG header. Any switch may be used. See the Robot Controller manual for wiring information.

5.2.7.1 Wiring Requirements

<R41> The wire supplied in the Kit is to be used to conduct electricity. The chassis of the robot is ***not*** be used to conduct electricity. You may use additional wire as long as it meets the gauge and insulation color requirements.

<R42> Electrical devices may only be wired as indicated in this section. For your convenience, reference the **2004 Robot Power Distribution Diagram.**

<R43> All wires distributing power with a constant polarity (i.e., except for Relay Module outputs, Speed Controller outputs or sensor output) must be color-coded as follows:

- Use Red or White wire for +12 Vdc and +5 Vdc connections.
- Use Black wire for Common (-) connections.

<R44> *You must use **6 AWG wire*** to connect the 12v battery to the quick disconnect connector, then to the 120A main circuit breaker/disconnect switch and then to all circuit breaker panels.

<R45> *You must use **10 AWG** or larger* diameter wire for connections from the Circuit breaker Panel or Block to the Speed Controllers if they are used with the Drill, CIM, Fisher-Price, Globe or Van Door motors.

<R46> *You must use **16 AWG** or larger* diameter wire for connections from the Circuit breaker Panel to the Speed Controllers if they are used with the seat motor or window motors

<R47> *You must use **16 AWG** or larger* diameter wire for connections from the Circuit breaker Panel to the Robot Controller, large muffin fans or Relay Modules

<R48> *You must use **24 AWG** or larger* diameter wire for connecting sensors (switches, potentiometers, pressure sensor, optical sensors, current sensor analog outputs) to Robot Controller inputs, for extending the PWM cables, for the small muffin fans, or for wiring LEDs. It is acceptable to use ribbon cable smaller than 24 AWG to connect to the 9 pin ports on the robot controller; color coding is not necessary.

5.2.8 Custom Circuit Rules

<R49> Additional electronics must be wired to their ATC breaker using a ***16 AWG** or larger* diameter wire.

<R50> The use of additional electronics is intended to allow teams to construct custom circuits for their robots. The custom circuits may be used to indirectly affect the robot outputs, by providing enhanced sensor feedback to the Robot Controller to allow it to more effectively decide how to control the robot. The custom circuits must draw power from a 20A circuit breaker. Smaller value fuses may be incorporated into the custom circuits for additional protection. All outputs from the custom circuits must be connected to the analog inputs, digital I/O, TTL Serial Port, or Program Port on the Robot Controller.

<R51> Inputs to custom circuits may be connected to the following sources:

- Circuit breaker outputs
- Speed Controller or Relay module outputs
- PWM or Relay outputs on Robot Controller
- Switches, Potentiometers, the outputs from Current Sensors, Optical Sensors, Motors, and other additional electronics allowed

<R52> Custom Circuits may **not:**

- Interfere with the operation of other robots
- Directly affect any output devices on the robot, such as by providing power directly to a motor, supplying a PWM signal to a speed controller or supplying a control signal to a relay module. (Custom high impedance voltage monitoring or low impedance current monitoring circuitry connected to the robot's electrical system are acceptable, because the effect on the robot outputs should be inconsequential.)
- Be used for wireless communication, such as sending or receiving a signal to and/or from the alliance station
- Connect to the radio or tether ports on the Robot Controller

5.2.9 Pneumatic System Requirements

The pneumatic system uses compressed air from a 12V DC powered compressor that discharges into two air storage tanks. The compressor may be mounted on the robot, or if teams prefer, they may leave it off their robot, and pre-charge and store compressed air in the storage tanks prior to bringing their robot onto the playing field. Tank pressure is automatically limited to 125 psi by means of a pressure relief valve and compressor controls provided in the Kit. The output of the storage tanks is fed to a pressure regulator that limits the downstream "line working air" to a maximum pressure of 60 psi. Instructions for configuring and using the pneumatics, and a list of additional available pneumatic components are provided in the FIRST Pneumatic Manual 2004.

<R53> Pneumatic components supplied in the Kit (pump, regulators, pressure switches, cylinders, valves, fittings, tubing, etc.) may not be modified except as follows:

- The tubing may be cut.

- The wiring for the valves and pressure switch may be modified as necessary to interface with the rest of the control system.
- Mounting and connecting pneumatics components using the pre-existing threads, mounting brackets, etc., is not considered a modification of the components.
- Do not, for example, file, machine, or abrasively remove any part of an air cylinder. Consider pneumatic components sacred. They must remain in "out of the shipping box" condition.

<R54> You may only use the Thomas Industries compressor and Clippard Instruments air storage tanks provided in the Kit to compress and store air on the robot. Please refer to the Pneumatics Manual for information about using pneumatics on your robot. **Teams are not allowed to remove or adjust the 125 psi set relief valve attached to the compressor.** The Nason Co. pressure switch must be connected to the output end of one of the Clippard tanks to sense the tank's pressure. The two wires from the pressure switch must be connected directly to a digital input and ground terminals on the Robot Controller, and the controller must be programmed to sense the state of the switch to operate the relay that powers the compressor.

- The pressure vent valve must be connected to a Clippard tank such that, when manually operated, it will vent to the atmosphere to relieve any stored pressure. The valve must be placed on the robot so that it is visible and accessible.
- "Working" air pressure on the robot must be no greater than 60psi. All working air must come from the Norgen adjustable pressure regulator, and all other pneumatic components must be downstream from this regulator. A pressure gauge must be placed adjacent to the pressure regulator and display the downstream pressure.
- There is no limit to the number of solenoid valves, air cylinders, and connecting fittings you may use on your robot. They must, however, be "off the shelf" pneumatic devices rated by their manufacturers for pressure of at least 125psi. Besides the "free" pneumatic components listed on the Pneumatic Components Order form, you may use additional air cylinders or rotary actuators, however, they must be identical to those listed on the Pneumatic Components Order form, and obtained from a Bimba or Parker Hannifan distributor.
- You may use a previous year's Kit pneumatic cylinders and solenoid valves in addition to those items in the 2004 Kit, but you must account for their costs as explained in the Cost Limits and Accounting section.
- You may use the TI pressure transducer provided in the Kit to measure the air pressure at any point in the pneumatic system. It provides an analog output voltage that may be used as an input to the Robot Controller or custom electronics.

5.2.10 Non-Functional Decoration Rules

Teams may add "Non-functional" decorations to robots under the following conditions:

<R55> Decorations must not cause the robot weight or size to exceed requirements.

<R56> Decorations must not affect the outcome of the match.

<R57> Any decorations that involve broadcasting a signal to/from the robot, such as remote cameras, must be cleared with FIRST Engineering prior to use. Teams may **not** use *900 MHz camera systems.*

<R58> Decorations may draw power from the 12v electrical system as long as they are powered via a dedicated 20A or 30A circuit breaker and do not affect the operation of other control system components.

<R59> Decorations must be on your robot at the time of final inspection.

<R60> Decorations must be in the spirit of "Gracious Professionalism."

5.3 ROBOT MATERIAL USAGE RULES

<R61> A FIRST robot may be built using only

- Items provided in the FIRST supplied Kit of Parts (or their exact replacement part)
- Allowed Additional Parts and Materials as defined in this section in quantities consistent with the Cost Accounting requirements

5.3.1 FIRST Provided Kit of Parts

FIRST provides each team a Kit of Parts. Only the exact parts provided in the Kit (or their exact replacement) are considered as Kit Parts. Some Kit Parts may legally be used in additional quantities. Additional quantities of these parts are considered to be Additional Parts and not Kit Parts.

The official list of Kit Parts and quantities appears in a separate section of this manual titled *The Kit.*

5.3.1.1 NEW - Kit Contents vary by Team Age

The FIRST 2004 Kit of Parts consists of two large plastic containers of robot parts and construction materials, a structural metals box, and a box containing documentation and software. (**Air compressor and battery charger not included.)**

Kit contents vary by team age. Teams that were new in 2003, and new 2004 teams are being provided with an additional "Year One and Two Team Box." The "Year One and Two Team Box" contains an air compressor, three vibration isolators for the compressor, and a battery charger. All teams that participated in FRC 2003 are to reuse their compressors and battery chargers that FIRST provided in the 2003 Kit of Parts. The reason for this policy change is to limit Kit costs.

5.3.1.2 NEW - Kit Inventory

FIRST has an extremely limited supply of replacement parts

Teams will have until **January 16, 2004** to inventory their entire kit of parts and determine if any parts are missing or broken and fax or mail their checklist back to FIRST. The 2004 Kit of Parts checklist is located in Section 6 of this manual.

- Missing items must be clearly marked on the checklist. – Please fax the checklist to 603-666-0043 attn: FRC parts. *Put your team number on EVERY PAGE*
- Broken items must be returned with the checklist in order to be replaced. FIRST will not provide replacements for broken parts due to any modifications. Please send them to: FRC Parts, FIRST, 200 Bedford Street, Manchester, NH 03101
- Unless otherwise specified, replacement parts shipped from FIRST will ship via 2nd day within one business day of receipt of the broken part. Teams may opt for overnight shipment at their expense by requesting it and providing their shipping company preference and account number (UPS or FedEx, ONLY.*)*.

5.3.1.3 NEW - Obtaining Replacement or Spare Kit of Parts

We will have a VERY LIMITED listing of parts available at events posted via the web no later than January 16, 2004.

Please note – If your robot uses any other parts, and there is a reasonable possibility it may become damaged or broken during a competition event, then it is STRONGLY RECOMMENDED that you obtain and bring appropriate spare parts to events.

FIRST Loan policy for Control System Components:

Teams are responsible for all Innovation First products required at events. If, at any event, a team needs to borrow any part of the Control System, the team must provide a Credit Card number to ensure proper return of the items after the completion of the event.

- If the part is not returned at the end of the event, FIRST retains the right to bill the provided credit card number for the borrowed items.
- All "loan" items are available on a first-come, first-served basis.

Innovation First Products:

Do not contact FIRST for repair or replacement of these Control System items as they are covered by a product warranty from Innovation First. Please visit the Innovation First web site for product support or to obtain a Return Merchandise Authorization Number (RMA#) to return Control System components for replacement.

Contact Innovation First at: 903-454-1978 or at www.innovationfirst.com/firstrobotics/

5.3.1.4 Kit of Parts Rules

<R62> The motors in the kit may **not** be modified except as follows:

- It is acceptable to modify the mounting brackets and/or other structural parts of the motors (output shaft, housing, etc.) as long as the electrical system is not modified and the integral mechanical system of the moving parts (bearings, bushings, worm gear output stages, etc.) is not changed or removed.
- The gearboxes for the Fisher-Price, Drill, and Globe motors are not considered "integral" and may be separated from the motors. FIRST will not provide replacement for parts that fail due to modification.

<R63> Teams may replace lost or damaged Kit components only with identical components of the same material, dimensions, and treatment.

<R64> Materials in the Kit may not be changed chemically with the following exceptions:

- Rope ends may be singed to prevent loose ends or to bind them together
- Metal may be heat treated
- Metal may be plated or anodized

<R65> You may not use the plastic Kit containers, part packaging, and any documentation in the Kit container as a component to build the robot or robot control system.

5.3.2 Additional Parts and Materials Rules

Besides items directly supplied in the 2004 Kit, teams are allowed to use Additional Parts and Materials in the construction of their robots.

<R66> The use of an Additional Part or Material shall not violate any design rule.

<R67> Additional Parts shall not be made from hazardous materials or be unsafe.

<R68> Additional Parts must be generally available from suppliers such that any other FIRST team, if it so desires, may also obtain them at the same price. (A specific device **fabricated by a team** from non-2004 Kit materials does not have to be available to others, however, the materials it is made from must be available to other teams.)

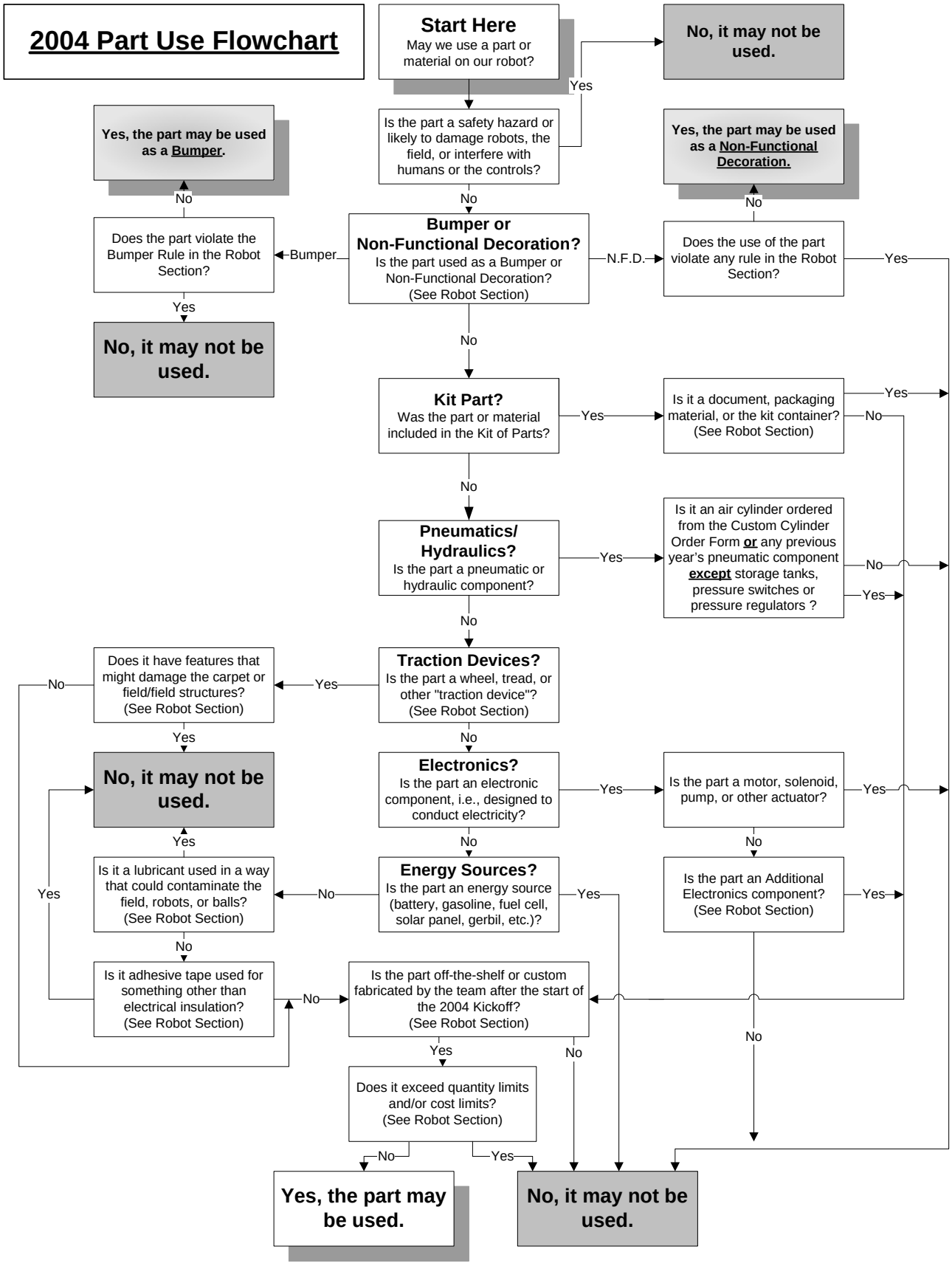
<R69> The sum of all Additional Parts and Materials must be compliant with the Cost Accounting Rules with which teams must comply.

<R70> Specific items NOT allowed include:

- Batteries different from or in addition to those provided in the Kit.
- Circuit breakers different from those provided in the Kit Note: the Snap Action brand circuit breakers provided have unique "trip" characteristics. No substitute brands are permitted.
- Electric motors different from or in addition to those in the Kit.
- Any air compressor, pressure relief valves, or air storage tanks other than those provided in the Kit.
- Hydraulic fluids or hydraulic components.
- Materials classified as hazardous by their MSD Sheets. (Teams should provide MSD Sheets for any materials they use that might be considered questionable during robot inspection.)

<R71> Additional electronic components for use on the robot must be currently available from Newark InOne (http://www.newarkinone.com), Future Active (http://www.future-active.com) or Digi-Key Corporation (http://www.digikey.com). The total catalogue value of additional electronic components must not exceed $200.00 USD. This cost is counted as part of the $ 3,500 limit. No single electronic component shall have a catalog value of over $100.00 USD.

<R72> Refer to the Part Use Flowchart to help determine the legality of a part.


2004 Part Use Flowchart
Start Here
May we use a part or material on our robot?
No, it may not be used.
Yes
Is the part a safety hazard or likely to damage robots, the field, or interfere with humans or the controls?
Yes, the part may be used as a Non-Functional Decoration.
No
Yes, the part may be used as a Bumper.
No
Bumper or Non-Functional Decoration?
Is the part used as a Bumper or Non-Functional Decoration? (See Robot Section)
Bumper
N.F.D.
Does the part violate the Bumper Rule in the Robot Section?
Does the use of the part violate any rule in the Robot Section?
Yes
Yes
No, it may not be used.
No
Kit Part?
Was the part or material included in the Kit of Parts?
Yes
Is it a document, packaging material, or the kit container? (See Robot Section)
Yes
No
No
Pneumatics/ Hydraulics?
Is the part a pneumatic or hydraulic component?
Yes
Is it an air cylinder ordered from the Custom Cylinder Order Form or any previous year's pneumatic component except storage tanks, pressure switches or pressure regulators ?
No
Yes
No
Traction Devices?
Is the part a wheel, tread, or other "traction device"? (See Robot Section)
Yes
Does it have features that might damage the carpet or field/field structures? (See Robot Section)
No
Yes
No
Electronics?
Is the part an electronic component, i.e., designed to conduct electricity?
Yes
Is the part a motor, solenoid, pump, or other actuator?
Yes
No, it may not be used.
Yes
No
No
Energy Sources?
Is the part an energy source (battery, gasoline, fuel cell, solar panel, gerbil, etc.)?
Yes
Is the part an Additional Electronics component? (See Robot Section)
Yes
Is it a lubricant used in a way that could contaminate the field, robots, or balls? (See Robot Section)
No
Yes
No
Is it adhesive tape used for something other than electrical insulation? (See Robot Section)
No
Is the part off-the-shelf or custom fabricated by the team after the start of the 2004 Kickoff? (See Robot Section)
Yes
No
No
Does it exceed quantity limits and/or cost limits? (See Robot Section)
No
Yes
Yes, the part may be used.
No, it may not be used.

5.3.2.1 Cost Limits and Accounting

<R73> The costs of all non-2004 Kit parts and materials used in the construction of a robot must be recorded (in US dollars) by the team, and a list of all such items and their costs made available during robot inspection**. An Additional Part or Material is defined as an allowed additional quantity of any part provided in the 2004 Kit, or any item that was not included in the 2004 Kit's inventory list.**

<R74> All costs are to be determined as explained in the *Cost Determination* section.

<R75> The total cost of all non-Kit items may not exceed $3,500.00 USD. No individual item may exceed $400.00. Non-functional decorations are exempt from this rule. The total cost of components purchased in bulk may exceed $ 400 USD as long as the cost an individual component does not exceed $400. Items such as fasteners, adhesives, lubricants, etc. are also exempt from the cost calculation, unless any one component exceeds $1.00.

<R76> The costs of "spare" parts are excluded from this rule. A spare part is defined as a part that a team has obtained as a direct replacement for a failed or defective Robot part (Kit part or non-kit part)

<R77> The costs of additional non-spare robot control system components obtained from Innovation First Inc. are included in the above $3500 limit. (Example: A team purchases a Victor Speed Controller from IFI to use on its robot in addition to the Victors provided in the Kit. The cost of the additional speed controller must be included in the above expense reporting and $3500 limit.)

<R78> A list of all purchased materials, including costs, used in the construction of the robot shall be made available if requested by FIRST during the robot inspection process. At each competition event, teams should be prepared to present a complete materials list/spreadsheet that details the source and cost of each additional component of the robot, if requested.

5.3.2.2 Cost Determination

The "cost" of each additional item is counted as follows:

- The purchase price of a non-custom built item offered for sale by a vendor to a general customer base.
- The total cost (materials + labor) of an item you pay someone else to make; Example: A team orders a custom bracket fabricated by a vendor to the team's specification. The vendor's material cost and normally charged labor rate apply.
- The fair market value of an item obtained at a discount or as a donation; Fair market value is that price at which the item would be normally offered by the supplier to any party. Also considered to be "fair market value" are the discounted prices offered to all teams by those suppliers who have established them for FIRST. Example: The special price discounts MSC Industrial Supply Co., Newark InOne, and Terminal Supply Co. are offering to all FIRST teams.
- The cost of raw material obtained by a team + the cost of non-team labor expended to have the material processed further. Team member processing labor is not included. Example: A team purchases steel bar stock for $10.00 and has it machined by a local machine shop that donates its 2 hours of expended labor. The team must include the estimated normal cost of the labor as if it were paid to the machine shop, and add it to the $10.00. Exception Examples: If the team members themselves did the actual machining, there would be no associated labor cost. If the machine shop were part of the team, its labor cost would not apply.
- The cost of items purchased in bulk or large quantities may be prorated on the basis of their actual use on the robot. Example: A team purchases a 4' x 4' sheet of aluminum, but only uses 30 square inches of it on their robot. The cost that the team would have to report would be 30 divided by 2304 times the actual cost of the whole sheet.
- Shipping costs of Non-Kit items are not counted.

5.4 ROBOT INSPECTION

FIRST will post a copy of the Offical Inspection Sheet approximately the first week of February. Use this sheet as a guide to pre-inspect your robot before it ships.

<R79> On Thursday, at each event, all robots must pass inspection for compliance with the rules herein before being allowed to compete in Qualification Rounds on Friday. At the time of inspection, teams must present a list of all Non-Kit items and costs used in the construction of their robot. **Noncompliance with any robot design or construction rule may result in disqualification of the machine at a FIRST competition event. At the discretion of the lead Inspector,** the robot may be allowed to participate in practice rounds before passing inspection.

<R80> If a team makes a modification to improve performance or reliability, the team may ask FIRST officials to reinspect. If you suspect that another team's robot is in violation of the robot rules, please approach FIRST officials and we will review the robot in question. This is an area where "Gracious Professionalism" is very important.

<R81> At the time of robot inspection, you must present ***all*** mechanisms that you will use on the robot during the entire competition event. It is acceptable, however, for a robot to play matches with a **subset** of the mechanisms that were present during inspection. Only mechanisms that were present during the inspection may be added, removed or reconfigured between matches. If subsets of mechanisms are changed between matches, the robot must still meet all inspection criteria. Robots must satisfy all rules and requirements at all times.

<R82> During inspection, teams must be able to demonstrate the operation of any robot mechanism intended to interact with the Pull-up Bar on the center structure on the field, and show that its tip velocity complies with the 10 feet/ second velocity maximum limit requirement. One way that this may be accomplished is by recording the tips motion with a camcorder with a known frame rate (to provide delta time) against a measuring tape background reference (to provide delta distance).

<R83> If a robot is rejected because of excess "tip velocity" or a safety concern related to the team's method of storing energy, the concerned mechanisms must be disabled or removed from the robot before it may compete in a match. The team bears the burden of proof that such a rejection is not valid. Teams should be prepared to provide justifiable test data or calculations during inspection to support their design.

5.5 OPERATOR INTERFACE REQUIREMENTS

<R84> The team number settings on the Operator Interface must be set to the team number assigned to the team by FIRST.

<R85> The Operator Interface Console designed by your team must fit on the 42" wide by 9" deep shelf in the Alliance Station and The Radio Modem connected to the Operator Interface must be able to reach the mounting bracket on the operator stations. Be sure to leave at least 48" of slack in the 9-pin cable.

