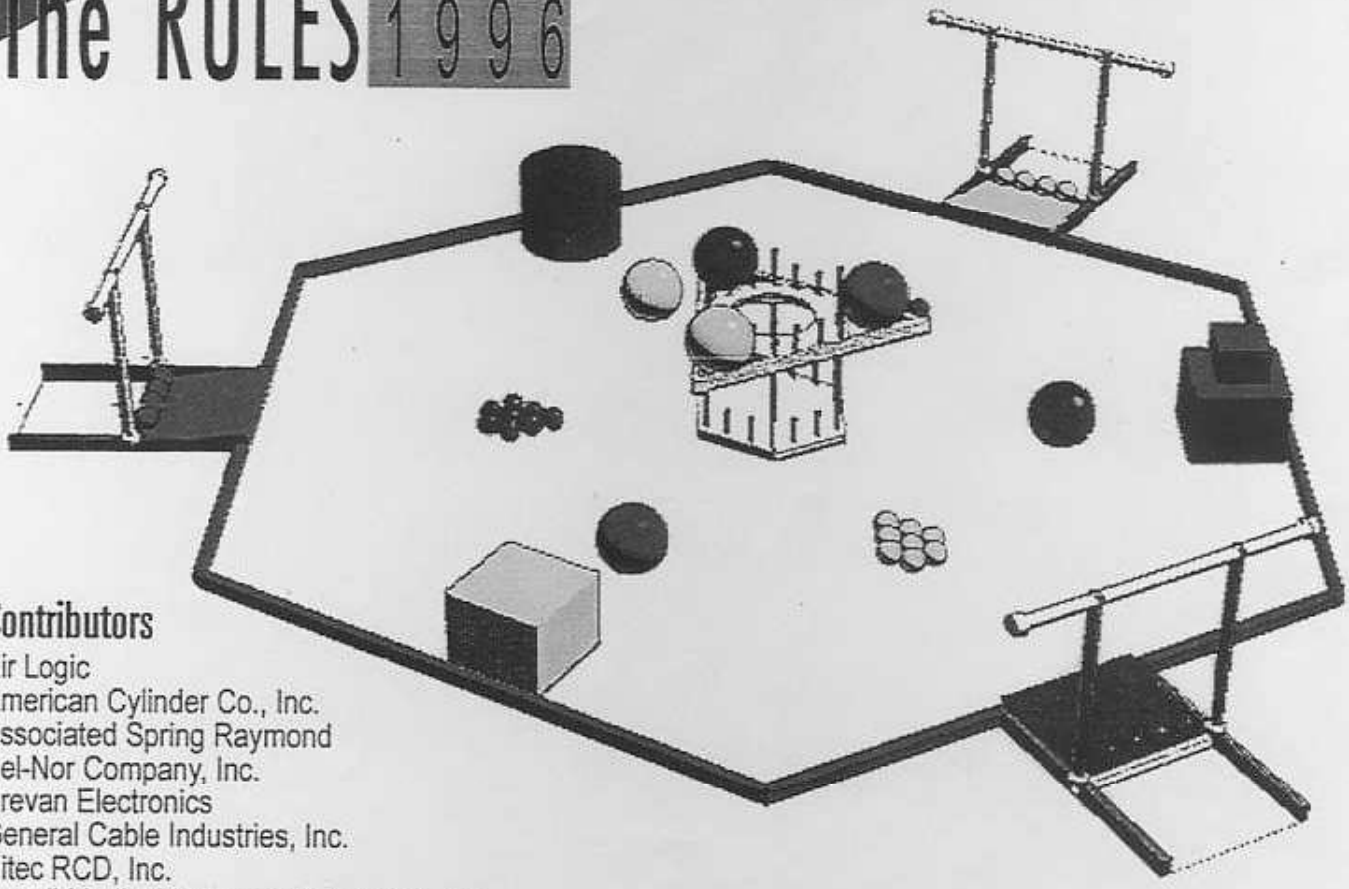
U.S. FIRST
THE COMPETITION

The RULES 1996

Official Sponsors

Honeywell's Microswitch Division
Motorola, Inc.
The Procter & Gamble Company



Contributors

Air Logic
American Cylinder Co., Inc.
Associated Spring Raymond
Bel-Nor Company, Inc.
Brevan Electronics
General Cable Industries, Inc.
Hitec RCD, Inc.
Lowell Medical Instrument Company, Inc.
McCord Winn / Subsidiary of Textron, Inc.
McMaster-Carr Supply Co.
Microsemi Corporation - Scottsdale
New Hampshire Industrial Suppliers
NOVA Biomedical
PIAB
Plastic Supply Inc.
Potter & Brumfield
(A Siemens Company)
Schleuniger USA, Inc.
Serco, Inc.
Snap-Action, Inc.
Sprague Air Controls
Sprague Fluid Connectors
Stanley Hardware Division
Tekin Electronics, Inc.
Thomas & Betts
Totalmed
UVEX Safety, Inc.
Value Plastics, Inc.
Xilinx, Inc.

Gold Suppliers

Autodesk, Inc.
Delco Electronics Corp.
Milwaukee Electric Tool Corp.
Small Parts, Inc.
United Parcel Service Foundation

Silver Suppliers

Numatics, Inc.
Richmond Aircraft Products
Sanmina-New England
Sport Fun, Inc.
The Torrington Company

Bronze Suppliers

CH Products
Hadco Corporation

New England Tournament Event Host

THE PHEASANT LANE MALL

1996 Kick-Off Workshop Official Sponsors

Baxter Healthcare Corp.
Lockheed Martin Corp.

1. THE GAME

1.1 Game Description

Remotely-controlled robots must be designed and built to collect, transport, and lift 8" and/or 24" diameter balls. There will be 12 small balls and 2 large balls per team. In addition to the robot, each team will be allowed to use a human player, seated at a station on the side of the playing field, to interact with the balls. Points will be awarded for balls located in the central goal at the conclusion of a two minute match. Ball color will be used to identify team ownership. Each small ball in or above the hexagonal portion of the goal will be worth 3 points. Each large ball in or above the hexagonal portion of the goal will be