<R86> Teams are permitted to connect a portable computing device (Laptop computer, PDAs, etc.) to the RS232 Output of the Dashboard Port of the Operator Interface for the purpose of displaying feedback from the robot while competing in Competition matches. Portable computing devices *may not* be connected to inputs on the Operator Interface. Please note that ***AC power will not be available at the playing field so these devices will have to run on internal batteries.***

<R87> Teams may not use Innovation First Operator Interfaces from previous years' competitions.

5.6 GUIDELINES FOR WIRING THE ROBOT

WARNING! *Please read this and the following sections very carefully. Failure to wire your robot properly could result in personal injury, damage to the control system, or damage to your robot. It could invalidate the control system warranty. FIRST and/or Innovation First will not provide free replacement of components damaged due to misuse or improper wiring. Teams will be required to correct wiring that is not configured according to this section and the control system rules in the Robot Rules section before being allowed to compete.*

5.6.1 Power Distribution Circuits

The 120A main circuit breaker/disconnect switch functions *both* as the Main power on/off switch for the robot *AND* as a safety current overload protection device.

Shut off robot 12v power manually by pushing the RED BUTTON on the breaker. Turn power back on by pushing the RESET lever back into position.

You **must** wire the 120A circuit breaker/disconnect switch supplied in the Kit of Parts in series with the *positive (+) terminal* on the 12v battery such that all power from the 12v battery flows through the 120A breaker. Do not connect anything other than the 120A main circuit breaker/disconnect switch directly to the 12v battery's positive (+) terminal.

The circuit breaker current ratings indicated for specific circuits are the *maximum* allowed, and the AWG wire sizes are the *minimum* allowed. The Maxi style circuit breaker panel will only hold the 40A Maxi auto re-settable circuit breakers. The 20A and 30A auto re-settable circuit breakers must be used in the two provided 12 position circuit breaker panels.

Table 5.1 Robot Circuits

Circuit	Power Source/Device
Main 12V Battery Circuit	Electric power from the 12v battery passes through a 120A main circuit breaker/disconnect switch to the circuit breaker/fuse panels.
Backup 7.2v Battery Circuit	Connects to the Robot Controller directly. Used as a backup to the Robot Controller only if 12v is not available. Also powers any servos connected to the PWM outputs.
Robot Controller, Relay Modules, Fans, LED, Optical Sensor, Custom circuits	Power is distributed from the circuit breaker/fuse panels via 20A auto-resetting breakers to these devices.
Speed Controller Circuit	Power is distributed from the circuit breaker/fuse panels via single 20, 30 or 40A auto-resetting circuit breakers to the Speed Controllers (see Table 5.2)
All other electrical devices circuits	Sensors, motors, air valves, and the air compressor receive power from either the Robot Controller, Relay Modules, or Speed Controllers as described below.

WARNING! *Be very careful to avoid short circuits!* The 12Vdc SLA batteries can deliver current in excess of 200 Amps for a sustained period of time (minutes). In a short circuit situation, this amount of current can make wires turn red hot and melt through their insulation in a fraction of a second, and can result in serious burns, or other injuries. Short circuits can also destroy control system components, cause fires, or cause the 12v battery to leak highly corrosive acid or explode. Always make sure that the 120A main circuit breaker/disconnect switch is wired in series with the 12v battery positive (+) terminal.

It is *unlikely* that the 120 main circuit breaker/disconnect switch will trip to "off" as a result of the large impact forces sometimes experienced by robots in competition matches.

FIRST ***recommends protecting the top of the breaker and the mechanical trip release. Power from the 120A breaker must be distributed to all loads via the three circuit breaker/fuse panels included in the kit.***

Note: Two of the circuit breaker/fuse panels each contain 12 protected (via the 20A or 30A Snap-Action circuit breakers) outputs connected to one input. On each panel, there is also a 12 position, un-fused terminal block that is isolated from the fused portion of the panel. This un-fused block is intended to act as a Common (-) terminal. Do not connect any 12Vdc (+) terminals of the circuit breaker/fuse panel to the Common (-) terminal. A third (Maxi-style) circuit breaker panel is provided that contains 4 positions to accommodate the larger size 40A Snap Action breakers that protect the Bosch drill and CIM motors.

The FIRST Robot Power Distribution Diagram shows more relay modules and speed controllers than are included in the Kit of Parts in order to show how additional devices may be connected on your robot. You may obtain additional relay modules and speed controllers by purchasing them from Innovation First.

Except as noted herein, each Ground (GND or Common (-) wire from a speed controller, relay, or Robot Controller must go directly from that item to one of the 12 Common (-) terminal tabs on the circuit breaker/ fuse blocks.

Exception: The Ground (GND or Common -) wires from low current items such as relays controlling solenoid pneumatic valves, custom circuits, sensors, LEDs, and fans may be connected as a group to one common wire that leads back to a Common (-) terminal tab on an ATC panel, or directly to the ground stud.

CAUTION! Check wiring periodically!

Be sure to check the wiring on a periodic basis to prevent failures that could harm the control system or cause a robot to stop dead in the middle of a match. Crimp-on connectors that are improperly crimped may work at first, but can fail easily due to the operating vibration of a robot. Also, be sure to avoid tension on the wires when components are installed on the robot, and never remove a connector by pulling on the wire. Loose connections can result in poor performance, intermittent failures, and/or short circuits.

- FIRST recommends that all wiring be laid out in a logical, orderly manner and be managed by the use of plastic quick ties, shrink-wrap tubing or plastic helical wire wrap. The wiring scheme should be easy to trace and interpret during technical inspection.
- It is advisable for a team to create a robot-specific wiring diagram for reference. This would greatly facilitate solving any electrical problems.
- It is also advisable to label wires and devices to facilitate tracing and reconnecting wiring.

5.6.2 Wire Size

At any given current level, the smaller the gauge of a wire, the greater the voltage drop and power loss in the wire due to its inherent resistance. FIRST has specified minimum allowed wire sizes based on guidelines used in the automotive industry. The wires and cables included in the Kit are intended for specific uses. Table 5.2 shows the minimum wire sizes allowed for hookup of the various control system devices. Note that you may use larger wire sizes than indicated in the table or shown on the 2004 Robot Power Distribution Diagram.

Table 5.2: Minimum Wire Size and Protection by Device Type

Device	Wire Type	Circuit Breaker
Power distribution from 12v battery through 120A Main Circuit Breaker/Disconnect Switch to fuse panels	6 AWG/red & black	120A
Drill motors, CIM motors; Speed Controllers used with Drill motors and CIM motors.	10 AWG/red & black	40 A
Fisher-Price motors, Van Door motors, Globe motors; Speed Controllers used with Fisher-Price Van Door, or Globe motors	10 AWG/red & black	30A
Robot Controller power, Relay Modules, seat motor, window motors, compressor, solenoids, large muffin fan; Speed Controllers used with window motors	16 AWG/2 conductor	20A (Relay Modules also have integral 20A fuses.)
All switches, PWM cables, optical sensors, potentiometers, pressure sensor, LEDs, small muffin fans, custom circuits	24 AWG/2 or 3 wire conductor	Requirements vary

It is acceptable to shorten or lengthen Control System cables containing 3 or fewer wires as needed as long as the following conditions are met:

- The connection is insulated.
- The proper wire type is used. (As specified above)

This means, for example, that you may use 24 AWG wire to lengthen a PWM/Relay cable.

Other devices that may be connected directly to the fuse panel (Robot Controller, Fans, etc.) must be connected via a 20A circuit breaker. The same breaker may power all these devices. The 12 Vdc panel mounted LEDs provided in the Kit are intended to be used on the robot as indicator lamps and may be used on Speed Controller or Relay Modules outputs alone, or in parallel with any other devices. You may also power the LEDs directly from an auto-resetting breaker.

5.6.3 Relay Modules

For information about the Relay Modules, refer to the *Spike Users Manual* available on Innovation First's website.

Warning! *Attempting to drive the Drill motors, Van Door motors, Globe motors or Fisher-Price motors directly with the Relay Modules could damage the Relay Modules and is, therefore, prohibited.*.

Under certain circumstances, it is acceptable to power more than one device from a single Relay Module. A single Relay Module may power no more than one motor or the air compressor. A single Relay Module may be used to power valves and/or fans in conjunction with a single window motor. Each Relay Module must receive power via a 20A circuit breaker. It is acceptable to distribute power from a single 20A circuit breaker to multiple Relay Modules.

The Spike Relay modules have a 20A fuse installed onboard. This fuse may be replaced with a 20A circuit breaker only on the Relay Module that is used to control the air compressor. This Relay Module must still be fed from a 20A circuit breaker on the ATC the breaker panel.

One way to achieve control of both solenoids on a double solenoid valve is to use only *one* Relay Module, and avoid running separate power return leads. You can use two diodes (max: 1A, 50V; peak rev.) to route power to one solenoid at a time. Figure 5.1 shows the schematic for this arrangement.

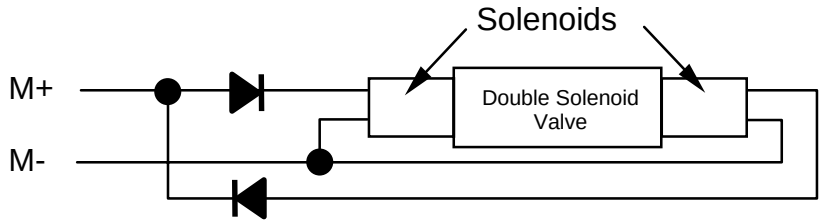


Figure 5.1 Use of Diodes with Double Solenoid Valve

5.6.4 Speed Controllers

For information about the Speed Controllers, refer to the document ***Victor /884 Users Manual*** on the Innovation First website. Each Speed Controller must receive power via a dedicated 20A, 30A or 40A circuit breaker.

Warning!

The Speed Controllers will be damaged if reverse polarity is applied to the power inputs. Please be careful when wiring the Speed Controllers.

5.6.5 Muffin Fans

12Vdc muffin fans are included in the Kit. FIRST recommends installing these fans to direct cooling air over the components that run the hottest (high use motors). You may provide constant power to the fans directly via a 20A circuit breaker or use a Relay Module to switch power to the fans.

Warning! The muffin fans provided in the kit are not reversible. You can damage them if you apply reverse polarity. Please be careful when wiring the muffin fans.

5.6.6 Sensor Inputs and the Robot Controller

Within the rules described below, and in compliance with the documentation supplied by Innovation First, teams may use sensor devices to create a custom sensor system on the robot. Innovation First provides detailed wiring information for sensor inputs connected to the Robot Controller. As a generic reference, Figure 5.2 illustrates typical wiring configurations for connecting analog sensors, switches and other devices to the **analog** or **digital** terminals on the Robot Controller.

Warning! Do not connect switches to +5v Output Pins) of the Robot Controller. The +5v Output Pins are intended to supply fused 5Vdc power for use by sensors.

Warning! *Do not connect any voltages greater than +5v to the analog inputs on the Robot Controller. It may damage the Robot Controller.*

Specific pin selections should conform to the *Pinout and Software Function Schedules* included in the Innovation First, Inc. ***Robot Controller Reference Guide***.

5.6.7 NEW - Current Sensors

New in the Kit for 2004 are two Allegro Microsystems, Inc. current sensors, part number AC750, and high current rated printed circuit boards on which the sensors must be mounted. The sensors are nominally rated to carry currents of 75Amp, and may be used to monitor the current being drawn by the Bosch and CIM motors. They consist of Hall effect devices that measure the strength of the magnetic field created by current passing through an integral copper bus. Their output is treated as an analog signal that may be connected to any analog input on the Robot Controller. This signal is proportional to the current passing through the bus. When soldering the sensor to the high current circuit board, pay particular attention to the integrity of the solder joints. Because both the sensor and circuit board have a high "thermal mass," they require the use of a heavy-duty soldering iron that can provide sufficient heat to properly flow the solder.

5.6.8 NEW - Infrared Receiver Module

In order to detect the infrared beacon signal that is part of The Game for 2004, a Vishay IR Receiver Module, P/N TSOP4840 has been provided in the Kit. It should be connected to a digital input port on the Robot Controller. It detects the 40KHz signal transmitted by the IR beacon, and allows teams to implement an IR tracking system.

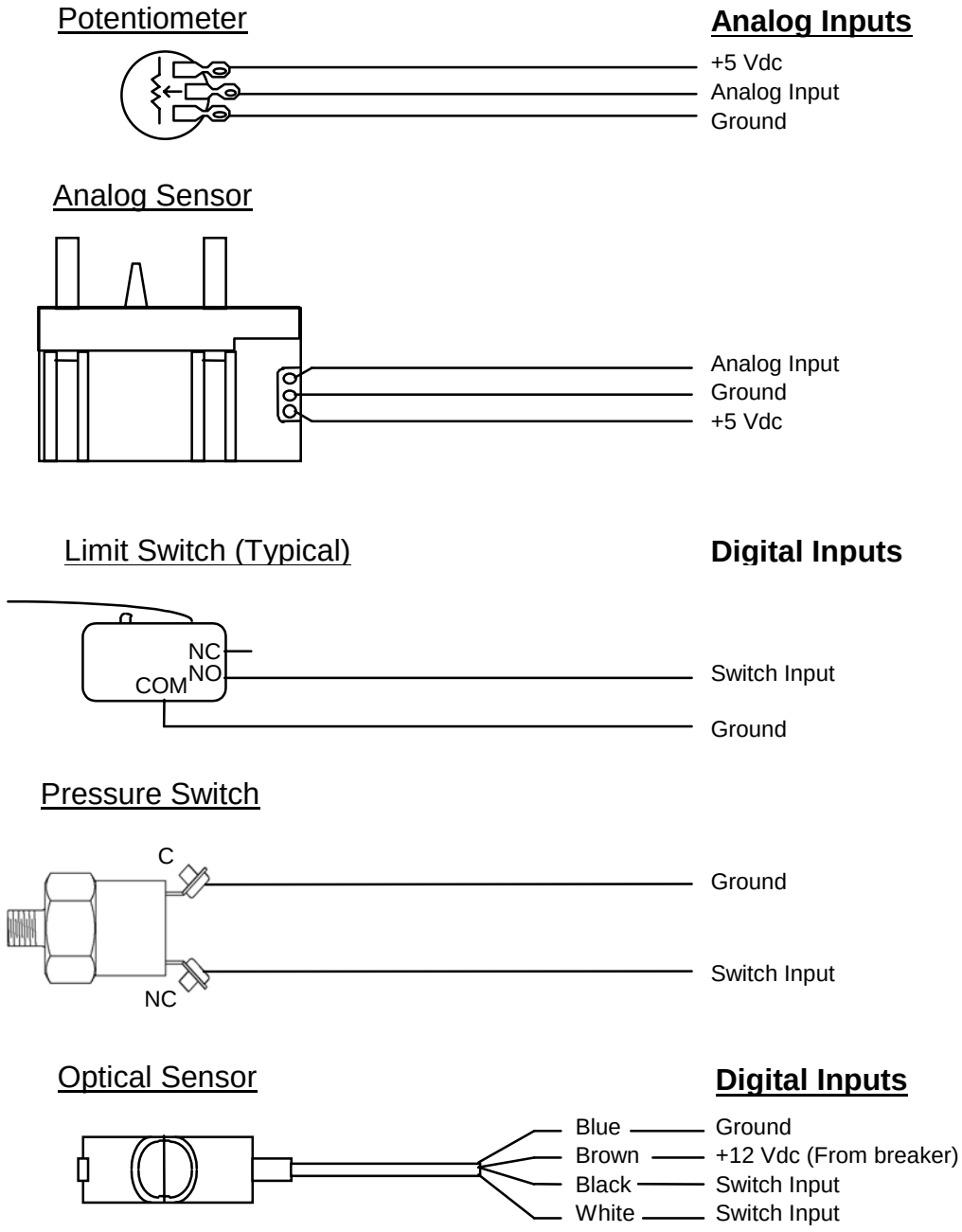


Figure 5.2: Examples of sensor connections to the Robot Controller

5.6.9 Custom Circuits and Additional Electronics

It will be impossible for FIRST to test all custom circuits, so we are relying on all teams to use Gracious Professionalism (and good engineering) when using custom circuits.

Please read the control system documentation from Innovation First for information on the robot controller sensor inputs. Support by FIRST and Innovation First for the additional electronics and custom circuits is limited to the documentation provided in your kit and on the Innovation First website.

5.7 OPERATOR INTERFACE GUIDELINES

5.7.1 Operator Interface Power Distribution

Power may be supplied to the Operator Interface in 3 different ways.

- The A/C Adaptor power supply for the Operator Interface can be plugged into the power jack.

- The Robot Controller will provide power to the Operator Interface when the units are connected together by the tether cable. This disables the radio modems, but is useful in situations where no AC power is available for the power supply.
- During competition matches, a cable that plugs into the Competition port will supply power for the Operator Interface.

Due to the low current used by all the devices that connect to the Operator Interface, 24 AWG or larger wire is sufficient for all Operator Interface wiring.

5.7.2 Operator Interface Sensor Inputs

The exact wiring configuration for the joysticks, switches, potentiometers, LEDs, and analog sensors connected to the Operator Interface is not specified. Teams may wire these devices, within the rules as described below and according to the documentation supplied by Innovation First, in order to create a custom interface for the robot operators.

Although not a requirement, it is suggested that teams use a project box as a housing for the switches, potentiometers, LEDs, and sensors. When using a project box, wire all components to the 15-pin male connector(s), mount the connector(s) on the project box, and use the 15-pin molded cable(s) to make the connection(s) to the Operator Interface.

The +12 Vdc LEDs may be connected between +5Vdc and Ground or between an LED output and Ground to serve as a visual indicator to the robot operators. This can be helpful during a competition match when a robot operator may not have a good view of the Operator Interface.

CAUTIONS Connect switches between a Digital I/O Signal and Ground. *Do not use lighted switches with the Operator Interface unless the light is disabled.*

Warning! Do not connect switches to the +5Vdc fused Aux Pin (Pin 1) of the Input Ports of the Operator Interface. It may damage the switches. Pin 1 is intended to supply fused 5Vdc power for use by analog sensors and Potentiometers.

Any analog sensor must be connected to +5 Vdc, Ground, and an analog input. Potentiometers must be connected to +5 Vdc and an analog input. Due to the special nature of the analog inputs on the Operator Interface, connecting potentiometers to Ground is optional but *not required.* See the Innovation First documentation for more information.

Figure 5.3 shows an example of the proper way to connect a switch, potentiometer, LED, and yaw rate sensor to the **Operator Interface**. Port and Pin designations shown in Figure 5.3 are examples and will vary depending on the number of devices connected.

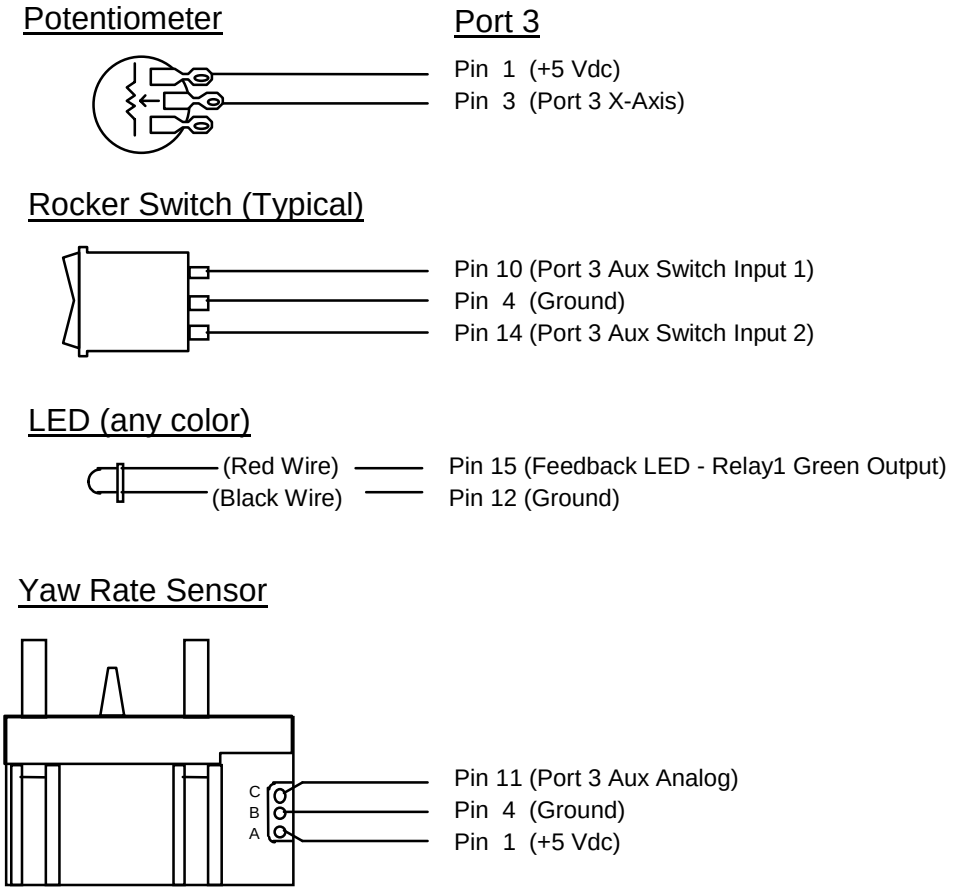


Figure 5.3: Connection Examples for Operator Interface

5.7.3 Dashboard Port

Innovation First offers pre-written software for use in a Dashboard. Teams assume all risk associated with use of this program and/or data collected from the Dashboard port. For more information, consult the Innovation First website at: http://www.innovationfirst.com/firstrobotics

5.8 GENERAL TIPS AND GUIDELINES

5.8.1 Motors

Selection of the appropriate motors to perform specific functions such as turning wheels, lifting arms and squeezing claws is an important part of the design process.

The motors supplied with the Kit of Parts have various power and torque/speed capabilities. Some are quite powerful and draw very high current when loaded to their limits. Others have very high-speed capability. Some have integral transmissions that magnify their torque output. Some are equipped with selectable two-speed transmissions. Before choosing a motor for a particular use, be sure you thoroughly understand the characteristics of the motor.

Drill motors have an internal cooling fan that is not effective at low motor speeds. Do not operate the Drill motors at the stall condition because they will quickly overheat and fail.

As a general rule, design your robot transmissions and choose gear ratios so that drive motors will not be operated beyond the current draw level of their maximum output power point. Verify this by monitoring motor current during robot design verification testing.

5.8.2 Motor Mounting

Many of the motors supplied in the Kit were not originally designed to drive robots. The motor shafts on the drill and Globe motors were designed to provide axial torque only, and cannot sustain large *side loads*

imposed on their motor shafts. *Take care to securely fasten these motors and couple them with flexible couplings to the rest of the drive train when they are used for motive power*.

5.8.3 Drive Train Construction

The Drive Train consists of those components that connect the drive motors to the wheels or tracks of the robot. Design your drive train so that the weight of the robot is supported by axles and shafts *and not* by the drive shafts of the motors. Incorporate sufficient gear reduction in your drive train to provide ample drive torque and sufficient robot speed. Use bearings and bushings to provide proper shaft support and minimize friction. Remember, *the more the robot weighs, the more internal friction the drive train components will experience.* Align mechanical power transmission components accurately. *If you couple a motor shaft to another shaft, support the coupled shaft with bearings at two points, and use a flexible coupling to connect the motor to it.*

FIRST recommends using the Kit-provided motor mounts, drive train mounts, shafts, gears, sprockets, chain, couplings, and connections to provide proper speed reduction and power transmission between the motors and the robot traction load.

5.8.4 Use of Two-Speed Drill Motor Transmissions

The Drill motor assembly provided in the Kit consists of the motor, a two-speed planetary gear reduction transmission, and an adjustable clutch.

The motor is a high-speed brush-type motor specifically suited to drive the transmission. Although it is not recommended, you may easily remove the motor from the transmission and use it separately. Thoroughly understand the internal workings of these units.

The two-speed transmission is capable of operating at 0-450 RPM in low speed range and 0-1500 RPM in high-speed range. Incorporated in it are two small spring clips that connect the internal shifter mechanism to the outer gear select sleeve. These clips should be held in place on the transmission using the rubber bands provided in the Kit. (Put the rubber bands in place before mounting the motor/transmission assembly as a unit into your robot's drive train.) If you plan to utilize both speeds (shift the transmission), be sure that the drill motor is stopped before shifting gears. Also, be sure to fully engage and securely hold the gear select sleeve in each speed range setting. If you plan to use only one speed range, fasten the gear select sleeve securely to prevent it from slipping out of gear.

The clutch is adjustable and can be set to disengage under different load conditions or not at all. *If not set properly, the clutch will slip under a lower load than required.* **The drill's clutch housing contains two internal back drive preventer pins that keep the motor shaft from being turned (back driven) by its output shaft. These pins may be removed, allowing the motors to be back-driven by the robot's momentum in an un-powered state. FIRST recommends that you remove these pins. Detailed instructions about doing so are available on our website.**

5.8.5 Motor Electrical Overload Protection

The Drill motors and CIM motors are protected by 40 Amp, Maxi-style auto-resetting circuit breakers. Since the motors are capable of drawing over 100 Amps at stall, operating a motor at high torque for more than a few seconds may trip the auto-resetting circuit breaker. This can result in a stopping of your robot until the circuit breaker cools sufficiently. The breaker will eventually reset, and the motor will resume operation. Sudden acceleration, pushing/pulling, climbing sloped surfaces, turning and rapid change of forward-reverse direction require high motor torque and could overload the circuit breaker.

It is essential to select drive train gear ratios that keep the motor's current within the protection limit of the circuit breaker. Circuit breaker protection is required to prevent burning up the motors, controllers, and wiring system.

5.8.6 Electrical Power Distribution

This section covers *power distribution* and *wiring rules* for the robot, Robot Controller, and Operator Interface system. It gives examples of how to wire parts included in the Kit to the Innovation First Control Systems. **New in 2004 is an additional 7.2V NiCad battery to be connected to the Robot Controller**. **This battery and connecting cable has been provided with the EDU Robot Controller, and must also be used with the 2004 Robot Controller**. **Also new are four Team Color LEDs that replaces the robot's rotating light.** The 7.2V battery provides backup electrical power to the Robot Controller during low voltage

conditions that can occur in the robot's 12V main power circuit. It also is the source of power for any servos connected to the PWM outputs of the Robot Controller. For information about the battery and Team Color LED, please refer to Innovation First's control system documentation on their website at:

http://www.innovationfirst.com/firstrobotics/

5.8.7 Batteries and Chargers

Teams are responsible for ensuring that their batteries are sufficiently charged to compete in each match. It is estimated that each battery can store sufficient energy to power a robot for at least 5 matches. It should not be necessary to swap batteries after each match.

5.8.7.1 Charging Your Battery

Teams must charge their batteries at their pit stations at each FIRST Robotics Competition event. For instructions on charging the batteries, please refer to the battery charger documentation. You may use additional battery chargers as long as their charging rate is no greater than the one provided by FIRST.

NOTE: If you have a battery that you know is damaged, please do not put it in the trash. **Immediately replace and properly recycle the damaged battery.**

WARNING! Allow a warm battery to cool before charging. Please do not attempt to cool a battery by immersing it in ice, water, or snow. A battery that has been left out in cold weather must be allowed to reach room temperature before charging. Failure to do so may cause serious damage to the battery and may leak toxic liquid as a result. Be careful to avoid shorting the batteries. Short-circuit current exceeds 200A and can cause fire, serious injury, and leakage of toxic fluids.

5.8.7.2 Battery Recommendations / Cautions

To connect the 12V battery to the rest of the control system, FIRST recommends using the ring terminal contacts and red Anderson Power Products connectors provided in the Kit. This allows for a quick exchange of batteries on the robot.

Although rare, the impact forces that robots sometimes experience during matches have been known to cause the Anderson Power Products connectors to disconnect. FIRST recommends utilizing a quick-release fastener, such as a Velcro strip, to hold the power connectors together during a match.

When connecting the battery, be very careful to observe the proper polarity in order to prevent damage to control system components.

In addition to the 7.2V Robot Controller backup battery, only one of the 12 Volt Direct Current Sealed Lead/Acid (SLA) batteries supplied by FIRST may be used to power a robot during a match. You may charge the 12V batteries through the normal operation of the battery charger that FIRST provides. Use the Innovation First EDU charger to charge the EDU 's 7.2V battery. Other 7.2V batteries must use the appropriate charger.

TIP: An example of an acceptable bumper design is a series of foam rubber tubes held in place by Velcro straps around the perimeter of the robot.

TIP: The 120A circuit breaker is also the power switch for your robot. *Please make it safely and quickly accessible.*

TIP: If using ribbon cable, please take care to protect it from physical abuse (straining, pinching, or sharp bending) or failure of the internal wires is likely.

TIP: Recognizable Team Identification is very important so that judges can give proper credit for exceptional performance and unique design features exhibited during competition matches.

6 THE KIT

6.1 THE KIT OF PARTS LIST

2004 Kit of Parts Checklist

Team Number

Bearing Bag

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Pillow Block, aluminum	accepts bearing for 5/8" shaft	Rods & Shafts	4	MMH Order form
	Radial Ball Bearing With Spherical O.D., RA008RRB	1/2" I.D., Self Locking Collar	Bearings	4	The Timken Company (formerly Torrington)
	Flange, Two Bolt Self-Aligning, 40MST	Fits 1/2" Bearing	Bearings	8	The Timken Company (formerly Torrington)
	Radial Ball Bearing, S7KDD, with Shields	5/8" I.D. - 1.375 OD - .344 Width	Bearings	12	The Timken Company (formerly Torrington)

CIM/Globe Bag

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Motor, Globe, with Drive Assembly	12Vdc	Motors & Pumps	2	Globe Motors
	Motor, CIM (aka Chiaphua or Atwood), 8mm keyed output shaft	8mm keyed output shaft	Motors & Pumps	2	MMH Order form
	CIM Motor Bracket	Zinc coated	Motors & Pumps	2	MMH Order Form
	Key Stock, Metric	Metric key stock; fits the shaft on the Chiaphua motor only: 0.079" x	Rods & Shafts	1	N/A

Control System Accesories

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Relay Module (Spike)	12V, 20A Max	Control System	4	www.innovationfirst.com
	Power Supply for Operator Interface	9 Vdc	Control System	1	www.innovationfirst.com
	Speed Controller (Victor 884)		Control System	4	www.innovationfirst.com

Control System Box

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Radio Modem for Robot Controller	RS-422, 9 pin F, rubber antenna	Control System	1	www.innovationfirst.com
	Radio Modem for Operator Interface	RS-422, 9 pin F, metal antenna	Control System	1	www.innovationfirst.com
	Robot Controller		Control System	1	www.innovationfirst.com
	Operator Interface		Control System	1	www.innovationfirst.com

Drive Train Bag

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Key Stock, 3/16" x 12"	3/16" key stock; fits 5/8" shaft	Rods & Shafts	1	ITW Bee Leitzke
	Key Stock, Step, 1/8"+3/16" x 6"	1/8" and 3/16" step key stock; the 1/8" side fits the 1" and 2" gears:	Rods & Shafts	1	ITW Bee Leitzke

2004 Kit of Parts Checklist

Team Number

	(GB), Gearbox, Pillow Block Half	Injection Molded	Rods & Shafts	8	MMH Order form
	(GB), Gearbox, Pillow Block Mounting Plate Used in Pairs	Injection Molded	Rods & Shafts	4	MMH Order form
	(GB), Gearbox, Clamping Plate for 2" x 4" Frame (can be used on smaller stock)	Injection Molded	Rods & Shafts	2	MMH Order form
	Gear, 2" Helical, 5/8" Keyed Bore, Right Hand		Rods & Shafts	2	www.mscdirect.com
	Gear, 1" Helical, 5/8" Keyed Bore, Right Hand		Rods & Shafts	2	www.mscdirect.com
	Chain, 10'	#35	Rods & Shafts	1	www.mscdirect.com
	Master Link for Chain	#35	Rods & Shafts	2	www.mscdirect.com
	Half Link (Offset Link) for Chain	#35, two pitch	Rods & Shafts	2	www.mscdirect.com

Electrical Bag (small)

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Servo	42 oz./in. peak torque, 0.19 sec./60°	Control System	2	N/A
	LED, Panel Mount	white, 5V, 5MM 1.7V-2.1V	Electrical	2	N/A
	LED, Panel Mount	Amber, 5V	Electrical	2	N/A
	LED, Panel Mount	Green, 5V	Electrical	1	N/A
	Breaker Panel	ATC, 100A. max	Electrical	2	www.connectorconcepts.com
	Breaker, Buss, Ckt Breaker / Disconnect Switch	120A., automotive style	Electrical	1	www.connectorconcepts.com
	Muffin Fan (Tiny)	12 Vdc	Electrical	6	www.ebmpapst.us
	Snap-Action Circuit Breaker	30 amp,12 volt, Auto-Resetting	Electrical	6	www.innovationfirst.com
	PWM/Relay Cable	Hitec/JR-style, 36" Long	Control System	8	www.innovationfirst.com
	PWM/Relay Y Cable	Hitec/JR-style, 24" Long	Control System	2	www.innovationfirst.com
	Snap-Action Circuit Breaker	20 amp,12 volt, Auto-Resetting	Electrical	6	www.innovationfirst.com.
	Snap-Action Circuit Breaker	40 amp,12 volt, Auto-Resetting	Electrical	4	www.innovationfirst.com
	Feed-Through Terminal Block	one #6 on one side; four #10 other side	Electrical	1	www.rockwellautomation.com look for Allen Bradley product
	25-Pin Solder Cup Connector	DB25 Male	Control System	2	www.tycoelectronics.com
	15-Pin Solder Cup Connector	DB15 Female	Control System	2	www.tycoelectronics.com

2004 Kit of Parts Checklist

Team Number

Loose

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Quick-Disconnect Power Connector (with 1' leads)	#6 AWG Red/Black Wire, pair	Electrical	2	N/A
	LED Light Cluster	Replaces the revolving light	Electrical	4	N/A
	Tiagene, Power Sliding Door Motor		Motors & Pumps	1	N/A
	Pneumatics, Pressure Transducer	0-130 psig transducer; has 1/4-18 NPT input port	Sensors	1	Texas Instruments
	Muffin Fan (Large)	12 Vdc	Electrical	2	www.ebmpapst.us
	9-Pin Cable (M-F) (Black)	DB9 Male to Female, 6', Shielde	Control System	3	www.innovationfirst.com
	9-Pin Cable (F-F) (Red)	DB9 Female to Female, 6', Shielded	Control System	1	www.innovationfirst.com
	Wheel, Wheelchair, 6"	6" Ø, 5/16" I.D. Bearings, 1-1/2" Wide Flange	Wheels	2	www.skywaywheels.com
	Wheel,**12.5"** Pneumatic Assembly, Skyway	5/8" keyed hub	Wheels	2	www.skywaywheels.com
	Ball, 34", Yellow, BIGENS Kit Ball	34" BIGENS Ball	Game piece for kit	1	www.sportfun.com

Pneumatics - SMC

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Pneumatics Kit, Double Solenoid Base Ported Valve. SMC		Pneumatics	2	www.smcusa.com
	Pneumatics Kit, Flow Control, SMC		Pneumatics	6	www.smcusa.com
	Pneumatics Kit, Fitting, Straight 1/4" Tube, SMC		Pneumatics	20	www.smcusa.com
	Pneumatics Kit, Fitting, 90 Elbow 1/4" Tube, SMC		Pneumatics	20	www.smcusa.com
	Pneumatics Kit, Fitting, Tee Union 1/4" Tube, SMC		Pneumatics	5	www.smcusa.com
	Pneumatics Kit, Fitting, Male Run T 1/8 NPT ~ 1/4" Tube, SMC		Pneumatics	5	www.smcusa.com
	Pneumatics Kit, 1/4" OD Tubing, SMC	20 meters	Pneumatics	1	www.smcusa.com

Seat/Window Bag

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Motor, Seat, Keyang	12 Vdc	Motors & Pumps	1	N/A
	Worm Gear Actuator-Right Hand	2 inch linear movement	Rods & Shafts	1	N/A
	Worm Gear Actuator-Left Hand	2 inch linear movement	Rods & Shafts	1	N/A

2004 Kit of Parts Checklist

Team Number

☐	Nippon-Denso Motor, Window, Right		Motors & Pumps	2	N/A
☐	Flexible Motor Shaft	13.5" Long, Fits Seat Motor	Rods & Shafts	2	www.grcontrols.com

Sensor Bag

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	IR Beacon - Vector Board	Vector board "circbord" 4.5" x 6.50"	Sensors	1	N/A
☐	Current Sensor - Tantalem Capacitors		Electrical	2	N/A
☐	IR Beacon - FET's		Sensors	2	N/A
☐	IR Beacon - LED's	Clear/White	Sensors	10	N/A
☐	IR Beacon - Resistors	33 Ohm	Sensors	8	N/A
☐	IR Beacon - 3pin Connectors	black	Sensors	2	N/A
☐	Current Sensor	75 Amp current sensor w/analog output	Sensors	2	www.allegromicro.com.
☐	World-Beam Diffuse Sensor w/screws		Sensors	2	www.bannerengineering.com
☐	IR Beacon - Photo Detector (Receiver)	Vishay P/N - TSOP34840	Sensors	5	www.newarkinone.com
☐	Current Sensor - Printed Circuit Board	40mm x 50mm x 1.575mm, FR4 material.	Electrical	2	www.newarkinone.com

Terminal Supply Bag

Container: Blue

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Stud, Insulated	3/8" dia	Electrical	1	www.terminalsupplyco.com
☐	Nylon ring terminal	Connects AWG #6 cable to 3/8" stud	Electrical	4	www.terminalsupplyco.com
☐	Nylon ring terminal	Connects AWG #6 cable to 1/4" stud	Electrical	4	www.terminalsupplyco.com
☐	Nylon ring terminal	Connects AWG 22-18	Electrical	12	www.terminalsupplyco.com
☐	Nylon ring terminal	Connects AWG 16-14	Electrical	12	www.terminalsupplyco.com
☐	Nylon ring terminal	Connects AWG #12-10	Electrical	12	www.terminalsupplyco.com
☐	Nylon ring terminal	Connects AWG #6	Electrical	12	www.terminalsupplyco.com
☐	Nylon insulated Quick Disconnect	Connects AWG #22-18	Electrical	6	www.terminalsupplyco.com
☐	Nylon insulated Quick Disconnect	Connects AWG #16-14	Electrical	6	www.terminalsupplyco.com
☐	Nylon insulated Quick Disconnect	Connects AWG #12-10	Electrical	12	www.terminalsupplyco.com

2004 Kit of Parts Checklist

Team Number _____

√					
☐	Wire Nut	Red	Electrical	8	www.terminalsupplyco.com

Metal Box

Container: Metal Box

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Shaft, 5/8" Keyed	5/8" keyed x 36"	Rods & Shafts	1	N/A
☐	Pipe, 1" Aluminum	1" x 24" schedule 40	Structural	2	N/A
☐	(TR), Threaded Rod , 3/8"	3/8" Ø x 36", 20 Pitch Coarse Thread	Structural	2	N/A
☐	Frame, 2" x 4" Extruded Aluminum	2" x 4" x 36"	Structural	2	N/A
☐	Aluminum, Solid, 1" Hex OD, 6" Long	Part of 3-piece assembly for 8mm Chiaphua shaft	Rods & Shafts	1	N/A

Battery Box

Container: Red

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Battery	12 volt, 18 AH Deep Cycle Non-Spillable	Electrical	2	www.batteriesplus.com Manchester, NH Store

Coupler Bag

Container: Red

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Flexible Shaft Coupling	Black	Rods & Shafts	2	MMH Order Form
☐	Coupler to Nippon-Denso Motor Gear	Injection molded	Motors & Pumps	2	MMH Order Form
☐	Coupling, 1/2" Drill Motor, Aluminum, accepts 1/2" Drill Shaft. 1" Hex OD	accepts 1/2" Drill Shaft, 1" Hex OD	Rods & Shafts	2	MMH Order Form
☐	Coupling, 1/2" Drill Motor, Aluminum, accepts 5/8" Keyed Shaft. 1" Hex OD	accepts 5/8" Keyed Shaft, 1" Hex OD	Rods & Shafts	2	MMH Order Form
☐	Coupling, Plastic, Round, Accepts 1" Hex Both Sides	Can insert 4 types: 1/2" drill motor unit; 8mm Chiaphua unit;	Rods & Shafts	4	MMH Order Form
☐	Coupling, Aluminum, accepts 8mm Chiaphua Shaft. 1" Hex OD	3-piece assembly for 8mm Chiaphua shaft	Rods & Shafts	2	MMH Order Form

Drill Bag

Container: Red

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Rubber Bands	2" x 1/2" Broccolli bands	Fasteners	10	Any office supply store
☐	Mount for 1/2" Drill Motor; 4 Pieces	Injection molded	Motors & Pumps	2	MMH Order form
☐	Screw, Left-Hand for Bosch 1/2" Drill Drive Assembly		Motors & Pumps	4	MMH Order Form
☐	Motor Assembly, 1/2"	0.87Nm @ 127A stall, 19670RPM No-Load	Motors & Pumps	2	www.boschtools.com
☐	Drill Drive Assembly (Transmission), 1/2"	2 Speed -12.07:1 & 42.62:1 Gear Ratios	Motors & Pumps	2	www.boschtools.com

2004 Kit of Parts Checklist

Team Number

Hardware Bag

Container: **Red**

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	Retaining Rings for 5/8" Keyed Shaft	Gearbox	Rods & Shafts	1 bag	www.fastenal.com
	(TR), Nut, NYLOCK NE 3/8-16Z	3/8" nut for threaded rod	Structural	1 bag	www.fastenal.com
	(TR), Washer, Flat, 3/8" Hole, USS F/W 3/8	Frame Washers	Structural	1 bag	www.fastenal.com
	(GB), Washer, Flat, 1/4" Hole, USS F/W 1/4	Gearbox Washers	Rods & Shafts	1 bag	www.fastenal.com
	(GB), Bolt, 307AHB 1/4-20 x 6.5Z, Hex Hea	For gear box	Rods & Shafts	1 bag	www.fastenal.com
	(GB), Nut, NYLOCK NE 1/4-20Z	For gear box bolts	Rods & Shafts	1 bag	www.fastenal.com
	(MM), Bolt, Motor Mount, 1/4-20 x 1"; 307AHB 1/4-20 x 1Z	Bolt (rear)	Motors & Pumps	1 bag	www.fastenal.com
	(MM), Bolt, Motor Mount, 10-32 x 2"; SHCS 10-32 x 2	Bolt (clamp)	Motors & Pumps	1 bag	www.fastenal.com
	(MM), Nut, Motor Mount, 10-32; NYLOCK NM 10-32Z	Nuts (clamp)	Motors & Pumps	1 bag	www.fastenal.com
	(MM), Nut, Motor Mount, 1/4-20; NYLOCK NE 1/4-20Z	Nuts	Motors & Pumps	1 bag	www.fastenal.com
	(MM), Washer, Motor Mount, 1/4-20; SAE F/W 1/4Z	Flat Washers	Motors & Pumps	1 bag	www.fastenal.com
	(MM), Washer, Motor Mount, 10-32; SAE F/W (#10) Z	Washers (clamp)	Motors & Pumps	1 bag	www.fastenal.com
	(MM), Bolt, Motor Mount, 1/4-20 x 3-1/4"	Bolt (front)	Motors & Pumps	1 bag	www.fastenal.com
	Latex Tubing	1/4" I.D., 3/8" O.D., 5'	Springs	2	www.kentelastomer.com

Loose

Container: **Red**

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
	(GB) Spacer, Steel	Spacer for 2" x 4" material;	Rods & Shafts	8	N/A
	(MM) Spacer, Steel	Spacer for 2" x 4" material;	Motors & Pumps	4	N/A
	(TR) Spacer, Steel	Spacer for 2" x 4" material;	Structural	4	N/A
	(GB), Spacer, Pipe, for Gear Box, Aluminur	0.652 ID; 0.75 OD; 0.049 wall x **0.250"**	Rods & Shafts	8	N/A
	(GB), Spacer, Pipe, for Gear Box, Aluminur	0.652 ID; 0.75 OD; 0.049 wall x **0.750"**	Rods & Shafts	2	N/A
	(GB), Spacer, Pipe, for Gear Box, Aluminur	0.652 ID; 0.75 OD; 0.049 wall x **3.1875"**	Rods & Shafts	2	N/A
	(GB), Spacer, Pipe, for Gear Box, Aluminur	0.652 ID; 0.75 OD; 0.049 wall x **1.210"**	Rods & Shafts	4	N/A
	Valve - Single Solenoid		Pneumatics/Hydraulic	1	www.boschrexroth.com Pneumatics division

2004 Kit of Parts Checklist

Team Number

☐	Fisher-Price 10 Web Jeep Driver (NO AXLE	Black	Motors & Pumps	2	www.fisher-price.com/ powerwheels
☐	Motor/Gearbox, Fisher-Price	12 Vdc stall torque (mNm) 532.19+/- 10%	Motors & Pumps	2	www.fisher-price.com/ powerwheels
☐	Joystick , Analog	AVB Top Shot Analog	Control System	2	www.innovationfirst.com CH Analog Joystick only
☐	Ball, 13", Red, Kit Ball	Kit ball	Game piece for kit	1	www.palossports.com

Pneumatics 1

Container: Red

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Pneumatics Kit, Volume Tank, Clippard	16 cu. in., 2" x 8"	Pneumatics	2	www.clippard.com
☐	Pneumatics Kit, Valve Kit, Solenoid, With Fittings, Festo		Pneumatics	1	www.festo.com
☐	Pneumatics Kit, Cylinder, Parker	1.5" bore x 8" stroke; rear pivot mount	Pneumatics	1	www.parker.com
☐	Pneumatics Kit, Pivot Bracket Set, Cylinder, Parker		Pneumatics	1	www.parker.com
☐	Pneumatics Kit, Rod Clevis, Cylinder, Park		Pneumatics	1	www.parker.com

Pneumatics 2

Container: Red

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Pneumatics Kit, Teflon Tape, 1/4" x 100'		Pneumatics	1	Various
☐	Pneumatics Kit, 0-160psi Gauge for Norgren Regulator, Wika		Pneumatics	1	Wika
☐	Pneumatics Kit, Secondary Pneumatic Regulator, Monnier		Pneumatics	1	www.monnier.com
☐	Pneumatics Kit, Regulator Mounting Bracket and Nut, Monnier		Pneumatics	1	www.monnier.com
☐	Pneumatics Kit, Pressure Switch Opens @ 115psi; Closes @ 95psi, Nason		Pneumatics	1	www.nasonptc.com
☐	Pneumatics Kit, Main Regulator with 60psi Max Output, Norgren		Pneumatics	1	www.norgren.com
☐	Pneumatics Kit, 0-160psi Gauge for Norgren Regulator, Norgren		Pneumatics	1	www.norgren.com
☐	Pneumatics Kit, Regulator Mounting Bracket and Nut, Norgren		Pneumatics	1	www.norgren.com
☐	Pneumatics Kit, Manual 2-Way Plug Valve, Parker		Pneumatics	1	www.parker.com
☐	Pneumatics Kit, Union Tee, Parker		Pneumatics	4	www.parker.com
☐	Pneumatics Kit, Adaptor 1/4" Female to 1/8" Male, Parker		Pneumatics	6	www.parker.com
☐	Pneumatics Kit, Hex Nipple 1/8" NPT, Park		Pneumatics	6	www.parker.com
☐	Pneumatics Kit, Bushing 1/8" Female to 1/4" Male, Parker		Pneumatics	12	www.parker.com

2004 Kit of Parts Checklist

Team Number

☐	Pneumatics Kit, Plug 1/8", Parker		Pneumatics	6	www.parker.com
☐	Pneumatics Kit, Plug 1/4", Parker		Pneumatics	6	www.parker.com