worth 10 points. Each large ball on or over the triangular corners of the goal will be worth 5 points. The geometric center of a ball will be used to determine its position. Starting locations of the balls, robots, and human players are shown in Figures 1 & 2. The winner of each match is the team with the highest score. In the case of a tie, the large ball closest to the center of the field breaks the tie.

1.2 Field Diagrams

The playing field is a carpeted, hexagon-shaped area with a central goal. Around the perimeter of the field are three stations for human players. The perimeter of the field is defined by a curb of 4x4 lumber, resting directly on the carpet. Approximately every 4' around the perimeter, a 1"Ø x 19" tall steel post is inserted into the wooden curb with three 1" size eye loops at 9", 13" and 18" from the field level. At each level, a 3/16"Ø plastic coated steel cable surrounds the field. There is a protective pipe plug on top of each post. The fence is a safety feature and no part of any machine may react against it.

The goal is hexagonal if viewed from above, and has an upper and lower section surrounded by wooden posts. The upper section has a triangular frame which juts out on three sides to provide pockets for the large balls. The upper section also has a 34"Ø hole which allows balls to fall through to the lower section. The goal is constructed of 3/4" plywood sheets, 2x4 beams, and 1-1/2"Ø wooden rods, as shown in Figures 3 and 4.

Each player station is comprised of a ramp, posts, seat belt, and base plate, as shown in Figures 5 and 6. The ramp is 3'-7" wide by 3' deep and consists of a 3/4" piece of plywood with one end on top of the 4x4 field border, and the other end on the carpet, so that it is sloped away from the center of the playing field. The 4x4 field border and wire rope fence extend to the sides of the ramp and base plate, so that there are actually 3 discrete sections of fence per field.