Wire Bag

Container: Red

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	2 Conductor Jacketed Wire	35', #16 AWG	Electrical	1	N/A
☐	3 Conductor Shielded Wire	30', #24 AWG	Electrical	1	N/A
☐	2 Conductor Jacketed Wire	30', #24 AWG	Electrical	1	N/A
☐	1 Conductor Wire	20', #10 AWG, Red	Electrical	1	N/A
☐	1 Conductor Wire	20', #10 AWG, Black	Electrical	1	N/A
☐	1 Conductor Wire	10', #6 AWG, Black	Electrical	1	N/A
☐	1 Conductor Wire	10', #6 AWG, Red	Electrical	1	N/A

Documentation Bag

Container: Separate Box

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Pneumatics FIRST Pamphlet		Documentation	1	
☐	FedEx Airbills		Documentation	3	FedEx
☐	FedEx Envelope - Introduction Letter		Documentation	1	FedEx
☐	FedEx Pouch		Documentation	3	FedEx
☐	EduBot CDROM		Documentation	1	N/A
☐	Discovering Fluid Power CDROM		Documentation	1	N/A
☐	Newark In One CDROM		Documentation	1	N/A
☐	Allegro Microsystems envelope		Documentation	1	N/A
☐	Magazine, Nut and Volts		Documentation	1	www.nutsvolts.com
☐	Magazine, SERVO		Documentation	1	www.servomagazine.com
☐	Infrared Beacon 1 Pager		Documentation	1	www.usfirst.org
☐	Current Sensor 1 Pager		Documentation	1	www.usfirst.org

2004 Kit of Parts Checklist

Team Number

Loose

Container: Separate Box

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Visio		Software	1	Microsoft
☐	Visual Studio C		Software	1	Microsoft
☐	Front Page		Software	1	Microsoft

Miscellaneous Bag

Container: Separate Box

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Stickers - Various Suppliers		Documentation	4	
☐	Maxi-Fuse holder for 40A breakers, 4 Positions	Brass, gold-plated	Electrical	1	N/A
☐	Sprocket	45 tooth, 5 1/2" diameter 5/8" keyed hub	Rods & Shafts	2	www.mscdirect.com
☐	Sprocket	10 tooth, 1 3/8" diameter 5/8" keyed hub	Rods & Shafts	2	www.mscdirect.com
☐	Idler Sprocket		Rods & Shafts	2	www.mscdirect.com

Direct

Container: Shipped from

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Inventor Professional 7, Autodesk	3D mechanical design software; includes Autodesk Inventor +	Software	1	Autodesk
☐	3D Studio Max 6, Autodesk	Includes Character Studio - see separate record	Software	1	Autodesk
☐	Mechanical Desktop, Autodesk	Included with Inventor Professional 7	Software	1	Autodesk
☐	Character Studio, Autodesk	Included with 3D Studio Max 6	Software	1	Autodesk
☐	Animations from 2003, DVD	1 DVD	Software	1	Autodesk

Direct

Container: Shipped from IFI

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	EduBot Replacement Board	Replacement board with upgraded processor and	Control System	1	www.innovationfirst.com

1&2 Yr. Teams ONLY

Container: Year 1 +2 Teams

√	Part Name/Description	Dimensions	Category	Qty /Kit	Product Supplier
☐	Battery Charger, Automatic	6 amp	Electrical	1	Midtronics (Exide spinoff)
☐	Pneumatics Kit, Compressor, Thomas		Pneumatics	1	MMH Order Form
☐	Pneumatics Kit, Vibration Isolators for Compressor, Lord Corp		Pneumatics	3	www.lord.com

7 THE TOURNAMENT

7.1 OVERVIEW

Each Regional Competition and the Championship will be played in a Tournament format. Each Tournament will consist of three sets of rounds called Practice Rounds, Qualifying Rounds and Elimination Rounds. The purpose of the Practice Rounds is to allow each Team a chance to run its Robot on the Playing Field prior to the start of the competition matches. The purpose of the Qualifying Rounds is to allow each Team to earn a Ranking that may qualify them for participation in the Elimination Rounds. The purpose of the Elimination Rounds is to determine the event Champions.

For the Championship Event, teams will be split into four Divisions. Each Division will play exactly like a Regional Event and produce a Division Champion Alliance. Those four Alliances will then proceed to the Championship Rounds to determine the Grand Champion Alliance.

7.2 PRACTICE ROUNDS

7.2.1 Schedule

The Practice Rounds will be played all day Thursday. Each team will randomly be assigned an equal number of Practice Rounds.

7.3 QUALIFICATION ROUNDS

7.3.1 Schedule

The Qualification Rounds will be played all day Friday and continue Saturday morning.

The Qualifying Rounds will consist of a series of Matches, with an Arena Reset between each Match.

7.3.2 Match Assignment

The Scoring System will randomly assign each team an Alliance Partner for each Qualifying Match played. All teams will play the same number of Qualifying Matches and receive their match schedule for all qualifying matches on Friday morning. If the number of teams in attendance is not divisible by four, the Scoring System will randomly select some teams to play an extra Match. For purposes of scoring, those teams will be called Surrogates for the extra Match.

7.3.3 Match Qualification Points and Ranking Points

At the completion of each Qualification Match, each team will receive a win, loss or tie depending on the final score. Each team on the winning Alliance will receive two Qualifying Points. Each team on the losing Alliance will receive zero Qualifying Points.

In the event of a tie Match Score, all four teams will receive one Qualifying Point.

All four teams will receive a number of Ranking Points equal to the Match Score of the losing alliance or their alliance score in the case of a tie. A Surrogate team will receive zero qualifying Points and will not receive any Ranking Points.

7.3.4 Qualifying Score

The total number of Qualifying Points earned by a team throughout their Qualification Rounds summed together will be their Qualifying Score.

7.3.5 Ranking Score

The total number of Ranking Points earned by a team throughout their Qualification Rounds, divided by the number of Matches played, then truncated to two decimal places, will be their Ranking Score.

7.3.6 Highest Match Score

The Scoring System will keep track of the Highest Match Score earned by each team during the Qualification Rounds but this score will not be displayed.

7.3.7 Qualification Ranking

All teams in attendance will be ranked during the Qualification Rounds. If the number of teams in attendance is 'n', they will be ranked '1' through 'n', with '1' being the highest ranked team and 'n' being the lowest ranked team.

The Scoring System will use the following Ranking Method:

- Teams will be broken into Tiers based on their Qualifying Score.
- Within each Tier, teams will be sorted by their Ranking Score.
- If any teams within a Tier have the same Ranking Score, they will be sorted by their Highest Match Score.
- If any teams within a Tier have the same Ranking Score and the same Highest Match Score, then the Scoring System will sort those teams based on a Random Electronic Coin Toss.

7.4 ELIMINATION ROUNDS

At the end of the Qualification Rounds, the top eight ranked teams will become the Alliance Leads. The top ranked Alliances will be designated, in order, Alliance One, Alliance Two, etc., down to Alliance Eight. Alliances One through Eight may invite any team below them in the rankings, that has not already declined an invitation, to join their alliance. The Alliance Selection Process will consist of two rounds so that each of the eight playoff alliances consists of three teams.

7.4.1 Alliance Selection Process

Each of the Alliance Leads will designate a student to be the Alliance Captain. Each remaining team will choose a student to act as Team Representative. Each Alliance Captain and Team Representative will proceed to the Playing Field at the designated time to represent his or her team. In ascending order, each Alliance Captain will invite a team ranked below them in the standings, which has not already accepted or declined an invitation, to join their Alliance. The invited Team Representative will step forward and either Accept or Decline the invitation. If the team accepts, it is moved into that Alliance. If the team declines, it is not eligible to be picked again and the Alliance Captain extends another invitation to a different team. If an invitation from a top eight alliance team to another top eight alliance team is accepted, the team currently ranked ninth will move up to become the number eight alliance. The process continues until Alliance Eight makes a successful invitation. The same method is used for each Alliance Captain's second choice. Any teams remaining after Alliance Eight makes their second choice will not compete in the Elimination Rounds.

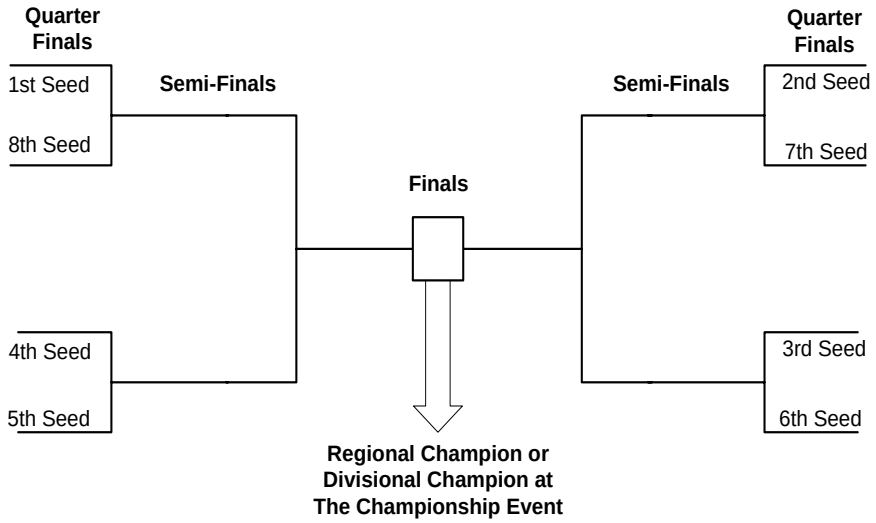
Only 2 teams play in an alliance at a time. ***The third team in the 1st match must play in the 2nd match, with no exceptions.*** Teams should consider the robustness of the robots when picking alliance partners.

7.4.2 Schedule

The Elimination Rounds take place on Saturday afternoon and will consist of a series of Matches, with an Arena Reset between each Match.

7.4.3 Match Ladder

The Elimination Rounds will play in a ladder format as follows:



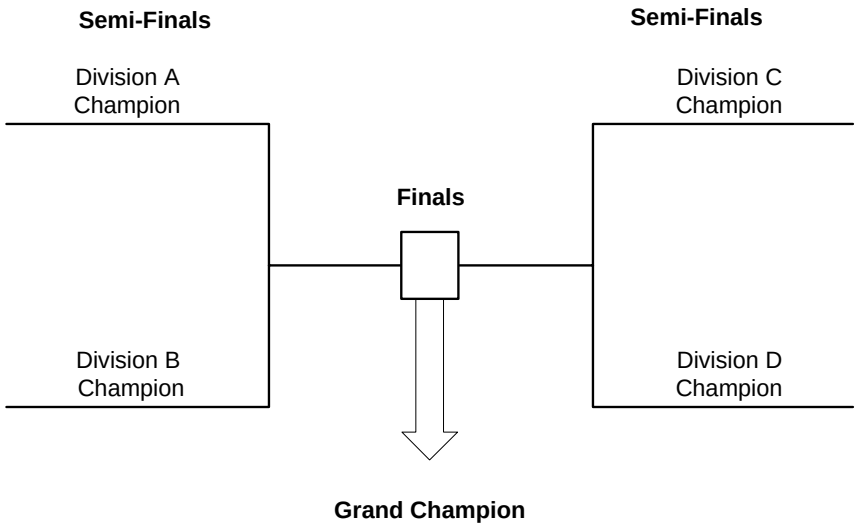
7.4.4 Elimination Scoring

In the Elimination Rounds, teams do not get "points (2, 1, 0)"; they get a win, loss or tie.

Within each bracket of the Elimination Match Ladder, Matches will be played to determine which Alliance advances, as follows:

- The first Alliance to win two matches advances.
- A **maximum** of four matches will be played; if, after four matches, neither Alliance has two wins, the Alliance with the highest match score in this round advances.

7.5 CHAMPIONSHIP ROUNDS



The Championship Rounds will play exactly like the Semi-Finals and Finals of the Elimination Rounds.

7.6 TOURNAMENT RULES

<T01> Referees have ultimate authority during the competition. THEIR RULINGS ARE FINAL! The referees will not review any recorded replays.

<T02> There are no time outs in the Qualifying Rounds; in the Elimination Rounds, each Alliance will be allotted one time out of no more than 6 minutes. The matches must progress according to schedule. If a robot cannot report for a match, the queueing manager shall be informed and at least one member of the team should report to the field for the match.

<T03> During the elimination rounds, alliances will have at least four minutes between scheduled matches.

<T04> Robots may not intentionally:

- Detach Parts (no connection at all to a robot);
- Damage another robot;
- Tip over another robot;
- Attach themselves to the vertical supports of the pull-up bar system;
- Attach themselves to the railings/walls of any field structure.

<T05> Robot Field power will not be re-enabled after a match; however, teams may use the tether feature to make any necessary adjustments to the robot in order to release from each other. For information on using the tether, please refer to the control system documentation from Innovation First.

<T06> Robots that become entangled in the field barriers, platforms or other robots will not be freed until after the match has finished unless the entanglement represents a safety hazard. Any entangled robot may be disabled if a referee deems it necessary.

<T07> The qualification match schedule will be available Thursday evening or Friday morning. This schedule will indicate alliance partners and match pairings. It will also tell the alliance its color, RED or BLUE, for each match. The color is used to determine the placement of each team's robot, students, and coach around the playing field.

<T08> Special clothing and/or equipment will only be allowed on the playing field for those who demonstrate a need based on a physical disability.

7.7 TOURNAMENT SAFETY RULES

<T09> Teams are responsible for providing their own safety glasses at each event. All team members, including coaches, must wear safety glasses while in the Pit or alliance stations during matches. Safety glasses must also be worn during the building of the Robot

<T10> All team members must wear sneakers or appropriate footwear while in the Pit area or competing on the field. No bare feet, sandals, or open-toed footwear are allowed.

<T11> Wireless/radio control mode of robot operation is not permitted in any of the Pit areas. Robots may only be operated via the tether when not competing on the field.

<T12> Always keep the main circuit breaker in the OFF position. Turn it on only when you wish to operate the robot.

<T13> Do not allow anything to come into contact with exposed electrical terminals other than the wires that are supposed to be connected to them. Periodically check your robot's wiring for loose connections and broken or cut insulation.

8 THE AWARDS

8.1 REGIONAL AWARDS

Please read below for a description of Regional Awards.

8.1.1 Chairman's Award - Regional

The concept of the Chairman's Award has expanded to include Regional Chairman's Awards, which enable FIRST to recognize more teams for their exemplary efforts in spreading the FIRST message, as well as their talents in organizing materials for their presentations. Refer to the *Chairman's Award* section for specifics.

The winning entries of the Regional Chairman's Awards will travel to the Championship for the continuing process of consideration for the most prestigious 2004 Chairman's Award.

8.1.2 *New or Returning Regional Awards

The asterisk (*) designates new or "back by popular demand" awards. For their descriptions, refer below in the "Regional Competition Awards" listing.

- Highest Rookie Seed
- Rookie Inspiration

8.1.3 Regional Competition Awards

FIRST will hold an Awards Celebration at each Regional Competition to present the following awards:

8.1.3.1 Autodesk Visualization Award

Presented by Autodesk, Inc., this award recognizes excellence in student animation that clearly and creatively illustrates the spirit of the FIRST Robotics Competition. Autodesk will award excellence in content, creativity, and mastery of multimedia. *Please refer to the Autodesk Visualization section for specifics.*

8.1.3.2 DaimlerChrysler - Team Spirit

This award celebrates extraordinary enthusiasm and spirit through an exceptional partnership and teamwork.

8.1.3.3 Delphi - "Driving Tomorrow's Technology™"

This award celebrates an elegant and advantageous machine feature. This award recognizes any aspect of engineering elegance including, but not limited to: design, wiring methods, material selection, programming techniques, and unique machine attributes. The criteria for this award are based on the team's ability to concisely verbally describe, as well as demonstrate, this chosen machine feature.

8.1.3.4 Engineering Inspiration

This award celebrates a team's outstanding success in advancing respect and appreciation for engineering and engineers, both within their school, as well as their community. Criteria include: the extent and inventiveness of the team's efforts to recruit students to engineering, the extent and effectiveness of the team's community outreach efforts, and the measurable success of those efforts. This is the second highest team award FIRST bestows.

8.1.3.5 General Motors - Industrial Design

This award celebrates form and function in an efficiently designed machine that effectively achieves the game challenge.

8.1.3.6 *Highest Rookie Seed

This award celebrates the highest-seeded rookie team at the conclusion of the qualifying rounds.

8.1.3.7 Imagery

This award celebrates attractiveness in engineering and outstanding visual aesthetic integration from the machine to team appearance.

8.1.3.8 Johnson & Johnson - Sportsmanship

This award celebrates outstanding sportsmanship and continuous gracious professionalism in the heat of competition, both on and off the playing field.

8.1.3.9 Judges' Awards

During the course of the competition, the judging panel may encounter a team whose unique efforts, performance, or dynamics merit recognition.

8.1.3.10 Kleiner Perkins Caufield & Byers - Entrepreneurship

The Kleiner Perkins Caufield & Byers Entrepreneurship Award celebrates the Entrepreneurial Spirit. This award recognizes a team, which since its inception has developed the framework for a comprehensive business plan in order to scope, manage, and obtain team objectives. This team displays entrepreneurial enthusiasm and the vital business skills for a self-sustaining program.

8.1.3.11 Leadership in Control

This award celebrates an innovative control system or application of control components to provide unique machine functions.

8.1.3.12 Motorola - Quality

This award celebrates machine robustness in concept and fabrication.

8.1.3.13 Regional Finalist

This award celebrates the team or alliance that makes it to the final match of the competition.

8.1.3.14 Regional Champion

This award celebrates the team or alliance that wins the competition.

8.1.3.15 Rookie All-Star

This award celebrates the rookie team exemplifying a young but strong partnership effort, as well as implementing the mission of FIRST to inspire students to learn more about science and technology. We encourage, but do not require, Rookies to enter a Chairman's Award submission relative to this award.

NOTE: NASA Grant teams must submit a copy of their Chairman's Award submission to NASA as part of the grant.

8.1.3.16 *Rookie Inspiration

This award celebrates a rookie team for outstanding effort as a FIRST team in community outreach and recruiting students to engineering. This team models gracious professionalism on and off the field and is a true inspiration to others.

8.1.3.17 Website Award

This award recognizes excellence in student-designed, built, and managed FIRST team websites. We have revised the process for this award for 2004. Please refer to the website section for specifics.

8.1.3.18 *Woodie Flowers Finalist Award

Small Parts, Inc. presents the Woodie Flowers Award to an outstanding engineer or teacher participating in each of the robotics Regional Competitions. Students choose and write about a person on their team who best demonstrates excellence in teaching science, math, and creative design. These Regional winners will receive consideration for the Championship Woodie Flowers Award.

8.1.3.19 Xerox - Creativity

This award celebrates creative design, use of a component, or a creative or unique strategy of play.

8.2 THE CHAIRMAN'S AWARD 2004

The FIRST Robotics Competition is about much more than the mechanics of building a robot or winning a competitive event. It is about the impact FIRST has on those who participate in the program and the impact of FIRST on the community at large. The FIRST mission is to change the way America's young people regard science and technology and to inspire an appreciation for the real-life rewards and career opportunities in these fields.

8.2.1 Overview

The Chairman's Award was created to keep the central focus of the FIRST Robotics Competition as our ultimate goal for transforming the culture in ways that will inspire greater levels of respect and honor for science and technology, as well as encourage more of today's youth to become scientists, engineers, and technologists.

The Chairman's Award represents the spirit of FIRST. It honors the team that best represents a model for other teams to emulate, which embodies the goals and purpose of FIRST. It remains the most prestigious team award FIRST presents.

FIRST will present a Regional Chairman's Award at each regional competition. There are twenty-six (26) regional competitions scheduled for the 2004 season, therefore, there will be twenty-six Regional Chairman's Award winners. Only the winners of the Regional Chairman's Award will be eligible for consideration in the selection of The Chairman's Award to be presented at The Championship.

8.2.2 First-Year (Rookie) and NASA Grant Teams:

Because the Chairman's Award recognizes sustained excellence and impact, not just a one-year team effort, it is not possible for a first-year (rookie) team to receive this honor**.** We encourage Rookies, however, to develop a Chairman's Award submission which judges will use as a criterion to judge the **Rookie All-Star Award**. This submission will document where your team started its FIRST journey and will also provide background for documenting the results of your team's efforts.

Teams applying for **NASA Grant**s must provide a copy of this submission as part of the grant.

8.2.3 Submission Information

The criteria for the 2004 Chairman's Award are essentially identical to those that have been traditional for the Chairman's Award in the past, with the exception that the judges will more consciously focus on teams' activities during the entire year, as distinguished from just the six-week design-and-build period. The FIRST Robotics Competition is not about machines; it is about the experience of people working together toward a shared goal. Documenting and preserving your team's FIRST experience becomes an important component of the over-all FIRST experience.

8.2.3.1 Submission Content

The Chairman's Award is presented to the team judged to have created the best partnership effort among team participants and which best exemplified the true meaning of FIRST through measurable impact on its participants, school, and community at large. There is no single "best way" for a team to win the Chairman's Award. Many factors come into play. The primary factors the judges will evaluate are:

1. How strongly does the submission document how FIRST impacted the learning experience of the students, school curriculum, engineers, and/or community?
2. Has the team explained/demonstrated why/how it should be a role model for other FIRST teams to emulate?
3. How well has the team communicated its excitement and impact within the entire school, community, and beyond (state/nation) through participation in FIRST?
4. Has the team documented an innovative way to spread the FIRST message?
5. How strong of a year-round team partnership effort is reflected? (You can define partnership in many ways, including: the partnership among the team's students/corporate sponsor/engineers; school/university sponsor/engineers; students/adults; community/team)

6. As a whole, does the content of the documentation exemplify the true meaning of FIRST?

Your Chairman's Award submission should include documentation for all of the above factors.

8.2.3.2 Submission Format

The growing number of FIRST teams necessitates that we standardize the submission format:

- Submit in a Microsoft Word document only.
- Limit to four (4) electronic pages of content (8 ½ x 11 inch pages)
- Content can be any combination of text and images.
- Text on all pages, including the Executive Summary, must use a minimum of font size 10. The judges do need to be able to read it! In preparing this documentation, bear in mind that the students, engineers, teachers, community, school, sponsors, families, and other supporters, as well as the machine itself, are all integral parts of your team experience. Your submission need not be professionally produced; it does need to clearly convey the factors outlined above.

8.2.3.3 Submission Requirements

Your team **must** be competing in the regional competition to which you submit your Chairman's Award entry. If your team is competing in more than one regional event, choose ONE of those events and submit your entry for that event.

- ***Submit only one entry*.**
  Any team that submits a Chairman's Award entry to more than one regional competition will automatically be ineligible for consideration for this award for the 2004 season.
- ***Send 2004 submissions in electronic form only***.
  Please feel free to bring hard copies of your submission with to your submission event.
- **Team Number:** Put your FIRST Team Number in the footer of ALL pages.
- **Revised Executive Summary Form:** At the time of submission, you must include a completed one-page, *revised for 2004,* Chairman's Award Executive Summary Form. *Do not restructure or rearrange this form.* The form is at the end of the Chairman's Award section of this Manual.

NOTE: *If you submit an entry without a completed, revised Executive Summary form, judges will not review or consider it.*

- **Yearbook Page:** Judges will review the information you enter in the *Yearbook Page* that you submit to FIRST, via e-mail. Check the web's *Important Deadlines Calendar.*

8.2.3.4 Submission Deadline

FIRST must receive your team's e-mailed Chairman's Award submission by 5:00 p.m. Eastern time, on Friday, February 20, 2004.

Judges will not review submissions received after the deadline.

8.2.3.5 2.3.5 Submission E-Mail Address, Subject Line

E-mail Subject Line: Event Name

List the event name where you wish your team's entry judged.