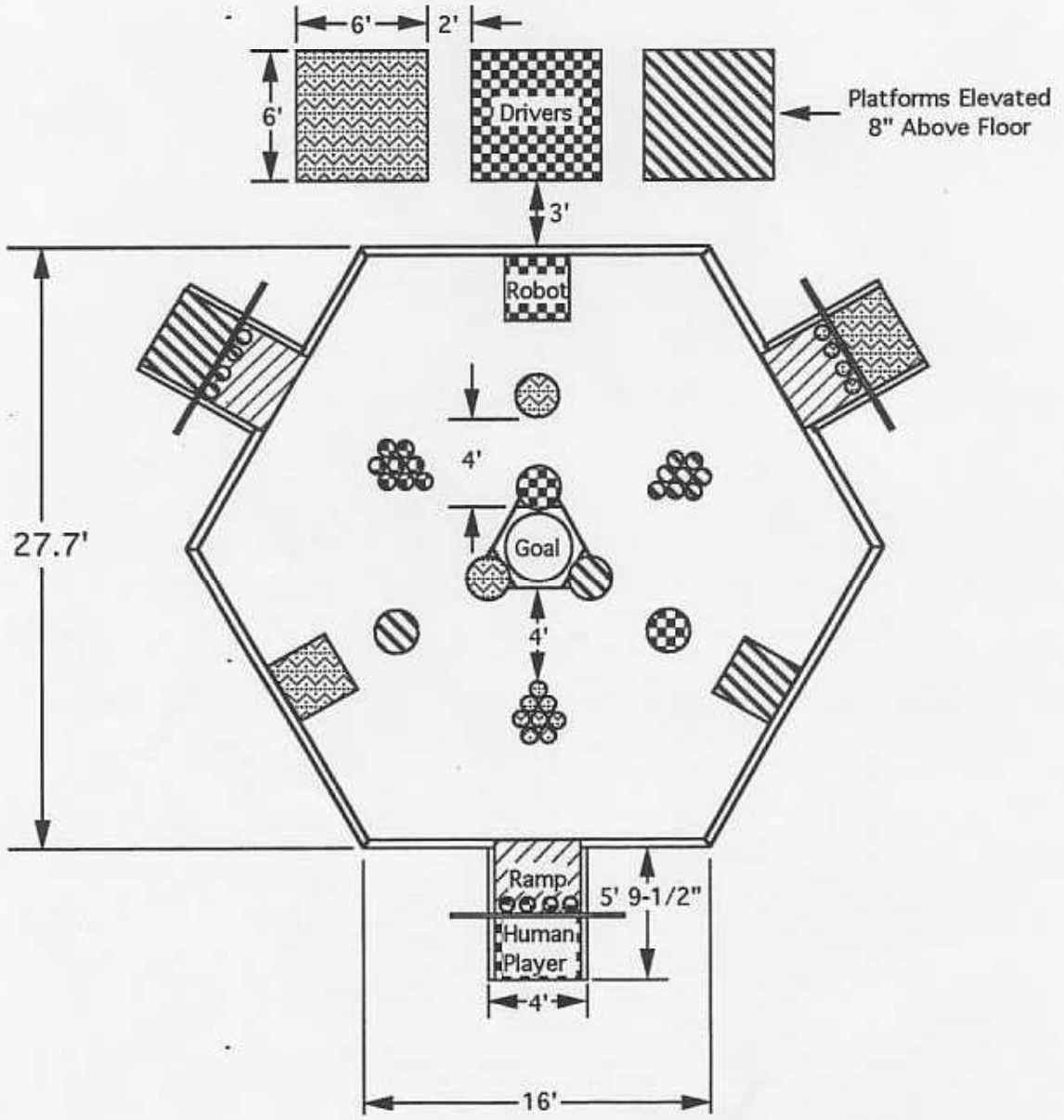
The base plate is a 3'-7" wide by 3' deep piece of 3/4" plywood connected to the lower edge of the ramp. It rests directly on the surface of the carpet. The base plate is used to secure the seat belt, the base of the posts, and indicate the area in which the human player may attempt to contain balls.

Two vertical posts of 2"Ø, schedule 40 PVC pipe are mounted to the base plate by pipe flanges located at the end of the ramp. An 8' long horizontal post of the same type of PVC pipe is mounted across the top of the two horizontal posts via T connectors. The ends of the 8' post are covered with PVC end caps. Each post structure is stabilized by 4 tension cables running from eye-bolts just below the T junction of the posts to eye-bolts mounted at various locations around the 4x4 field border.

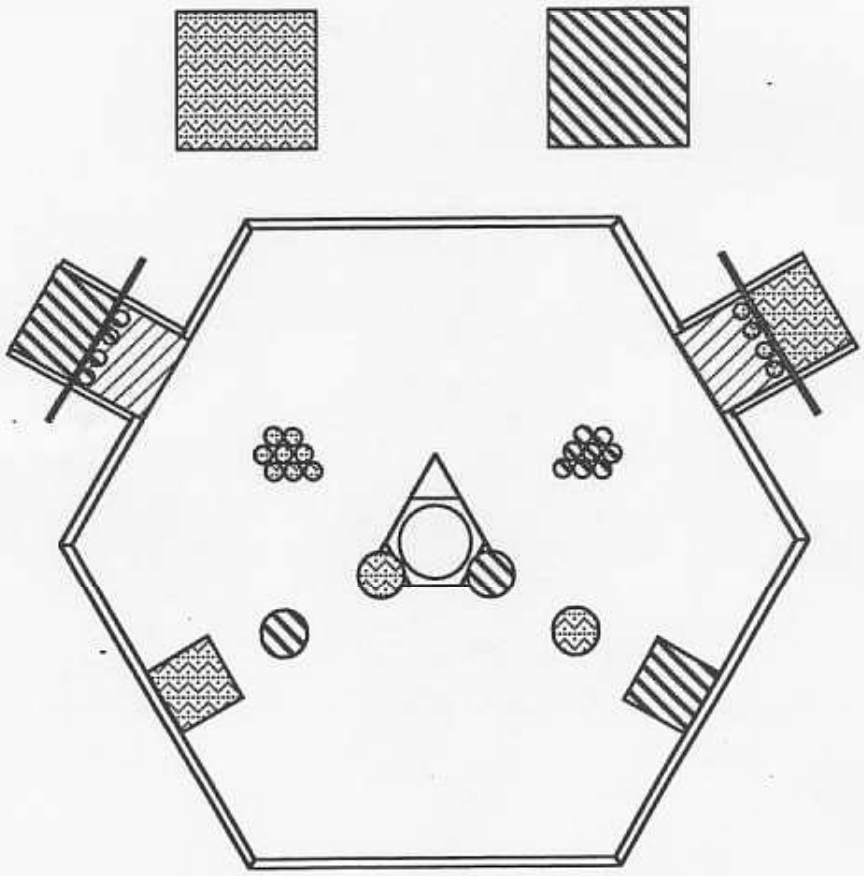
The seat belt is threaded through two slots in the rear center of the base plate.

All field dimensions are ± 1" non-cumulative. The large balls have a diameter of 24" ± 2". The small balls have a diameter of 8" ± 1". Both types of balls will be inflated to size, not pressure.

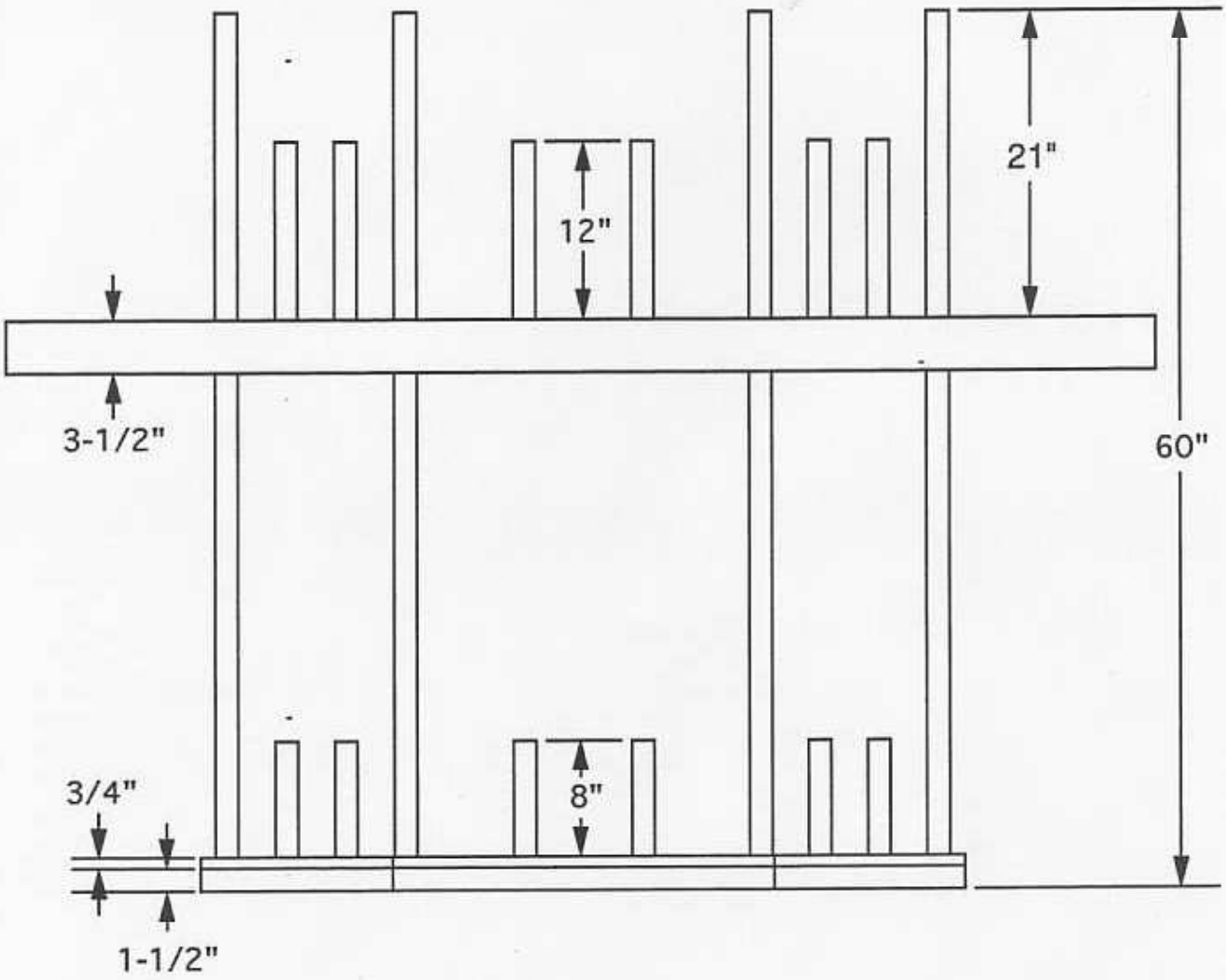
Playing Field - Top View
Seeding/Double Elimination Rounds
Figure 1