E-mail Address: Chairmans@usfirst.org

8.2.4 Judging Process

The Regional Award Process: On Friday mornings of each Regional Competition, FIRST will announce when interviews will take place, later in the day on Friday or on Saturday morning. A panel of judges will review the Chairman's Award entries at each Regional and will conduct on-site Chairman's Award interviews with those teams who have entered a submission for that regional event. Judges will select one winner for the Regional Chairman's Award at each regional competition.

- Interviews are limited to ten (10) minutes with not more than three (3) team members (students and/or adults) to best represent them. The team selects these representatives.
- During the first five minutes of the interview, the team members give a presentation to the judges, and the judges will use the second five (5) minutes for their interview.

- As part of the Chairman's Award judging process, FIRST judges will also review the Executive Summary page *AND* the yearbook page for each of the submitting teams.
- Your team's submission will be a key factor in the selection process, along with the judges' own observations of the team at the competitions. A team may bring additional material to the interview; however, the judges will require that the team will also provide any equipment necessary to display that material.

The Championship Award Process: At The Championship, a panel of judges will review the winning twenty-six (26) Regional Chairman's Award submissions, and will select one ultimate Chairman's Award winner. This winning team has the additional honor of choosing one of its junior or senior student members to be the recipient of the Allaire Medal.

8.2.5 The Allaire Medal - Leadership Exemplified

The Chairman's Award is presented at the Championship to the FIRST team judged to have the best partnership effort. The Allaire Medal recognizes leadership exemplified, and is awarded to an individual student on the winning Chairman's Award team.

Named in honor of Paul A. Allaire, a long-serving FIRST Chairman of the Board, the Allaire Medal is given to the student who has demonstrated outstanding leadership on his/her FIRST team, within his/her school and community, and whose personal character best embodies the spirit of FIRST.

The team receiving The Chairman's Award at the Championship will select the Allaire Medal recipient. The adult and student team members determine the winner. The recipient must be a high school junior or senior who has been accepted into a four-year degree program at a college or university. The Allaire Medalist receives the Allaire medallion and up to $10,000 in total scholarship support for undergraduate tuition, room and board, fees, and books at his or her intended university or college.

The Allaire Medalists for 2003 are Allison Guerin and Kathryn Urbanowicz, Team 103.

8.2.6 2004 Chairman's Award–Executive Summary

Complete and return *this* ONE-page overview with your Chairman's Award submission.
You must use this form and this format. DO NOT restructure or rearrange order.

TEAM #:

TEAM NAME:

Corporate/University Sponsors:

Regional Competition submitting Chairman's Award entry to:

Briefly describe the impact of the FIRST program on team participants:

Examples of role model characteristics for other teams to emulate:

Describe the impact of the FIRST program on your team and community:

Team's innovative methods to spread the FIRST message:

Describe the strength of your partnership

Team's communication methods and results:

Other matters of interest to the FIRST judges, if any:

8.2.7 Hall of Fame

FIRST Robotics created The Hall of Fame to recognize the teams that have had the most impact on FIRST growth. A team earns hall of fame status by winning the National Chairman's Award, *the* most prestigious FIRST award. Unlike other Halls of Fame, the model teams in the FIRST Hall of Fame are not retired, but begin a new, higher level of competition.

Congratulations to all the previous Chairman's Award winners! This year's twenty-six (26) Regional Chairman's Award winners will vie for the one spot reserved for the 2004 winner.

THE FIRST HALL OF FAME

Year	Team #	Official Team Name
2003	103	NASA/Amplifier Research/Custom Finishers/Lutron Electronics/BAE Systems & Palisades High School
2002	175	Hamilton Sundstrand Space Systems International/The New England Air Museum/Techni-Products/Veritech Media & Enrico Fermi High School
2001	22	NASAJPL/Boeing/Rocketdyne/FADL Engineering/Decker Machine & Chatsworth High School
2000	16	Baxter Healthcare Corporation & Mountain Home High School
1999	120	NASA Lewis Research Center/TRW, Inc./Battelle Memorial Institute & East Technical High School
1998	23	Boston Edison & Plymouth North High School
1997	47	Delphi International & Pontiac Central High School
1996	144	Procter & Gamble & Walnut Hills High School
1995	151	Lockheed Sanders & Nashua High School
1994	191	Xerox Corporation & JC Wilson Magnet High School
1993	7	AT&T Bell Labs & Science High School
1992	191	Xerox Corporation & JC Wilson Magnet High School

8.3 FOUNDER'S AWARD

Each year FIRST presents this award to honor an organization or individual that has contributed significantly to the growth of FIRST.

8.4 WOODIE FLOWERS AWARDS

The Woodie Flowers Award celebrates effective communication in the art and science of engineering and design. Dr. William Murphy and Small Parts, Inc. began this prestigious award in 1996. For the 2004 season, this award is being enhanced to honor more exemplary communicators in the FIRST community. Following Dr. Murphy's lead, FIRST wishes to bring more attention to these FIRST heroes.

FIRST will recognize one adult team member at each of the twenty-six (26) Regional Competitions as a Woodie Flowers Finalist Award winner. Of these twenty-six talented mentors, one will receive the Woodie Flowers Award at the Championship in Atlanta.

8.4.1 Award is Students' Choice

Students on a FIRST Robotics team will choose one adult team member as their candidate. They will describe how this mentor has given them the best understanding of the challenges, opportunities, and satisfaction involved in the discipline of engineering and design. Professor Flowers will lead the past Woodie Flowers Award winners as they judge and select the 2004 recipient, based on student essays.

8.4.2 Spirit of the Award

Two aspects of this award are important. Of course, the accomplishments in communication by the mentor are essential. Also very important is the student's ability to communicate clearly and concisely. Communication in both directions is an integral part of learning. This award recognizes an individual who has done an outstanding job of motivation through communication. The award also challenges the student body to be clear and succinct in recognizing the value of communication.

8.4.3 Judging Criteria

Only one candidate from a team may be nominated. This nominee must be an adult mentor who truly inspires the team. This individual demonstrates excellence in engineering instruction by explaining complex ideas to students in an inspiring way. Judging criteria is based on the team's description of how the teacher or engineer inspired each member of the team in some or all of the following ways:

- Level of student participation
- Creativity of effort
- Clear explanation of mathematical, scientific, and engineering concepts
- Demonstration of enthusiasm for science and engineering
- Encouragement to work on projects as a team effort
- Inspiration to use problem-solving skills
- Inspiration to become an effective communicator

FIRST team completes a product development cycle as it designs a concept, develops a prototype, and builds and debugs a unique machine. This requires teamwork, attention to detail, scheduling, and hard work. The award-winning essay should answer this question; "How did the candidate inspire your team throughout this process?" If the essay describes how this individual excels above all others as he or she inspires the team, then that mentor truly deserves to be recognized with the award that honors Professor Woodie Flowers and his contribution to engineering, education, and communication.

8.4.4 Entry Requirements

Students enter their candidate at the Woodie Flowers Award entry web page by entering team and candidate information, reference information, and a six hundred-word (600) essay. Teams may also add up to six (6) pictures, totaling no more than 1.0 Mb. of memory. This essay should be a team effort and will stand alone as the team's entry to award their candidate the deserved recognition.

8.4.5 Submission Deadline

The Woodie Flowers Award entries are due on Friday, February 27, 2004.

8.4.6 Entry Process

Students will go to the website to enter information in the following fields.

Team Number

Candidate Information:

First Name
Middle Initial
Last Name
Address
City, State, zip code
Employer
Occupation
Position on team

Student Advocate's information: (Student recommending candidate)

First Name
Last Name
Phone Number
E-mail Address
Position on Team

Adult Reference (On the same team)

First Name
Last Name
Phone Number
E-mail Address
Position on Team

Adult Reference (Any FIRST affiliation)

First Name
Last Name
Phone Number
E-mail Address

Regional Selection (Team must attend this Regional)

Upload Pictures (Up to 6, no more than 1.0 Mb total)

Essay (600 words or less) – The students will see a quote from Dr. Murphy and/or Woodie about the value of concise and clear writing.

Once candidates' information and essays are submitted, they are sorted and posted on a private, password-protected site where only the Judges can read the entries. Each Regional will have its candidates listed and the Judges will review the submissions.

8.5 THE AUTODESK INVENTOR® AWARD

8.5.1 Purpose of Award

This award honors excellence in student mechanical design.

8.5.2 Competition Period

Saturday, January 10, 2004, to Monday, March 15, 2004. After January 10, 2004, Autodesk Award updates (if any) may be found on the FIRST Robotics Competition section of the FIRST website www.usfirst.org and on the Autodesk Streamline site created for FIRST teams www.streamline.autodesk.com/first .

8.5.3 Questions

If you have any questions regarding the Autodesk Inventor Award or Entry Requirements, please write to Autodesk at: first.entries@autodesk.com and put "Inventor Question" in the subject line.

8.5.4 Award Overview

Autodesk wants to honor those young inventors and engineers who make the FIRST Robotics Competition possible! Once again we are excited to offer the Autodesk Inventor Award. With **Autodesk Inventor,** we have provided the tool that allows you to design without limits. Now we want to see what you do with this tool. We know that before your team can start building your robot, you need to design it. We want to see the exciting journey of how your designs evolved into a real-life robot!

Autodesk Inventor allows you to quickly and easily design and modify your robot using the same iterative techniques professional engineers employ. From concept through completion—the Autodesk Inventor Award was created to honor those who bring their ideas to reality.

8.5.5 Award Description

The Autodesk Inventor Award honors the team that best uses **Autodesk Inventor** software to design its 2004 FIRST Robotics Competition robot, posts various drawings of the robot onto the web, and includes photographs of the final robot.

8.5.6 Award Criteria

The competition has three required phases:

8.5.6.1 Phase One: The Design

The deliverables are as follows:

- A set of drawings (.idw) which document the basic dimensions of the design
- The assembly data for your robot (.iam and .ipt) --- parts and assembly

8.5.6.2 Phase Two: The Photograph

- A series of pictures (screen shots) that emphasize the advantages of your design.
- Digital photographs of your completed robot entered into the 2004 FIRST Robotics Competition. Photographs should clearly show the front, rear, and side views of your robot.

8.5.6.3 Phase Three: Web Postings (Designs and Photo)

Post your entry to a website. Please title each document clearly and concisely so the judges will know what they are viewing.

8.5.6.4 Phase Four: Bonus (Not required)

Animation of one mechanism using driven assembly constraints (.avi). Capture the animation using Autodesk Inventor's record functionality in the Drive Constraint dialog box.

TIP: Watch the Autodesk Inventor Online Tutorial presented by Phil Dollan. You can find the tutorial at www.autodesk.com/first.

8.5.7 Autodesk Streamline™

Autodesk has created a special site just for the FIRST Robotics Teams on Autodesk Streamline—a secure, Autodesk-hosted service that is easy to use. On this site you will find:

- Examples of Autodesk Inventor drawings (.iam)
- Examples of mechanism animations (.iam)
- Examples of exploded assembly animation (.ipn)
- Autodesk Design Academy curriculum (Great section on Autodesk Inventor!)
- "Virtual" kit of parts done in Autodesk Inventor
- Autodesk award updates, if any.

To access the Autodesk Streamline FIRST site, please go to: www.streamline.autodesk.com/first

Log in information for the site is: User Name: (public) Once you type in "public," the password field will grey out, as no password is required. This is a public site for the FIRST teams. You will not have to set up an Autodesk Streamline account.

8.5.8 Judging Criteria

In scoring your entry, judges will address specific criteria:

Robot Design	50 points
Technical Expertise	30 points
Presentation of final design	20 points
TOTAL POINTS:	100 points
Bonus:	
Animation of one mechanism using driven assembly constraints (.iam)	10 points
TOTAL POSSIBLE POINTS:	110 points

8.5.9 The Judging Process

The judging panel is made up of volunteers from business, industry, and education. Some of the judges are Autodesk employees and others are Autodesk Inventor customers or educators. Judges are familiar with the FIRST Robotics Competition, with previous Autodesk Award competitions, and with the application of Autodesk products and other technologies in engineering, design, and education.

Judges will select one Grand Prize Winner for the 2004 Autodesk Inventor Award. The Winner will be announced during The 2004 FIRST Competition Championship Event Awards Ceremony. Representatives from the winning team will be acknowledged on the main stage. A link to the winning team's website will be posted on www.autodesk.com/first after the Championship event.

8.5.10 Entry Deadline

The entry deadline is Monday, March 15, 2004, at 5:00 pm PST.

8.5.11 Entry Requirements/Submission Address

- Entrant must be a fully registered team participating in the 2004 FIRST Robotics Competition.
- Limit one (1) entry per school. If a team includes multiple schools, each school may submit an entry.
- You must submit a completed and clearly legible Entry Form to Autodesk.
- You must submit a completed and clearly legible Archive Consent and Release Authorization Form to Autodesk.
- Use the forms provided at the end of this section. Please type in the information as handwritten forms are often illegible.
- Send signed original forms to:
- **ATTN: FIRST ROBOTICS COMPETITION – AIA**

  Autodesk, Inc.
  111 McInnis Parkway
  San Rafael, CA 94903
  U.S.A.
- Send an Email notification* to: **first.entries@autodesk.com,** announcing that your entry is posted to your website, no later than Monday, March 15, 2004, 5:00 p.m., PST. In your email, you must also include:
  1. Subject header should say "AIA Entry, Team No. xxxx" (Put your team number)
  2. Team name and number
  3. At least one team contact name, telephone number, and email address. It is important that we have this information in case our judges need to contact you with any questions or concerns regarding your entry.
  4. School name(s)
  5. Corporate sponsor's name and telephone number
  6. Autodesk products used
  7. Other non-Autodesk products used
  8. Active link to your website

Autodesk is not responsible for any technical malfunctions; lost/delayed data transmission; omission, interruption, deletion, line failures of any telephone network; computer equipment or software; the inability to access any website or online service. Autodesk is not responsible for late, lost, stolen, misdirected, incomplete, or illegible entries; postage-due mail; Internet downtimes or malfunctions, or other errors.

***Note**: Any Entry Forms and/or Autodesk Archive Consent and Release Authorization Forms hand-delivered to Autodesk must be left at the front desk of the Autodesk Headquarters at 111 McInnis Parkway, San Rafael, CA, prior to 5:00 PM on March 15, 2004.*

8.5.12 Prizes and Prize Rules

Detailed information on the prizes and prize rules will be announced on the FIRST website after the Kickoff event.

8.5.13 Scores/Compilation Email

If your team wishes to receive its score, you must send an email to: first.entries@autodesk.com. The subject header should say: "AIA, Team #xxxx, Request for Score."

8.5.14 Autodesk Inventor® Award - 2004 Entry Form

The following are required:

- Complete this Entry Form. Its contents are required for judging. It must be legible, and you must include it with your Entry submittal. Please read the Entry Requirements carefully before completing this Entry Form. Information on this form must be complete.
- Complete and include the Autodesk Archive Consent and Release Authorization agreement with your entry. It is required for judging.

Entry Deadline

Autodesk must receive entries no later than 5:00 PM, March 15, 2004.

Entrant information (Please print or type)

FIRST Team Number _____ Team Name _____

Autodesk Inventor Award Entry URL: _____

School Phone _____ School Name _____

School Contact (Teacher) and e-mail _____

Team Contact Name and e-mail _____

Telephone _____ Cell Phone _____

Individual Student Designers

Your team can select up to 10 individual student designers as potential Award recipients. List the information requested for each student on Attachment "A.".

Student Name _____

Current Address _____

Telephone Number _____

E-mail Address _____

Individual Team Champion

In past competitions for the Autodesk Award, we have heard impressive stories of outstanding individuals on some competing teams. Please tell us who your "Team Champion" is this year and about his/her contribution to the team and your Entry. Your champion may be a student, teacher, engineer, community member, or other individual contributor.

_____

_____

_____

_____

_____

Software Use—Describe which Autodesk products you used…and how. Also, name and describe other design, visualization, or animation software products you used in your entry.

_____

_____

_____

_____

8.5.15 Attachment “A” Autodesk Inventor Award 2004

Student Designers:

Include name, address, phone number and e-mail address for each student listed.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

8.5.16 Inventor Archive Consent/Release Authorization

Use this form for the Autodesk Inventor Award at The 2004 FIRST Competition

Dear Contributor,

We appreciate your interest in submitting material to Autodesk, Inc. The following allows us to legally use your work.

By signing and returning this consent form, the individual named below and/or if applicable the individual's employer, middle or high school(s), or corporate or college/university sponsor(s) and individual student, faculty, and corporate contributors (hereinafter referred to collectively as the "Entrant") understand that the Entrant is agreeing to the following terms which will govern use of the images, animation, sounds, files, and other material (the "Material") described below:

- Entrant grants a nonexclusive, irrevocable, perpetual, worldwide license to Autodesk, Inc. to use the images, animation, sounds and other material contained in the "Material" in any manner it deems appropriate. "Nonexclusive" means that Entrant can allow others to use the Material and that the Entrant retains all rights to the Material other than those specifically granted to Autodesk.
- Autodesk may change, reproduce, distribute, and sublicense the Material to its subsidiaries, affiliates, customers and to third parties granting them the same rights which Autodesk has received.
- Autodesk will try to include the credit line shown below when the Material is used and will also try to require others to whom it grants sublicense to do the same. However, Autodesk and its sublicensees may not always be able to include the credit line or otherwise acknowledge the source of the Material. The compensation the Entrant will receive for agreeing to license the Material will be limited to the exposure the Entrant receives by Autodesk's use and sublicensing of it. No other compensation will be paid. The Entrant agrees that the Entrant will not at any time make any claim for compensation for the rights granted to Autodesk.

The Entrant represents and warrants that the Material is owned by the Entrant free and clear of any liens or claims of any third party; that the Entrant has a legal right to grant the permission given in the Entry Form and in this Agreement. The Entrant indemnifies and hold Autodesk, its subsidiaries, associated companies, successors, assigns, agents, and employees harmless against liability should any third party claim that the use of the Material or any part thereof by Autodesk violates any right of such third party. The Material does not include any proprietary information, logos, or trademarks of any third party. NOTE: Use of the FIRST Foundation logo is permitted without permission, as long as that logo is not at all altered.

The authorized signatory for the Entrant is over 18 years old and **either** owns the copyright to the material in these files, **or** has the right to grant this consent on behalf of the owner, **or** knows that the material in these files is in the public domain. This consent does not conflict with any others the Entrant has granted or any other rights to the files.

FIRST TEAM SPONSOR OR SCHOOL (where applicable)

FIRST Team Name and Number:

Number: _____ Name: _____

Inventor Award Entry URL: _____

Name, email and Telephone # of Entry Contact:

_____

Address, City, State, ZIP:

_____

School/Sponsor Name & Address:

_____

Telephone # _____E-mail _____

Authorized Signatory (print) _____

Authorized Signature (sign) _____

The above release shall be void if amended in any manner. Autodesk shall not be responsible for the return of any materials submitted.

8.6 THE AUTODESK VISUALIZATION AWARD

Purpose of Award: Honor excellence in student animation.

Entry Deadlines:

There are two separate deadlines this year!

- Paperwork Due: Monday, February 16, 2003
- Animation and Storyboard due: Monday, February 23, 2004 no later than 8:00 a.m. (PST)

Questions ?:

If you have questions regarding the Autodesk Visualization Award or Entry Requirements, please write to Autodesk at: **first.entries@autodesk.com** and put "AVA Question" in the subject line.

Award Updates:

You can find award updates (if any) under the "Documents and Updates" link on the FIRST Robotics Competition section of the FIRST website (http://www.usfirst.org) after January 10, 2004, or on Autodesk Streamline site created especially for the FIRST Robotics teams: https://projectpoint.buzzsaw.com/client/FIRST Log in information for the site is: User name: **(public)** [NOTE: Be sure to include the parentheses!] Once you type in "(public)" the password field will become grey as no password is required.

Award Overview:

All FIRST teams are invited to create a submission for the Autodesk Visualization Award (AVA) using **3ds max®.** The AVA will be judged at regional events by your animation peers. All award-winning AVA's (one per regional event) will advance to the professional round of judging. The winner of the professional round of judging will be announced at the FIRST Robotics Championship event in Atlanta. Rookie entries will be considered for the "Rising Star" Award. This award will be judged solely by the Autodesk experts during the professional round of judging to take place at Autodesk Headquarters.

(For more details on judging, please see "Regional Judging" and "Professional Judging" sections below.)

Note: Winning a Regional AVA does NOT earn a team qualification points towards, or a spot at the FIRST Robotics Competition 2004 Championship event.

8.6.1 Award Description

The Award recognizes 30-seconds of student animation that clearly and creatively illustrates what FIRST means to your team, meets entry requirements, and is judged to have the highest score. Entries will be scored on the criteria for the three key areas outlined below.

8.6.1.1 Scoring Criteria:

Concept (Maximum: 35 points)

Judges will look for distinction in the use of design and animation to illustrate and communicate a clearly defined message of what FIRST means to your team. Your entry will be measured in terms of how well your team identifies and executes on a concept and organizes the content for your 30-second story. Also measured is how well your animation follows your storyboard.

Drawing from your team members, your school and corporate partnership, your community involvement and/or your robot, identify and illustrate a specific aspect of what FIRST means to your team. Some examples of appealing aspects of FIRST: mentorship, collaboration, leadership and/or community. **You must include a statement before your 30-second animation begins as to what "appealing aspect of FIRST" you are trying to communicate.** Using graphic imagery and animation developed with **3ds max** (as well as other *Autodesk* products if you wish), your animation should be an informative and clearly focused 30-second spot that supports your message of what FIRST means to your team. Your entry will be judged on how well your animation visually illustrates this written statement.

Creativity (Maximum: 35 points)

Judges will look for distinction in the use of design and animation to make your entry visually exciting, arresting, striking and memorable. The challenge is to create a compelling, creative and distinctive spot – one that stands out from the rest. Think of what you are producing as being a 30-second "spot" that might be intended for use on national television to inform viewers in an exciting and creative way about FIRST and the benefits of the FIRST experience.

Technical Execution (Maximum: 30 points)

Distinction in the application of Autodesk software. The challenge is to demonstrate how skillfully your team uses **3ds max** and other Autodesk products to create a technically impressive animation. Your entry will be measured in terms of how well your team uses all the features of **3ds max** and other Autodesk products. Some examples of technical applications are: modeling, materials application, lighting, camera motion and angles, sound effects, texture mapping, color, special FX, character animation, editing technique. In addition to using the features of **3ds max**, judges will review how well you have incorporated elements such as voice-over, music, photography, or live video into the animation.

NOTE: Animations *that use copyrighted music without written permission from the legal copyright owner will be disqualified. For more information on the use of music in your animation, please see document entitled "Copyright Music Information.PDF" which is posted on Autodesk Streamline, see link below.*

8.6.1.2 Submittal Process and Entry Requirements

- Entrant must be a fully registered team participating in the 2004 FIRST Robotics Competition.
- Limit one (1) Entry per school. If a team includes multiple schools, each school may submit an Entry. Please identify each school entry with the team number, and then a letter starting with "a". Example: "Team 123a Smith High School" "Team 123b Jones High School."
- A completed and clearly legible Entry Form and a completed and clearly legible Autodesk Archive Consent and Release Authorization Form.
  - Find forms on the Autodesk Streamline site https://projectpoint.buzzsaw.com/client/FIRST
  - Ensure that forms are legible.

Forms should be posted onto Autodesk Streamline no later than Monday, February 16, 2004. Please place forms into the file folder named "AVA Forms."

- Storyboard (no size or length requirements). Electronic storyboards are acceptable. Upload them to your specific team's folder on Streamline. If a hard copy of the storyboard is submitted, please use #3 pencil or softer. You may use color on the original, but is not required.