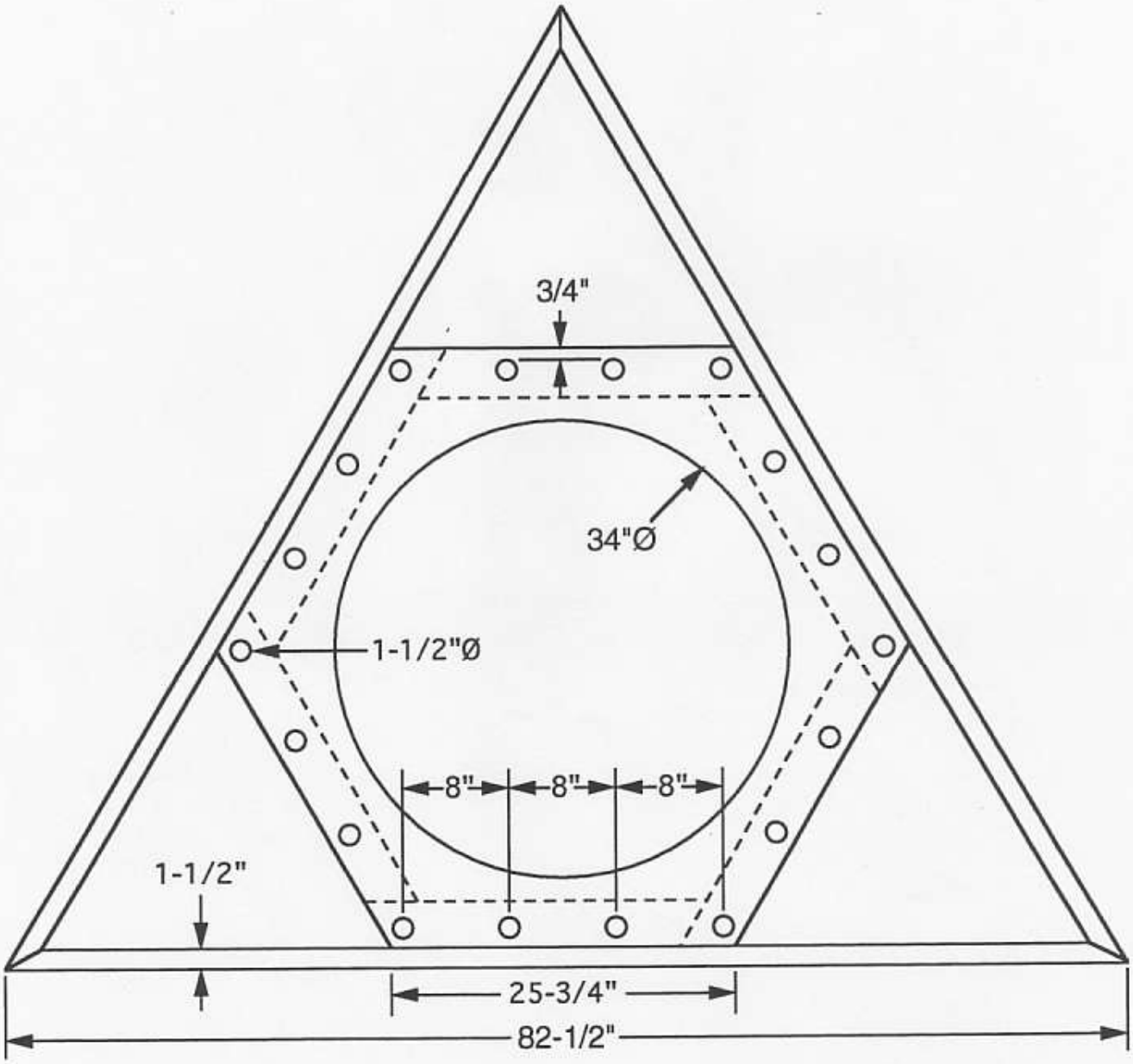
Playing Field - Top View
Finals Rounds
Figure 2



Central Goal - Side View
Figure 3

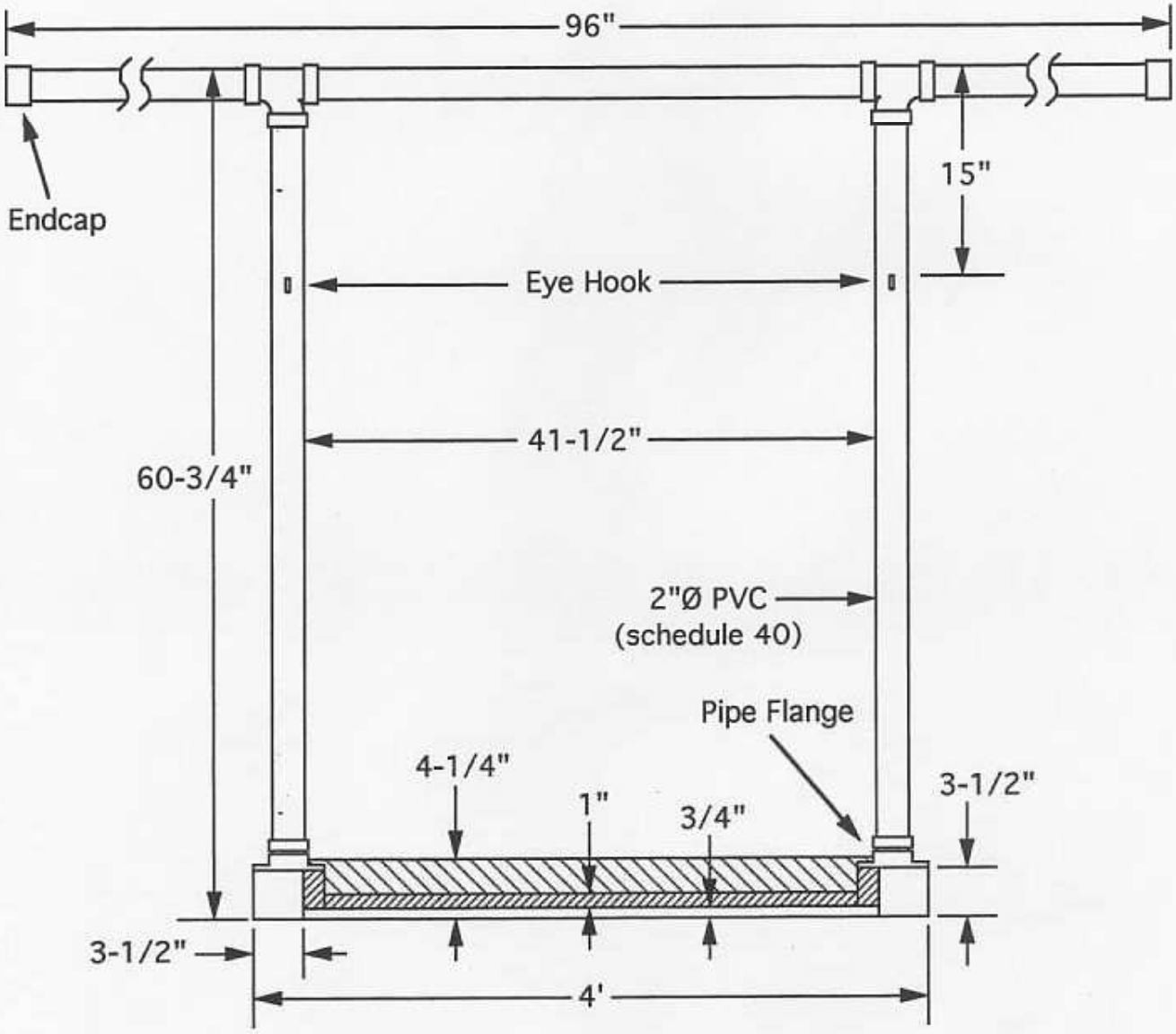


Central Goal - Top View
Figure 4



Notes: 34"Ø Hole and triangular frame exist on upper level only.
Dashed lines indicate presence of 2x4s under 3/4" plywood on both levels.