  The Storyboard must be clearly labeled with Team Number, Team Name, School(s) Name and Sponsor(s) name. Without this information entry will not be judged. Mail Hard copy storyboards to: Autodesk, Attn: FIRST Robotics Competition, 111 McInnis Parkway, San Rafael, CA 94903.
- Storyboards are due with the AVA submission, no later than 8am (PST) Monday, February 23, 2004.
- Post your Animation on Autodesk Streamline under the file folder with your team number, no later than 8 am (PST) Monday, February 23, 2004.
- Once you post your animation, you must send an email to first.entries@autodesk.com announcing that you posted your animation. Please include all identifying team information in your e-mail. Subject header should say "Notice of AVA Posting, Team number xxx"
- Your entry must include: 5-second slate followed by one second of black, followed by the animation, followed by one second of black. Slate must include:

  Team number (example: R1234 or 1234)

  Team Name

  School

  Title

  Statement about what appealing aspect of FIRST your animation is about

  Duration (not including slate and black)

Audio (stereo, mono, none)

Credits may follow that still frame, but will not be included as part of the timing, judging or scoring process, nor will they be included in the compilation reels distributed by Autodesk Inc.

Acceptable file formats: QuickTime (.MOV) NOTE: QuickTime is included on the **3ds max 6** CD.

Acceptable Codecs: DV-NTSC and Cinepak. Do not use DiVX or any other non-standard Codec

Frame Rate: 29.97 frames per second

Frame Size: 720 x 480 or 640 x 480. **NOTE:** See "Frame Size" section on Tips and Tricks document posted on Autodesk Streamline.

Maximum File Size: Please keep your entry well under 250MB

Naming convention: You must name your animation in the following format: "[insert your team number]_AVA2004.[appropriate extension]"

Example: 1234_AVA2004.MOV

ROOKIE ENTRIES: If your team is making a first entry for the Autodesk Visualization Award, you will be considered a rookie entry. As such, you must place an "R" in front of your team number on all components of your entry (entry form, archive and consent form, slate (on the animation), etc.). **Example: "R-1234"** Without this "R" your entry will not be judged as a rookie entry.

Note: For the purposes of this award, Autodesk defines rookie as a team that has never submitted for the Autodesk Visualization Award before. This means that both veteran and first year teams who have never submitted an AVA are eligible to submit as rookies.

Entry Deadline: All Entries must be posted on Autodesk Streamline not later than 8:00 AM (PST) on February 23, 2004. Entries will not be accepted for judging after the deadline. Autodesk is not responsible for Entries not posted onto Autodesk Streamline by the deadline, nor for any lost, late, misdirected, illegible, incomplete, or damaged Entries.

Post Entry to: https://projectpoint.buzzsaw.com/client/FIRST

Log in information for the site is: User name: **(public)**. **[Note:** Be sure to use the parentheses.**]**

Once you type in "(public)" the password field will become grey as no password is required.

Entries will remain the property of Autodesk, Inc. No materials will be returned.

8.6.1.3 The Judging Process

Autodesk Initial Screen

As in past years, Autodesk will screen all Entries for compliance with submittal guidelines. Those Entries not in compliance will not be judged – but, they may be incorporated on the end of season compilation reel.

Autodesk will have a preliminary judging of all Entries in full compliance. As a result of this preliminary judging, a select number of Entries will advance for judging at the FIRST Robotics Competition Regionals.

Regional Judging

There will be one AVA winner announced at each Regional. Your animation will be judged at each regional event your team attends. Judging at the regional events will be conducted by your peers and judged based on the Autodesk Awards Criteria set out above.

Notes on the Regional Judging process

- Only teams that submit an animation will be eligible to participate in judging at the regional level. These teams will be eligible to designate one student from their team to be a student judge. The student selected must have been involved in some way with the development of his/her team's own submittal.
- Judging will take place at a designated time and location at each regional venue. Check at the on site registration for exact location of judging. The regional entries will show continuously on a dedicated system all day Thursday. Actual judging will be at a pre-announced single time Friday. Student judges will be encouraged to watch the animations on Thursday reviewing the entries against criteria, so that they are well prepared for formal judging on Friday.

- Ballots will be distributed only to those teams competing for the AVA in the particular Regional. The ballots will be pre-printed with the team name/number and will be provided in the registration packets at the onsite registration for each regional. Student judges will not be allowed to score the animation submitted by their own team.
- There will be an adult volunteer representing Autodesk on site Friday to facilitate judging.
- Each regional event will announce an AVA award winner at the closing ceremonies at each Regional.
- The name of each winner will be on the FIRST website the week following each regional event.
- The scores will be posted onto Autodesk Streamline following the regional events based on Autodesk staff availability.
- The winner from each Regional will advance to the professional round of judging.

Professional Round of Judging

All animations winning at the regional level will advance to the next phase of judging. A professional panel of judges made up of volunteers from business, industry and education will conduct the next phase of judging. They are professional animators, artists, engineers and educators. Some of the judges are Autodesk employees, others are 3ds max customers or trainers. Judges are familiar with the FIRST Robotics Competition, with previous Autodesk Award competitions, and with the application of Autodesk products and other technologies in engineering, design and education.

Professional judges will select one regional winner to be designated as the Championship winner and they will also select one rookie entry as the "Rising Star" winner. Both winners will be announced at the FRC Championship event.

"Rising Star" (Rookie) winner:

The "Rising Star" award will not be awarded on a regional level. For the purposes of this award, the "Rookie" designation is given to any school that has not submitted for the Autodesk Visualization Award previously. Teams submitting with a "Rookie" designation (R plus team number) will also be part of the Autodesk Visualization Awards being judged at the regional level if they have met all the qualifications and pass the prescreen process. Schools that have submitted previously but have been disqualified do not qualify as "Rookie" teams under these Guidelines. Should a "Rookie" team win the 2004 Championship Award, there will be no "Rising Star" Award presented.

Winners' names will be posted on the www.autodesk.com/first website along with the winning animations.

Prizes and Prize Rules

Detailed information on prizes and prize rules will be announced on the FIRST website after the Kickoff.

Scores/Compilation Disc

If a team wishes to receive its score, send an email to: first.entries@autodesk.com. The subject header should say: "AVA, Team #xxx, Request for Score." Scores will be provided for teams who advance to the Regional and Championship judging rounds only. Each team participating in the AVA will receive a DVD containing all the animations submitted for the 2004 competition. The top scoring animations will be shown at The 2004 FIRST Championship.

8.6.2 Autodesk Visualization Award 2004 Submittal Checklist

Item	Deadline (No Later than)	Completed
Entry Form and Autodesk Archive Consent and Release Authorization Form. (Post on Autodesk Streamline* site or mail**)	Monday February 16, 2004	☐
Written permission note to use music from the legal copyright owner, *if* your animation contains copyrighted music. (Post on Autodesk Streamline* site or mail**)	Monday February 16, 2004	☐
Storyboard (Upload to Autodesk Streamline* site or mail*)	Monday February 23, 2004 8am (PST)	☐
Animation (Posted onto Autodesk Streamline* under the file folder with your team number)	Monday February 23, 2004 8am (PST)	☐
Send email to: first.entries@autodesk.com to announce your animation has been posted. Subject header should say: "Notice of AVA posting, team number XXX"	Monday February 23, 2004 8am (PST)	☐

*Autodesk Streamline site:
https://projectpoint.buzzsaw.com/client/FIRST
username: "(public)"

**Mailing address:
Autodesk Inc.
Attention: FIRST Robotics Competition
111 McInnis Parkway
San Rafael, CA 94903

8.7 ARCHIVE CONSENT AND RELEASE AUTHORIZATION

Use this form for the Autodesk Visualization Award at The 2004 FIRST Competition

Dear Contributor,

We appreciate your interest in submitting material to Autodesk, Inc. The following allows us to legally use your work.

By signing and returning this consent form, the individual named below and/or if applicable the individual's employer, middle or high school(s), or corporate or college/university sponsor(s) and individual student, faculty and corporate contributors (hereinafter referred to collectively as the "Entrant") understand that the Entrant is agreeing to the following terms which will govern use of the images, animation, sounds, files and other material (the "Material") described below:

- Entrant grants a nonexclusive, irrevocable, perpetual, worldwide license to Autodesk, Inc. to use the images, animation, sounds and other material contained in the "Material" in any manner it deems appropriate. "Nonexclusive" means that Entrant can allow others to use the Material and that the Entrant retains all rights to the Material other than those specifically granted to Autodesk.
- Autodesk may change, reproduce, distribute, and sublicense the Material to its subsidiaries, affiliates, customers and to third parties granting them the same rights which Autodesk has received.
- Autodesk will try to include the credit line shown below when the Material is used and will also try to require others to whom it grants sublicense to do the same. However, Autodesk and its sublicensees may not always be able to include the credit line or otherwise acknowledge the source of the Material. The compensation the Entrant will receive for agreeing to license the Material will be limited to the exposure the Entrant receives by Autodesk's use and sublicensing of it. No other compensation will be paid. The Entrant agrees that the Entrant will not at any time make any claim for compensation for the rights granted to Autodesk.

The Entrant represents and warrants that the Material is owned by the Entrant free and clear of any liens or claims of any third party; that the Entrant has a legal right to grant the permission given in the Entry Form and in this Agreement. The Entrant indemnifies and hold Autodesk, its subsidiaries, associated companies, successors, assigns, agents, and employees harmless against liability should any third party claim that the use of the Material or any part thereof by Autodesk violates any right of such third party. The Material does not include any proprietary information, logos, or trademarks of any third party. NOTE: Use of the FIRST Foundation logo is permitted without permission, as long as that logo is not at all altered.

The authorized signatory for the Entrant is over 18 years old and **either** owns the copyright to the material in these files, **or** has the right to grant this consent on behalf of the owner, **or** knows that the material in these files is in the public domain. This consent does not conflict with any others the Entrant has granted or any other rights to the files.

FIRST TEAM SPONSOR OR SCHOOL (where applicable)

FIRST Team Name and Number: _____

Animation Entry Title: _____

Name, Email and Telephone # of Entry Contact: _____

_____

Address, City, State, ZIP: _____

School Name & Address: _____

School Telephone #: _____

Teacher Name & Email: _____

Does you animation contain audio? Yes_____ No_____ If so, is it music? Yes_____ No____
If yes, what is the title of song(s), and the author(s) name, and/or name of band or artist:

_____

Is it original music created specifically for your animation? Yes_____ No_____
If no, do you have written consent from the legal copyright owner to use this music in your animation?
Yes_____ No_____ (If yes, written consent must accompany your entry form. If no, your animation will be disqualified.)

Authorized Signatory (print) _____

Authorized Signature (sign) _____

The above release shall be void if amended in any manner. Autodesk shall not be responsible for the return of any submitted materials.

8.8 WEBSITE DESIGN AWARDS

The Website Design Award recognizes excellence in student-designed, built, and managed FIRST team websites. Eligible websites are judged/scored *PRIOR* to the competition by a panel of judges. **Two** subcategories of awards will be given for website design:

1) "Website Excellence"
2) "Best Website."

Every submission that meets the FIRST website design standards of excellence will receive the Website Excellence award. Website Excellence award winners will receive an electronic certificate to include on their websites, and will be featured prominently on the FIRST website. At each Regional Competition, there will be one award for Best Website. The overall championship Best Website award winners will be chosen from among the regional winners.

8.8.1 Submission and Deadline Information

Only team websites that are entered into the FIRST team management information system via the FIRST website by noon (12:00 p.m.) on February 20, 2004 will be judged. Team websites are eligible for these awards at every regional event in which the team is competing. Only one electronic Website Excellence certificate will be awarded per team for the entire competition season. A team is eligible to win the Best Website award at multiple regional events.

8.8.2 Finding Team Website Links

Go to http://www.usfirst.org/robotics/2004/rgevents.htm and click on "Team List" for each of the regional events. Teams with websites that are registered with the team information management system will have their team names listed in blue font.

8.8.3 Scoring Criteria

The following criteria will be used to judge the Website Design Awards:

8.8.3.1 Content. (25 points – 5 points each)

- Does the website include team information and great stories?
- Does the website include recognition of sponsors and volunteers?
- How well does the site explain FIRST and promote the vision of FIRST?
- Does the website include helpful resources for other FIRST teams?
- Does the website contain interesting non-text content such as music, sound, animation, or video?

8.8.3.2 Structure and Navigation. (25 – 5 points each points)

- Is the site well organized?
- Is the easy to navigate through?
- Is important information easily accessible?
- Is there a prominent link to the FIRST website?
- Are links available to related sites? (School, sponsors, other teams, FIRST, useful resources, etc.)

8.8.3.3 Visual Design. (25 points – 5 points each)

- Does the website communicate a visual experience reflective of the team identity?
- Does the website communicate a visual experience reflective of the mission of FIRST?
- Does the site use color and iconography in a consistent way?
- Does the website homepage use the official FIRST logo?
- Does the website include photos of the team participants, volunteers, and sponsors?

8.8.3.4 Functionality and Interactivity. (25 points – 5 points each)

- Does the site work well?
- Does it load quickly?
- Do the links work?
- Does it take into consideration those with diverse user requirements including file sizes, file formats, special access needs, (i.e. alt tags for images) and download speeds?
- Are there effective opportunities for a visitor to interact with the website?

8.8.4 Judging Process

- Each website submitted for consideration will be reviewed by a panel of judges prior to each competition.
- There will be no on-site interviews. If the judges have questions about a particular website, they may contact the team via email prior to the competition to resolve their questions.
- Websites scoring at least 80% will receive the Website Excellence award.

8.8.5 Award Presentation

- Each team that wins Best Website at a competition will receive an award at that event.
- Teams that earn the Website Excellence award will have their names read aloud and will receive an e-mailed, electronic certificate to place on their websites following the competition.

2004 Website Award Scoring Sheet Event:_____

Team Numbers	#	#	#	#	#	#
Content. (25 points)						
· Does the website include team information and great stories? · Does the website include recognition of sponsors and volunteers? · How well does the site explain FIRST and promote the vision of FIRST? · Does the website include helpful resources for other FIRST teams? · Does the website contain interesting non-text content such as music, sound, animation, or video?						
Structure and Navigation. (25 points)						
· Is the site well organized and easy to navigate through? · Is important information easily accessible? · Are links available to related sites? (School, sponsors, other teams, FIRST, useful resources, etc.)						
Visual Design. (25 points)						
· Does the website communicate a visual experience reflective of the team and of the mission of FIRST? · Does the site use color and iconography in a consistent way? · Does the website homepage use the official FIRST logo?						
Functionality and Interactivity. (25 points)						
· Does the site work well? · Does it load quickly and do the links work? · Does it take into consideration those with special access needs? · Are there effective opportunities for a visitor to interact with the website?						
Total Scores. (0-100 points)						

8.9 CHAMPIONSHIP AWARDS

FIRST will hold a Championship Awards Celebration where a special judging panel will present the following awards.

8.9.1 Champion

This award celebrates the team or alliance that wins the Championship.

8.9.2 Championship Finalist

This award celebrates the team or alliance that makes it to the final match of the Championship.

8.9.3 Division Finalist

This award celebrates the team or alliance that makes it to the final match in its division at the Championship.

8.9.4 Division Champion

This award celebrates the team or alliance that wins the final match in their division at the Championship.

8.9.5 Autodesk Visualization Award

Presented by Autodesk, Inc., this award recognizes excellence in student animation that clearly and creatively illustrates the spirit of the FIRST Robotics Competition. This year, Autodesk will award excellence in content, creativity, and mastery of multimedia.

8.9.6 Autodesk Inventor Award

Presented by Autodesk, Inc., this award recognizes the team that best understands, communicates, and documents the distinct phases of the design process from concept to completion. Autodesk will reward excellence in documenting the design process, technical competence using Autodesk software, and web page design.

8.9.7 Chairman's Award

The Chairman's Award represents the spirit of FIRST; it honors the team that best represents a model for other teams to emulate and which embodies the goals and purpose of FIRST. It remains the most prestigious team award FIRST presents. Please refer to the "Chairman's Award" Section for more about the award.

8.9.8 DaimlerChrysler - Team Spirit

This award celebrates extraordinary enthusiasm and spirit through an exceptional partnership and teamwork.

8.9.9 Delphi - "Driving Tomorrow's Technology"

This award celebrates an elegant and advantageous machine feature. This award recognizes any aspect of engineering elegance including, but not limited to: design, wiring methods, material selection, programming techniques, and unique machine attributes. The criteria for this award are based on the team's ability to concisely verbally describe, as well as demonstrate, this chosen machine feature.

8.9.10 Engineering Inspiration

This award celebrates a team's outstanding success in advancing respect and appreciation for engineering and engineers, both within their school, as well as their community. Criteria include: the extent and inventiveness of the team's efforts to recruit students to engineering, the extent and effectiveness of the team's community outreach efforts, and the measurable success of those efforts. This is the second highest FIRST award a team can garner.

8.9.11 Founder's Award

The Founder's Award is presented each year by FIRST Founder Dean Kamen to one organization or individual for exceptional service in advancing the ideals and mission of FIRST. Past winners of this award include: Motorola, Inc. (1993), Honeywell (1994), Walt Disney World's Epcot (1995), The City of Manchester, NH (1996), Francois Castaing of Chrysler Corporation (1997), Johnson & Johnson (1998), NASA (1999), Dr. William Murphy, Founder of Cordis Corporation & Small Parts, Inc. (2000), Autodesk, Inc. (2001), John Doerr, partner, Kleiner Perkins Caufield & Byers (2002), and Innovation First (2003)

8.9.12 General Motors - Industrial Design

This award celebrates form and function in an efficiently designed machine that effectively achieves the game challenge.

8.9.13 Imagery

This award celebrates attractiveness in engineering and outstanding visual aesthetic integration from the machine to team appearance.

8.9.14 Johnson & Johnson - Sportsmanship

This award celebrates outstanding sportsmanship and continuous gracious professionalism in the heat of competition, both on and off the playing field.

8.9.15 Judges' Awards

During the course of the competition, the judging panel may encounter a team whose unique efforts, performance, or dynamics merit recognition.

8.9.16 Kleiner Perkins Caufield & Byers - Entrepreneurship

The Kleiner Perkins Caufield & Byers Entrepreneurship Award celebrates the Entrepreneurial Spirit. This award recognizes a team, which since its inception has developed the framework for a comprehensive business plan in order to scope, manage, and obtain team objectives. This team displays entrepreneurial enthusiasm and the vital business skills for a self-sustaining program.

8.9.17 Leadership in Control

This award celebrates an innovative control system or application of control components to provide unique machine functions.

8.9.18 Motorola - Quality

This award celebrates machine robustness in concept and fabrication.

8.9.19 Rookie All-Star

This award celebrates the rookie team exemplifying a young but strong partnership effort, as well as implementing the mission of FIRST: to inspire students to learn more about science and technology.

8.9.20 *Rookie Inspiration

This award celebrates a rookie team for outstanding effort as a FIRST team in community outreach and recruiting students to engineering. This team models gracious professionalism on and off the field and is a true inspiration to others.

8.9.21 Website Design Award

This award recognizes excellence in student-designed, built, and managed FIRST team websites. We have revised the process for this award for 2004. Please refer to the website section for specifics.

8.9.22 Woodie Flowers Award

Small Parts, Inc. presents The Woodie Flowers Award to an outstanding engineer or teacher participating in the robotics competition. This person best demonstrates excellence in teaching science, math, and creative design and is chosen from among the Regional winners for this award. This award was presented in 1996 to its inaugural recipient, Dr. Woodie Flowers, Pappalardo Professor of Mechanical Engineering at MIT and National Advisor for FIRST. Past winners of this award include: Elizabeth Calef, Teacher, Bridgewater-Raynham Regional High School (1997); Michael Bastoni, Teacher, Plymouth North High School (1998); Ken Patton, Engineer, GM Powertrain (1999); Ms. Kyle Hughes, Teacher, OSMTech Academy (2000); and William Beatty, Beatty Machine & Manufacturing Company (2001); David Verbrugge, Engineer, GM Proving Ground (2002), and Andy Baker, Engineer, Delphi Automotive Systems (2003).

8.9.23 Xerox - Creativity

This award celebrates creative design, use of a component, or creative or unique strategy of play.

FIRST Pneumatics Manual

2004

Custom Cylinder and Rotary Actuator
Order Form on Page 19.

The Advantages of Using Pneumatics in 2004

Fluid power technology encompasses both hydraulics and pneumatics. Hydraulic applications use pressurized fluids, mostly oil, while pneumatic applications use pressurized gases, mostly air. Mobile construction equipment uses a hydraulic pump mounted on the engine. The outlet of the pump is plumbed to a set of valves. Each valve is then plumbed to a cylinder. This allows you to distribute power from the engine all around the equipment. The same is true for a FIRST robot. Once you install the compressor operating one valve and cylinder combination, you've done most of the work. To add additional valve and cylinder combinations, you just tee into the pressure line and add in the additional circuit.

Weight

Compare the weight of several valves and cylinders to that of the motors, gears, belts, and chains used on some lift mechanisms and you will find the weight comparable, if not much lighter.

Simple to Design

Using pneumatics is much easier than building a motor; gear, chain and sprocket lift mechanism. Once you have reviewed the layout on page 15, you will find it very easy to build a circuit.

Adjustable Force

To adjust the force of the cylinder, all you have to do is adjust the regulator in front of it. The force is equal to the area of the cylinder piston times the pressure. Remember that the valves are rated at a minimum of 15-30psi to work properly.

Durable

All of us have problems burning up motors from time to time. You can stall an air cylinder against a load indefinitely and turn off the compressor. These are industrial grade products.

Strong

If you look at the force table on page 12, you have the option of using a small 3/4" bore cylinder at 20psi, which will produce a force of around 9 pounds. If you use a 2" bore cylinder at 60psi, you can get 180 pounds of force. As you can see, your options are wide open.

Custom Cylinders and a Rotary Actuator

You can now order the exact cylinder you need for the job and get them in a few days via regular UPS.

Last Minute Additions

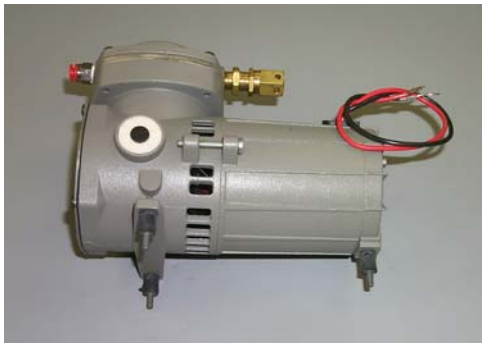
At the last minute, you can add a cylinder and valve very quickly.

Congratulations on receiving your pneumatic kit for the FIRST 2004 competition.

This year we have worked very hard to make it easier for you to use pneumatics on your robot. We have also chosen components that match each other. This year almost all the major components have been manufactured exclusively for this year's competition. There are some exciting new additions to this year's kit which we hope will make using pneumatics easier than ever

COMPRESSOR

We have the same compressor provided by **Thomas Industries** that we've had over the last few years**.** The compressor will put out approximately 125psi before the **Norgren** relief valve opens. Because the compressor can produce a significant amount of vibration, we have included vibration isolation mounts donated by the **Lord Corporation**. They can be screwed directly into the feet of the compressor as shown on the following picture. In order for these to isolate the vibration, they need to be mounted to a stiff piece of metal such as a 1/4" aluminum plate. The distance between the front feet is 3.5". The distance from the centerline of these feet to the rear foot is 5.19". A spike relay should be used to control the power to the compressor using a 20amp breaker, not a fuse. Ensure that the relay is programmed to provide "forward" power only to the compressor. Do not reverse the compressor!



Warning: The compressor head can get quite hot during extended operation.

PRESSURE SWITCH

We have included a pressure switch manufactured by **The Nason Company.** These switches are normally closed. The switches will open at approximately 115psi and will not close again until the pressure drops to approximately 95psi. This will allow you to turn off the compressor once you are up to 115psi, saving power in the battery. It should be wired directly to the robot controller digital input bank with PWM type cable. No specific Digital Input Port is designated for the pressure switch. The Robot Controller must be programmed to react to the Input Port that is connected to the pressure switch The Robot Controller will activate the designated Spike Relay to turn the Compressor "on" and "off". There is no default program in the Robot Controller to control the Compressor power. Do not put the pressure switch in series with the power supply to the compressor.

PRESSURE TRANSDUCER

Texas Instruments has donated a pressure transducer that gives an output based on the input pressure. It could be used to monitor system pressure as shown in the pneumatic schematic or to monitor an individual circuit.

TANKS

We have two tanks from **Clippard Instruments.** They should be mounted right after the compressor, before the Norgren primary pressure regulator.

REGULATORS

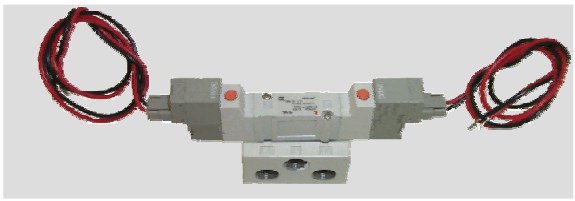
Norgren has donated the primary pressure regulator. These are relieving regulators. Assume that you extend the cylinder or the apparatus the cylinder is attached to against a wall. Then push against the wall with your robot. That would increase the pressure in the cylinder. The increased pressure will relieve out of the regulator and the cylinder will slowly retract. This regulator has a maximum output pressure of 60psi. <u>This regulator must be placed in-line right after the tanks to limit the pressure to all working circuits to 60psi.</u> It is adjustable and the outlet pressure may be reduced at your discretion. Look at the top of the regulator. You will note that one port extends out a little bit more than the others. It also has an arrow on it to denote the outlet of the regulator. The opposite port is the inlet. A pressure gauge may be placed in either of the other ports. You will have to plug the other gauge port with the enclosed hex plug.

Monnier has donated the secondary regulator, which has a yellow ring around it. This is also a relieving regulator. Its purpose is to allow you to have a reduced pressure leg, if needed. There is an arrow denoting the direction of flow. The gauge may be placed in either of the other ports. The Monnier bag provides you with plugs to put into the gauge ports.

ELECTRIC VALVES

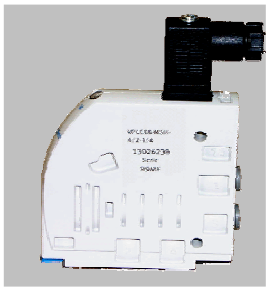
SMC has provided two valves. The following relates to the double solenoid valve:

If you pulse one of the solenoids to make the cylinder extend, you must then pulse the opposite solenoid to make it retract. Either solenoid may be left in the energized state. This is a great valve to use to maintain position when the power is turned off at the end of the match. If you use a single solenoid valve and the power is turned off, the valve would shift back to its original position and the cylinder will retract. A double solenoid valve will maintain its position until you turn on the opposite solenoid. The orange buttons on the top of the valves are manual overrides. With a double solenoid valve you can depress the override and the valve will shift and stay in that position. The valve is pilot operated and requires a minimum pressure of 20 psi to work. The valve comes ready to assemble with two gaskets. Use the thicker of the two as the other is for another purpose. <u>One last thing--Always avoid turning on both solenoids at the same time. While this won't hurt the valve, you cannot be sure which way the spool will shift.</u>



The other **SMC** valve is a single solenoid valve. This valve requires you to screw in the fittings in the pressure and cylinder ports. Its manual override is similar to the one on the double solenoid valve. However, the valve will not maintain its position when the override is released.

FESTO has also supplied a single solenoid valve. In order to wire the valve you must remove the white plastic pin protector that comes over the pins. Instructions in the package explain how to wire the valve. The fittings are the push to connect type so all you have to do is push in the tubing. The manual override will not maintain its position if released, similar to the single solenoid valve from **SMC**.



Bosch-Rexroth has also provided us with a single solenoid valve. The fittings allow you to push on the tubing and then tighten down on the tubing with the nut. The pressure port is shown on the top of the valve and marked "P". Flow comes out the "B" port and switches to the "A" port when the coil is energized. Two connectors are also included which allows you to crimp and wire on to the connector and then just push it over the spade. The yellow arm on the opposite side of the valve is the manual override. On this valve you can turn the override on and leave it in that position. Note there is no nut on the "R" port, which is the exhaust port.

FLOW CONTROLS

We have flow controls donated by **SMC Pneumatics.** The purpose of a flow control is to control the speed of the cylinder when it is extending or retracting. Always mount these into the ports of the cylinders before you hook up the tubing.

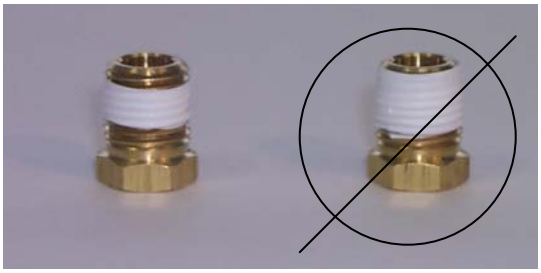
Warning: Even if flow controls are used or the needle is turned out counter clockwise, the cylinder can extend very quickly. Always stay clear of any cylinder in motion.

PLUG VALVE

Parker Hannifin donated the plug valve. This valve can be used to release all the air in the system.

BRASS FITTINGS

Parker Hannifin donated all the brass fittings. These are useful where you want to plug a port or plumb from one size port to another. It is important to note that all male threads require Teflon tape to seal properly. Wrap the tape around the fitting, leaving the first two threads free of tape This is because the threads are tapered and the tape may come loose from the first thread or so and clog up one of your valves.



QUICK CONNECT FITTINGS

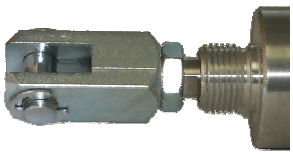
SMC Pneumatics donated the quick connect fittings. These are really easy to use. All you have to do is push the tube into the fitting. Make sure you push the tubing all the way into the fitting. To release the tubing, just push on the release button and then pull the tubing out. Don't attempt to pull the tubing without first pushing the release button.

TUBING

SMC Pneumatics has donated the tubing.

KIT CYLINDERS

We have included a cylinder from **Parker-Hannifin Manufacturing.** It is included in the kit for you to get started and understand pneumatics. Hopefully, you will find a use for it on your robot. **Please note: The switches provided by BIMBA will not work with this cylinder, as it has no magnetic piston.**



CUSTOM BIMBA CYLINDERS

You will be able to order custom cylinders for your robot again this year. You have a choice of 3/4" bore (diameter), 1-1/2" bore and 2" bore. You can order the amount of stroke you require. (See ordering sheet) This will significantly increase your ability to design a great robot. Most all of the bore and stroke models are in stock and **Bimba** is ready to ship directly to your team. This year all the actuators can be ordered with a magnetic piston and two magnetically operated reed switches. These switches will close when the piston is underneath them. It is not recommended to try to sense a mid-stroke position with these. **There is a PowerPoint presentation on www.pneumaticsfirst.com that contains some great discussions on how to design your cylinders in order to get the proper height for a lift mechanism.**

***Please use great care in filling out the form when ordering. The cylinders will be shipped to the address on the order form. If the address is wrong--no cylinders will arrive for your team.**

Quantities of no charge custom cylinders will be limited to **3** per team. Additional cylinders can also be purchased through a Bimba or Parker-Hannifin Distributor. You can find a distributor in your area by going to:

http://www.bimba.com/distrib/distrib.htm
or
http://www.parker.com/distloc/english/search.asp

How to calculate the retracted and extended length of a cylinder

Look at the drawing of the 1-1/2" bore cylinder (page 10). You will notice that the cylinder pivots about a pivot pin located in the rear of the cylinder. There is a dimension on the drawing from that pin to the back of the thread on the rod end. That dimension is "4.38 + Stroke". We will use this later. Look at the drawing of the rod clevis. There is a locking nut shown on the drawing. If you look, there is a dimension of the width that is 0.25". The locking nut threads on the rod first and is used to keep the clevis in place. Lastly, look at the dimension 1.31" on the rod clevis.

Therefore, if you thread the locking nut on the rod thread all the way to the bottom of the thread and then tighten the clevis against it, you can calculate the distance from the rear pin to the clevis pin. This is called the pin to pin distance. Assume you want to move something 8 inches. You will need to order an 8" stroke cylinder.

To find the retracting pin-to-pin dimension, do the following:

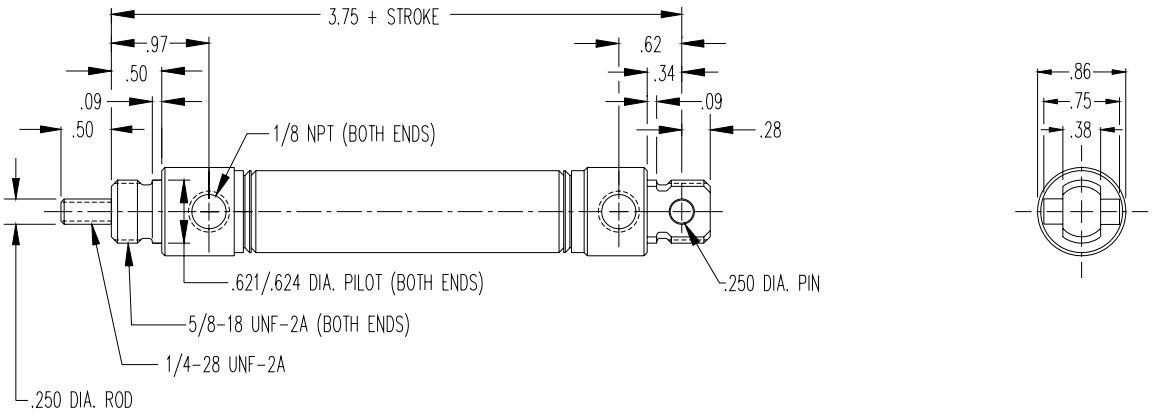
Base dimension	= 4.38"
Stroke	= 8.00"
Locking nut width	= 0.25"
Clevis dimension	= 1.31"
Pin-to-Pin Retraction	= 13.94"

To find the extended pin-to-pin dimension, just add the stroke:

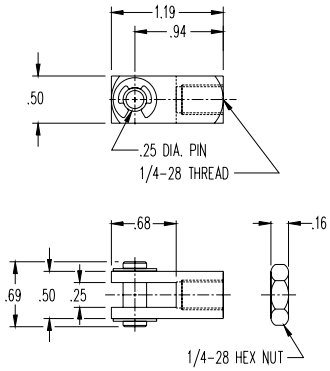
Pin-to-Pin retracted	= 13.94"
Stroke	= 8.00"
Pin-to-Pin Extended	= 21.94"

Note: The retracted length may be somewhat longer by not tightening the clevis all the way to the end of the thread.

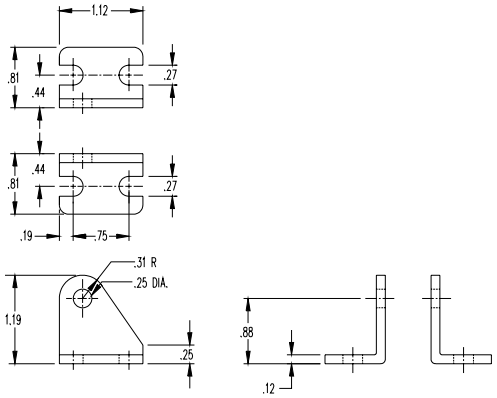
3/4” BORE



Cylinder

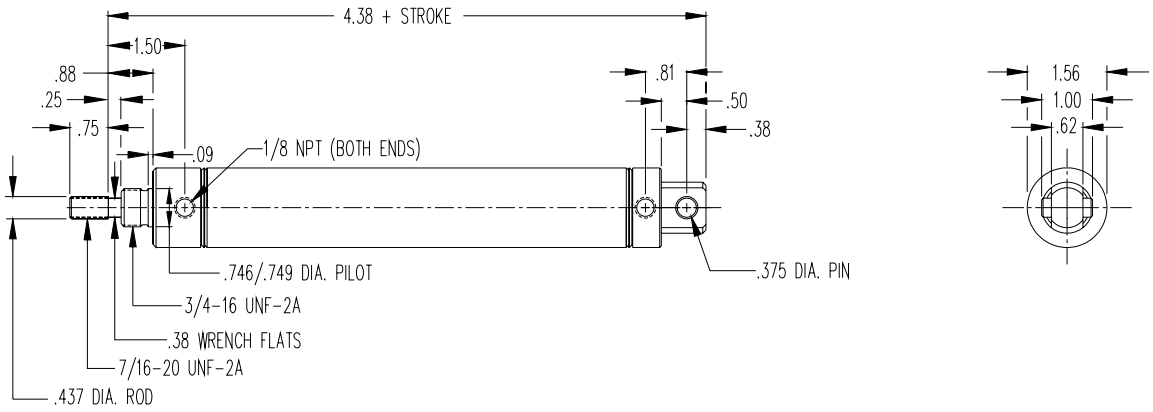


Rod Clevis
Bimba Part Number **D-166-3**

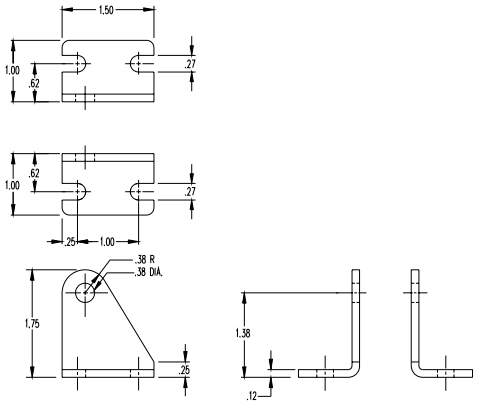


Rear Pivot Bracket
Bimba Part Number **D-167**

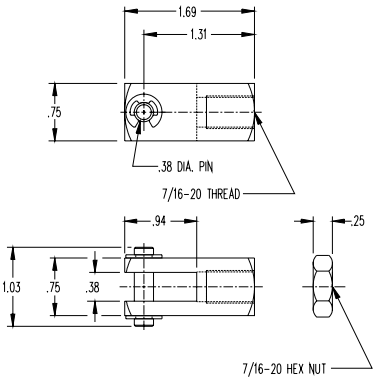
1-1/2” BORE



Cylinder

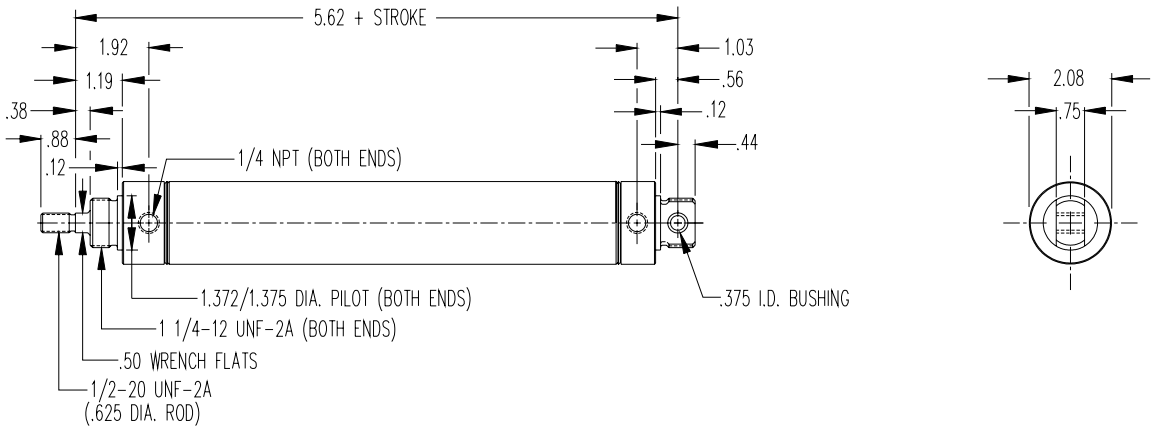


Rear Pivot Bracket
Bimba Part Number **D-229**

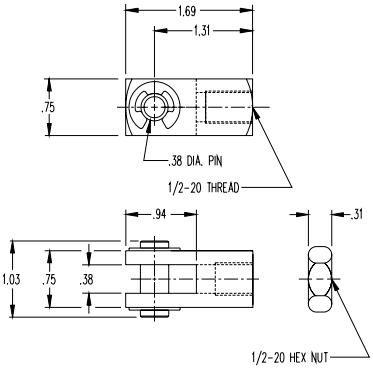


Rod Clevis
Bimba Part Number **D-231-1**

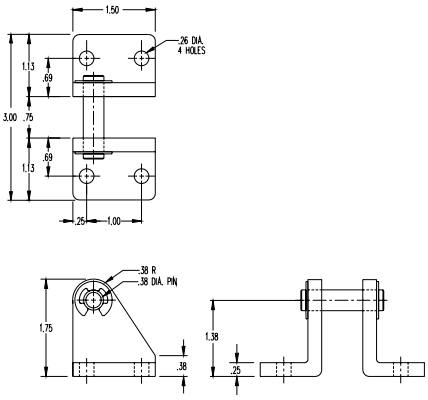
2” BORE



Cylinder



Rod Clevis
Bimba Part Number **D-231-3**



Rear Pivot Bracket
Bimba Part Number **D-620**

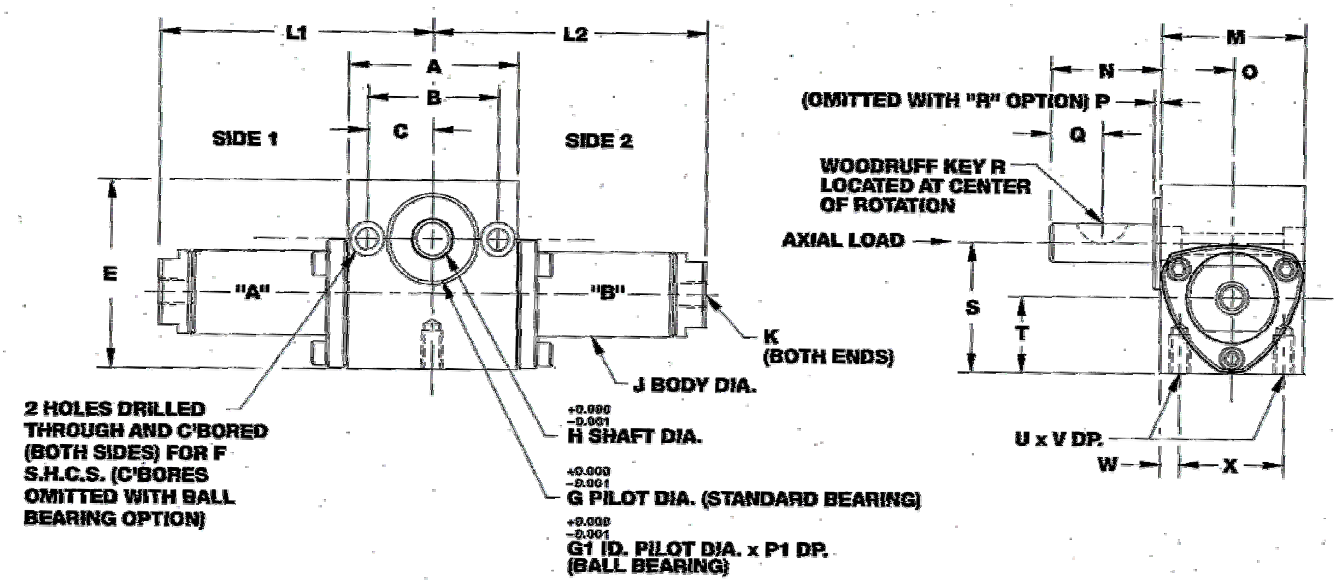
Extend and retract forces of all three bore sizes

	3/4" Bore	3/4" Bore
Pressure	Force Extended	Force Retracted
(pounds/sq. inch)	(pounds)	(pounds)
20	9	8
25	11	10
30	13	12
35	15	14
40	18	16
45	20	18
50	22	20
55	24	22
60	26	24
	1-1/2" Bore	1-1/2" Bore
Pressure	Force Extended	Force Retracted
pounds/sq. inch	(pounds)	(pounds)
20	35	32
25	44	40
30	53	48
35	62	57
40	71	65
45	79	73
50	88	81
55	97	89
60	106	97
	2" Bore	2" Bore
Pressure	Force Extended	Force Retracted
pounds/sq. inch	(pounds)	(pounds)
20	63	57
25	79	71
30	94	85
35	110	99
40	126	113
45	141	128
50	157	142
55	173	156
60	188	170

Rotary Actuator

This year **Bimba** is offering you a 90° rotary actuator. This is ideal for grippers, gear shifters, brakes etc. If you choose to use one of these you will only be allowed to order 2 free cylinders instead of three. As with the cylinders, you may order a magnetic piston, which will activate the switches when the piston is directly underneath the switch. **The unit is only available in a 90° configuration.** The rotational tolerance of the unit is 90 degrees –0 degrees +15 degrees. Exact angle adjustment should be made with external stops. The theoretical torque of this actuator is 0.166 inch-lbs/PSI. Using the maximum allowed pressure of 60 psi the unit could develop a theoretical torque of almost 10 inch-lbs.

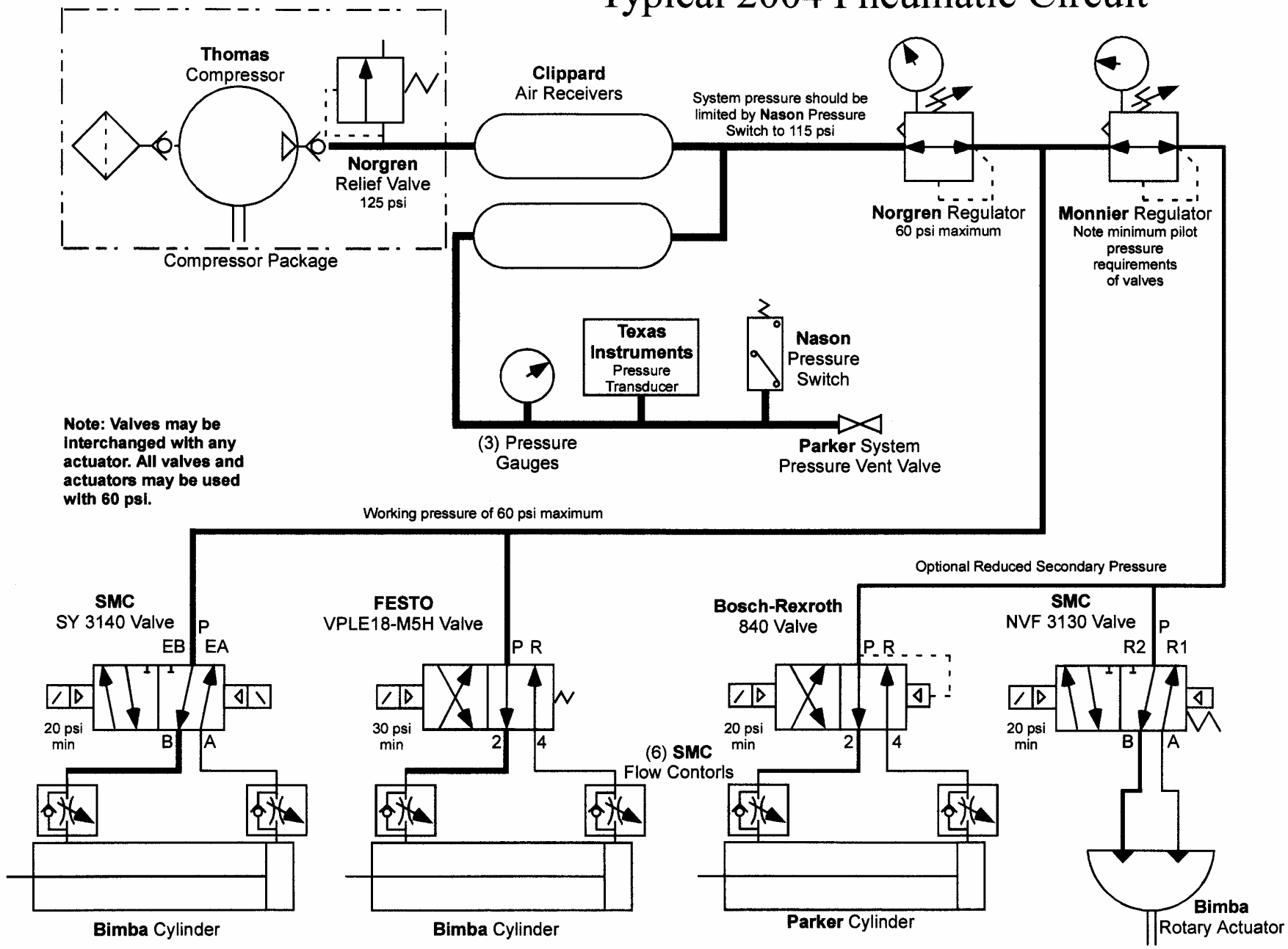
The following are the specifications for the rotary actuator.