Player Station - Back View
Figure 5

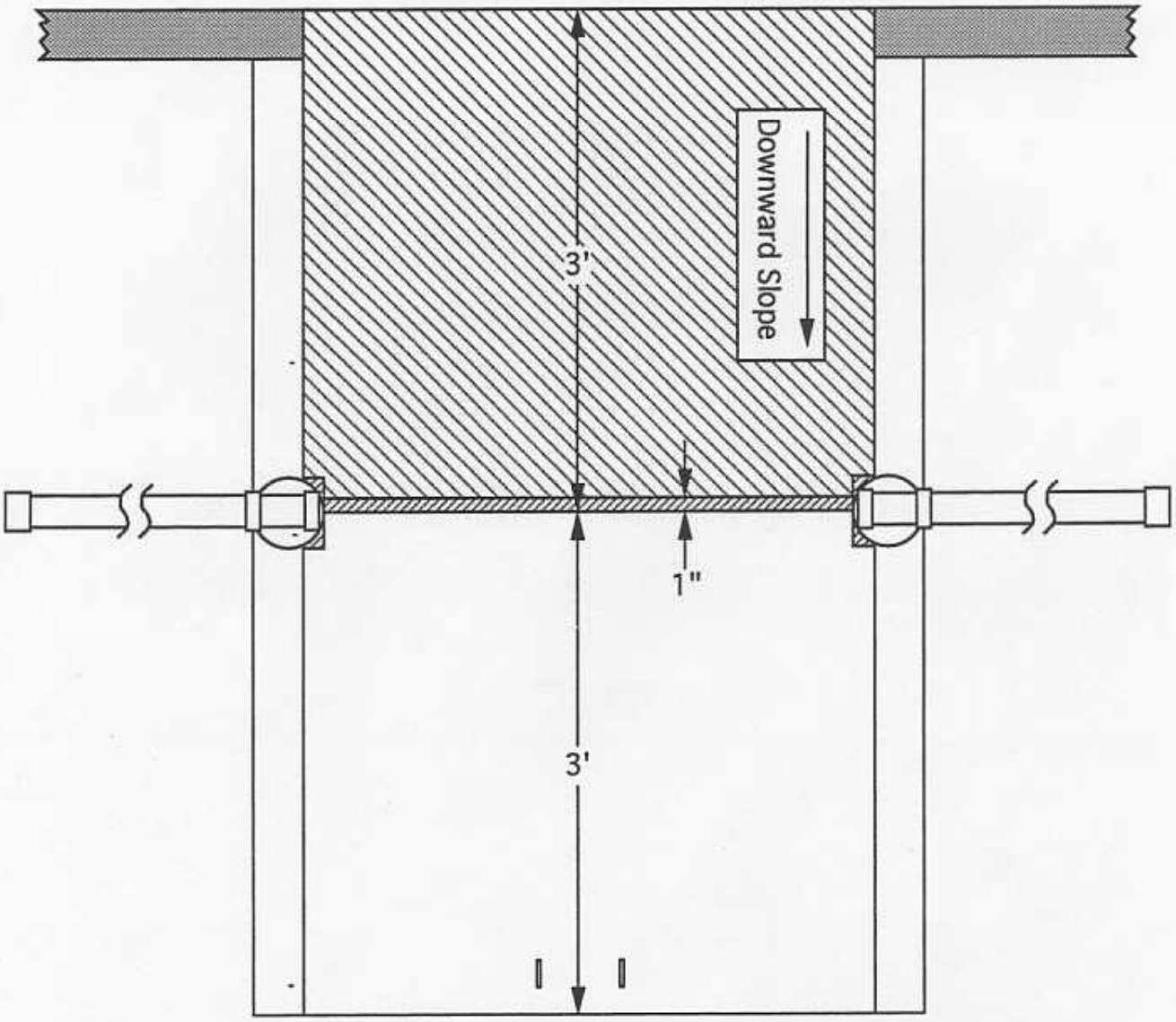


Notes: Nylon rope and lower eye hooks and omitted for clarity.

Ramp (3/4" plywood on slope)

Pipe flange supports and ball stop

Player Station - Top View
Figure 6



Notes: Center PVC bar omitted for clarity.

Ramp (3/4" plywood on slope)

Pipe flange supports and ball stop

Field border

1.3 General Tournament Rules

(see complete list of rules in Appendix B)

T1. Referees have ultimate authority during the competition--their rulings are final.

T2. If a machine is disqualified by a referee, that machine is turned off for the remainder of the match, and any points scored during that match will be forfeited.

T3. If a machine is disabled by a referee, that machine is turned off for the remainder of the match, and any points scored during that match will count.

T4. A machine may not win a match through an advantage gained by breaking a rule, even accidentally. The effect of the infraction on the outcome will be decided by the referees.

T5. Strategies aimed solely at the destruction, damage, or entanglement of opponents' machines are not in the spirit of the tournament and will not be allowed. Turning over an opponent's machine is not considered damaging and will be allowed, but stabbing, cutting, etc., is illegal. If a breach of this rule occurs the contestant's control system may be disabled by the referees.

T6. Limited amounts of machine shoving will be allowed; however, if you damage opponents' machines, referees may take action against your team. Possible actions include, but are not limited to; stopping the match to allow the damaged machine to be repaired before resuming play, a complete rematch after repairs have been made, or disqualification of your machine and forfeiture of any points scored.

T7. If a team's machine is damaged to the point that it cannot complete a round on a fair basis, that team may be eligible for a rematch. This decision will be up to the referees.