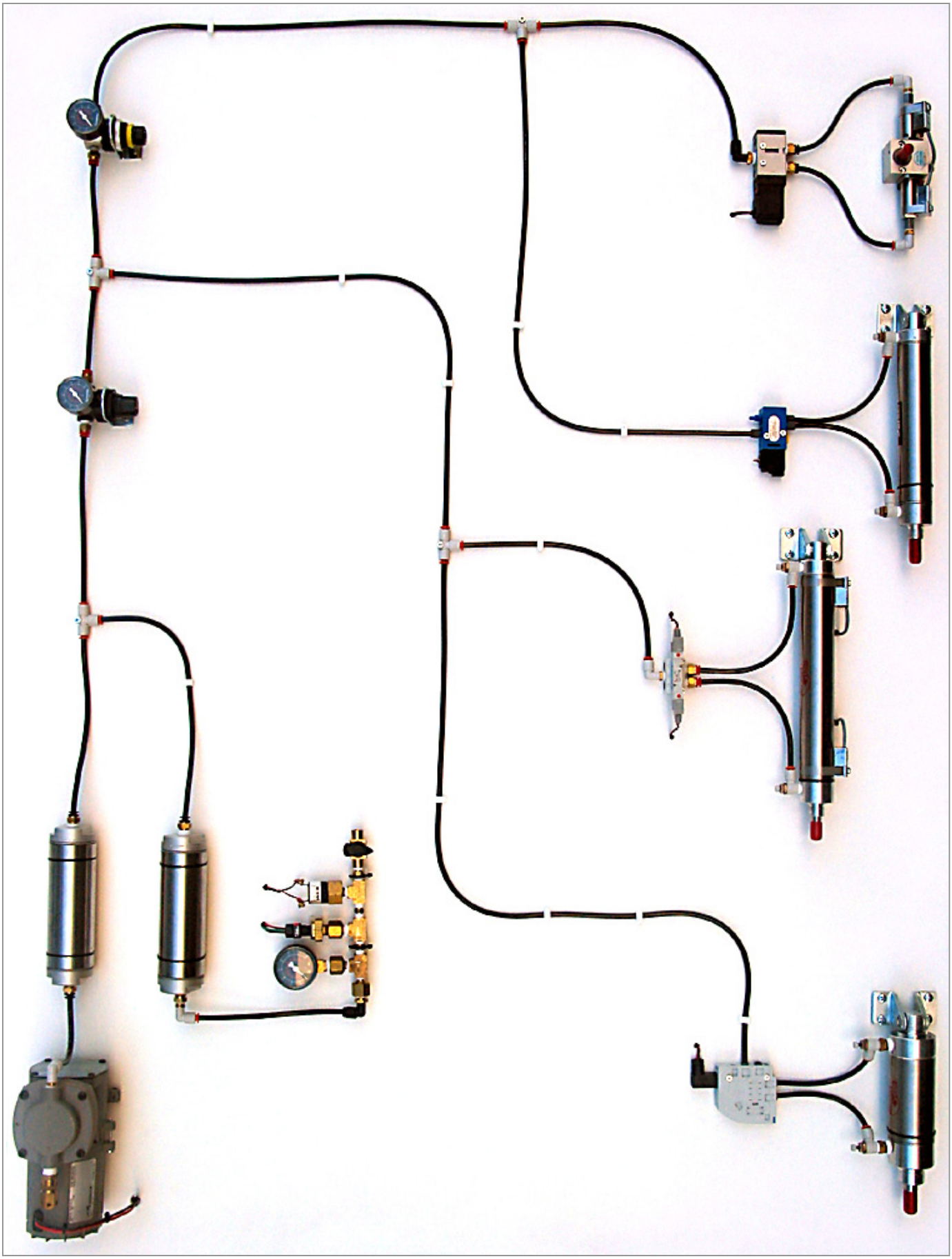


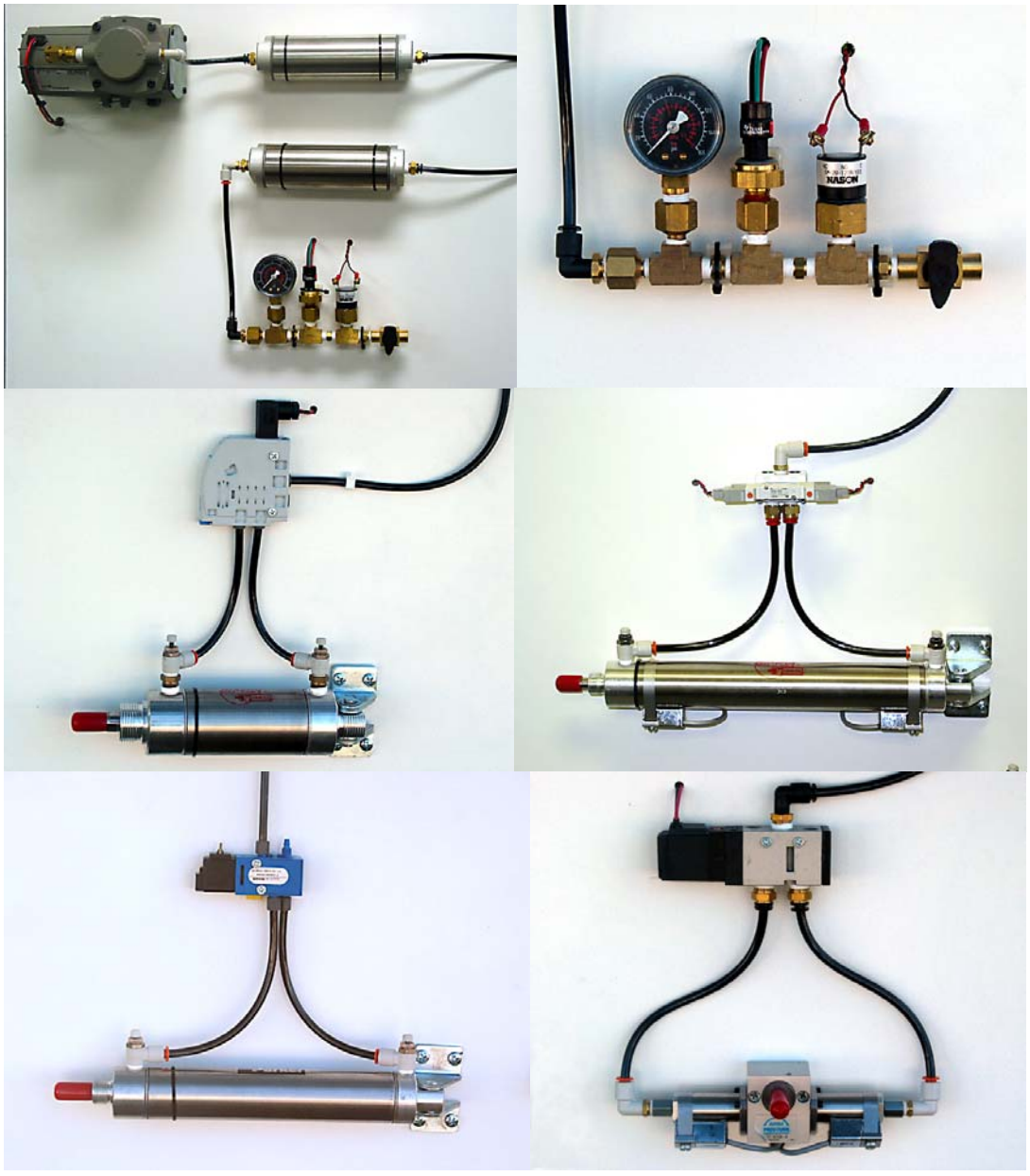
Bore	A	B	C	E	F
0.075	1.62	1.25	0.62	1.81	#10 S.H.C.S.
G	**G1**	**H**	**J**	**K**	**M**
0.875	0.875	0.375	0.82	#10-32	1.37
N	**O**	**P**	**P1**	**Q**	**R**
1.06	0.69	0.06	0.06	0.5	**Below**
S	**T**	**U**	**V**	**W**	**X**
1.25	0.73	#10-24	0.38	0.19	1

The woodruff key is 0.0625” wide and 0.032 “ high

Typical 2004 Pneumatic Circuit







FIRST
Pneumatic Component
Bill of Material

Vendor	Quantity Per Kit	Part Number	Product Weight Each	Description
SMC Pneumatic Kit				
SMC	1	SY3240	3.0 oz.	Double solenoid valve
SMC	1	NVF3130	3.0 oz.	Single solenoid valve
SMC	6	NAS2201F-N01-07S	0.6 oz.	Flow control
SMC	10	KQH07-34S	0.3 oz.	Fitting, Straight 1/4 Tube
SMC	10	KVH07-35-D	0.4 oz.	Fitting, Straight 1/4 Tube
SMC	10	KQ2L07-34S	0.2 oz.	Fitting, 90 Elbow 1/4 Tube
SMC	10	KVL07-35-D	0.2 oz.	Fitting, 90 Elbow 1/4 Tube
SMC	5	KQ2T07-00	0.5 oz.	Fitting, Male Run T 1/8 NPT -1/4 Tube
SMC	1	TIUB07G-20	1#	1/4" OD tubing - 20 meters
Parker Cylinder Div.				
Parker	1	1.5DPSR8.00	7.3 oz.	Cylinder 1.5" bore x 8" stroke
Parker	1	L071310300	1.6 oz.	Cylinder pivot bracket set
Parker	1	L071300400	1.0 oz.	Cylinder rod clevis
Parker Brass Div.				
Parker	1	PV609-2	2.4 oz.	Manual 2-way plug valve
Parker	4	2203P-2	1.3 oz.	Union Tee
Parker	6	222P-4-2	1.1 oz.	Adapter 1/4" female to 1/8" male
Parker	6	216P-2	0.4 oz.	Hex nipple 1/8"npt
Parker	12	209P-4-2	0.4 oz.	Bushing 1/8" female to 1/4" male
Parker	6	218-2	0.3 oz.	Plug 1/8"
Parker	6	218-4	0.7 oz.	Plug 1/4"
Norgren Kit				
Norgren	1	16-004-015	5.1 oz.	120 psi relief valve
Norgren	1	R07-153-RNEA	4.7 oz.	Main regulator w/60psi max output
Norgren	1	18-025-003	0.7 oz.	Regulator mounting bracket and nut
Festo Valve	1	VPLE18-M5H-4/2-1/4	3.3 oz.	Single solenoid valve
Bosch/Rexroth	1	P-026641-00004	2.7 oz.	Single Solenoid Valve
Clippard	2	AVT-32-16	14 oz.	Volume Tank 2" bore by 6" length
Nason	1	SM-2B-115R	2.1 oz.	Pressure switch
Texas Instruments	1	5CP3-7	2 oz.	Pressure transducer
Monnier	1	101-3002-1	3.2 oz.	Secondary pneumatic regulator
Monnier	1	13536	1.2 oz.	Regulator mounting bracket and nut
Wika	3		4.0 oz.	Pressure Gauges
Lord Corporation	1	SMB003-0100-2	0.3 oz.	Vibration isolators for compressor
HPE Teflon tape	1	HPE	0.2 oz	1/4" by 100"
Thomas Compressor	1	405ADC38-12	4 lbs.- 12oz.	Compressor (purchased @ $60.00 each)
BIMBA	3	Not included in the kit		Special order Cylinders

The following companies provided product for the 2004 Competition:

Bimba Manufacturing
Bosch-Rexroth
Clippard Instrument Laboratory, Inc.
Festo
Lord Corporation
Monnier, Inc.
Nason Corporation
Texas Instruments
Norgren
Parker Hannifin, Inc.
SMC Pneumatics, Inc.
Thomas Industries, Inc.
Wika Instrument

Web Sites for Product Suppliers and Foundations

Bimba Manufacturing	- http://www.bimba.com/
Bosch-Rexroth	- http://www.boschrexroth.com/
Clippard Instrument Laboratory, Inc.	- http://www.clippard.com/
Festo	- http://www.festo.com/
Lord Corporation	- http://www.lordmpd.com/
Monnier, Inc.	- http://www.monnier.com/
Nason Company	- http://www.nasonptc.com/
Texas Instruments	http://www.ti.com
Norgren	- http://www.norgren.com/
Parker Hannifin, Inc.	- http://www.parker.com/
SMC Pneumatics, Inc.	- http://www.smcusa.com/
Wika Instruments	- http://www.wika.com/
FPEF	- http://www.fpef.org/

FIRST Free Pneumatic Components Order Form

Team # _____

A maximum of **3** free cylinders may be ordered. You may substitute **1** rotary actuator for a cylinder. **LIMIT IS 3 ITEMS!** Additional cylinders and rotary actuators may be purchased from local distributors. See below for details.**

How to Order

The example is a 2" bore x 6" stroke cylinder with a magnetic piston.

M - 31 6 - DXP

Air Cylinders

*M-Magnet	Bore	Stroke in inches	Mounting
(Optional) Includes (2) MRS-.087-B position sensors	04 = ¾"	0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10	DP for ¾"
	17 = 1 ½"	0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 24	DP for 1 ½"
	31 = 2"	0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 12, 24	DXP for 2"

All cylinder orders include clevis, jam nut and pivot brackets. Please allow up to 4 days for shipment.

The example is a 3/4" bore, 90° rotary actuator with magnetic pistons.

PT - 017 090 – M

90° Rotary Actuators

Model	Bore	Rotation	*M-Magnet
PT	**017 – 3/4"** (Only bore available)	090 (90° is the only rotation available)	(Optional) Includes (2) MRS-.087-B position sensors

Team Name/School: _____ Person Ordering: _____

Email: _____ Phone: _____

Quantity	Model
_____	_____
_____	_____
_____	_____

Shipping Information

School/Business:_____ Attention: _____

Address: _____

City:_____ State: _____ Zip: _____

Shipments are sent UPS Ground Complete at no cost to teams.

IF Express Service is needed, each team is responsible for charges. Supply carrier account # **OR** credit card information

Please circle carrier: **UPS** or **Fed Ex** Choose Service: ☐ **Next Day** or ☐ **Second Day**

Carrier Account #: _____ **OR** Credit Card # _____

☐ Visa ☐ MC ☐ Amex Name on Card: _____ Exp. Date: _____/_____

FAX ORDER TO THIS NUMBER: 954-429-9515

Order Inquiries: first@hpeco.com **Technical Help:** fhord@hpeco.com

Emergency Only—Phone: 954-429-9560 Back-Up Fax Number: 954-429-0858

*****After order is placed, go to www.bimba.com and click on "Order Tracking" to check the status of your order. (Customer PO = Team No.)

******Any additional actuator or accessories can be purchased through your local Bimba or Parker-Hannifin Distributor. To find one in your area go to: www.bimba.com or www.parker.com

DEVICE	WIRE SIZE	BREAKER SIZE
POWER DISTRIBUTION FROM BATTERY THROUGH 120A MAIN CIRCUIT BREAKER/DISCONNECT SWITCH TO DISTRIBUTION BLOCKS AND FUSE PANELS.	6 AWG	120A
DRILL MOTORS, CIM MOTORS; SPEED CONTROLLERS USED WITH DRILL MOTORS AND CIM MOTORS.	10 AWG	40 A
FISHER-PRICE MOTORS, VAN DOOR MOTORS, GLOBE MOTORS; SPEED CONTROLLERS USED WITH FISHER-PRICE VAN DOOR, OR GLOBE MOTORS.	10 AWG	30A
ROBOT CONTROLLER POWER, RELAY MODULES, WINDOW MOTORS, COMPRESSOR, SOLENOIDS, LARGE MUFFIN FAN; SPEED CONTROLLERS USED WITH WINDOW MOTORS.	16 AWG/2 CONDUCTOR	20A RELAY MODULES HAVE 20A FUSES
ALL SWITCHES, PWM CABLES, OPTICAL SENSORS, POTENTIOMETERS, LEDS, SMALL MUFFIN FANS, CUSTOM CIRCUITS.	24 AWG/2 OR 3 CONDUCTOR	REQUIREMENTS VARY

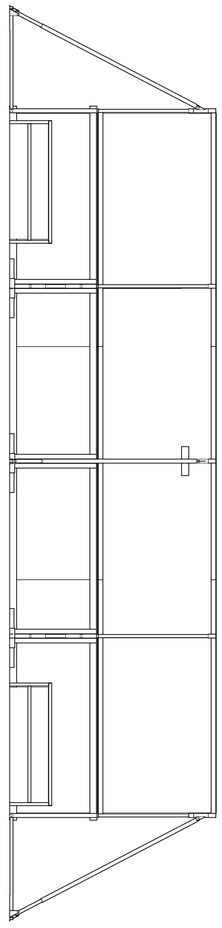
NOTE:

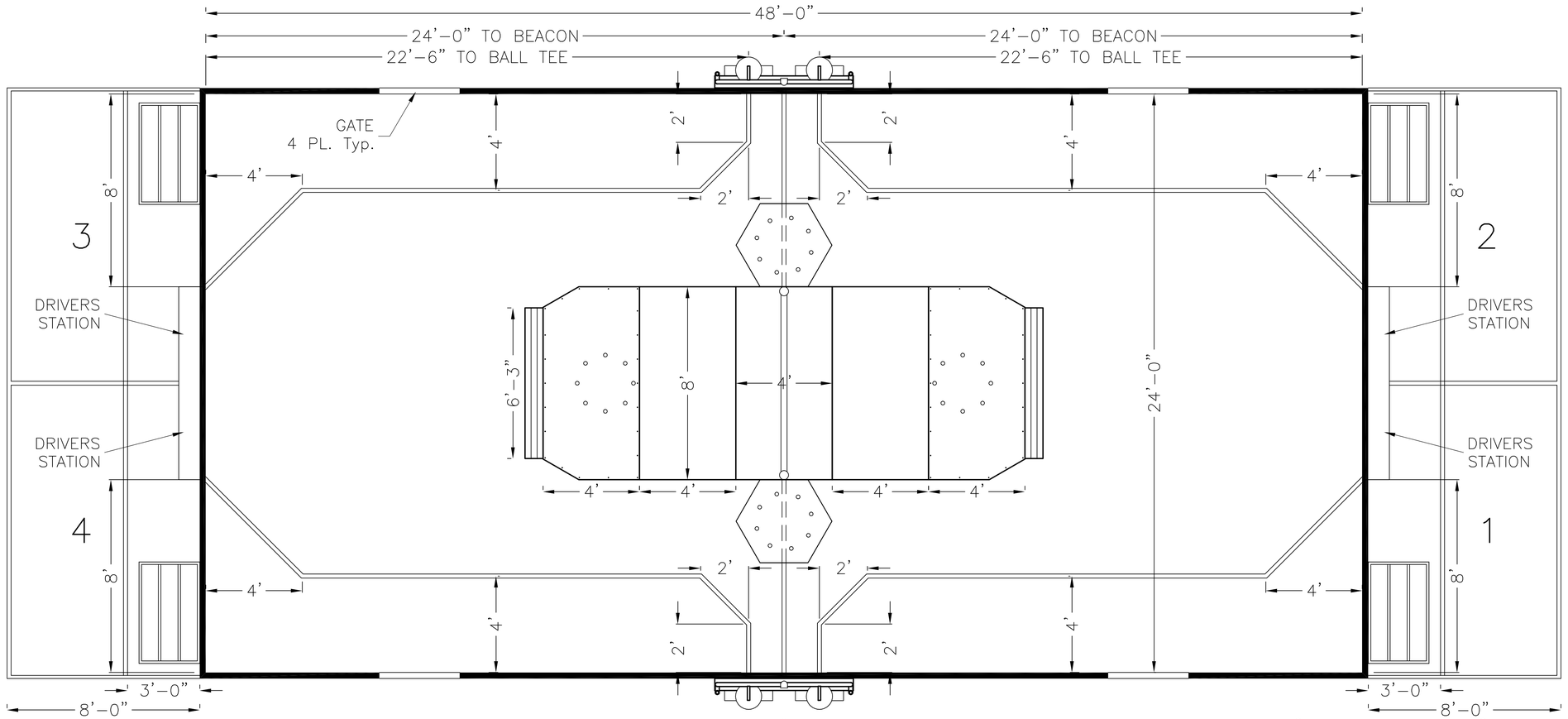
WIRES ARE NOT CONNECTED:

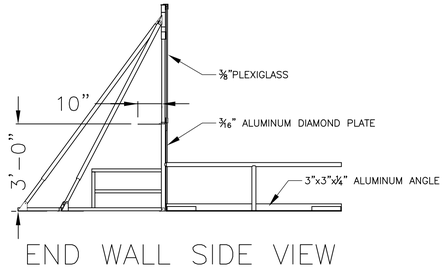
WIRES ARE CONNECTED:

FIRST
200 Bedford Street, Manchester, N H. 03101
(603) 666-3906 ♦ FAX (603) 666-3907

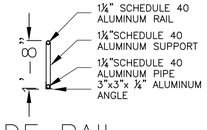
ENGINEER	DATE	TITLE	2004 ROBOT POWER DISTRIBUTION DIAGRAM
DRAWN JRR	DATE 12/22/03		
CHECKED	DATE		
APPROVED	DATE	SIZE D	CLASS ID. D
ISSUED	DATE	DRAWING NO. D04-0343-01-01	REV. –
		SCALE NONE	SHEET 1 of 1



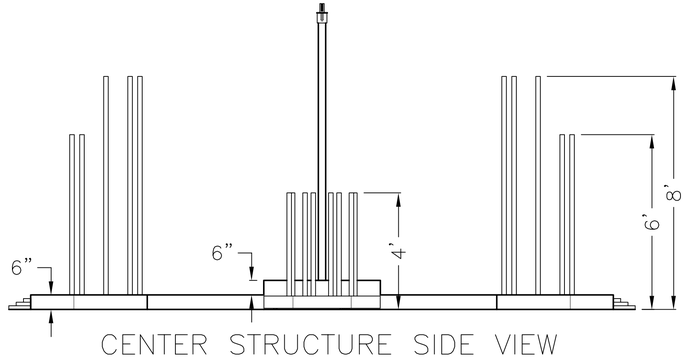




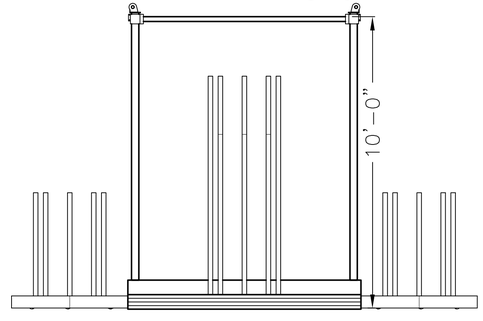
END WALL SIDE VIEW
(BALL RELEASE NOT SHOWN)



SIDE RAIL SECTION



CENTER STRUCTURE SIDE VIEW



CENTER STRUCTURE END VIEW

FIRST
200 Bedford Street, Manchester, N H. 03101
(603) 666-3906 ♦ FAX (603) 666-3907

ENGINEER	DATE	TITLE			
DRAWN JRR	DATE 1/03/04	2004 FIELD LAYOUT AND MARKING			
CHECKED	DATE				
APPROVED	DATE	SIZE D	CLASS ID. FAS	DRAWING NO. D04-0007-01-01	REV. –
ISSUED	DATE	SCALE NA		SHEET 1 of 1	