T8. If one team intentionally damages another team's machine, it may result in disqualification. However, if the damaged team's machine is considered too flimsy to begin with, the other team may not be disqualified. The ultimate determination will be with the referees.

T9. The playing field carpet will be directly on the floor.

T10. Deliberately damaging the playing field, controls, or balls (using spiked wheels, for example) is strictly illegal and may result in disqualification.

T11. A machine may not intentionally contaminate the playing field, balls, goal, or another machine with lubricants.

T12. After a match, team member are not allowed on the playing field until referees have completed the scoring procedure.

T13. The fence is a safety feature, not part of the playing field. Therefore, no part of any machine may react against it.

T14. No remote communication devices, such as air phones, walkie-talkies, cellular phones, etc., may be used by teams during a match.

T15. During the tournament, teams will be notified of their field positions at least two minutes prior to the start of their match in the staging area. Teams will be allowed a maximum of one minute to set up their machines on the field and a maximum of one minute to remove all machine parts from the playing field following a match. You will have at least 4 minutes before your next scheduled match.

T16. If a team is not ready to setup their machine on the field, and the two minute notification period is about to expire, and they do not wish to forfeit the match, then

they must call a time-out. Each team may take up to 10 minutes (cumulative) of time-outs during the double-elimination rounds. The duration of a single time-out may not exceed 5 minutes. If a machine is still not ready at the end of the time-out period, the team will forfeit the match.

T17. During the finals matches (quarter-finals on), each team may take up to 10 minute (cumulative) of time-outs which can be used to delay the start of a match if their machine is not ready. The duration of a single time-out may not exceed 5 minutes. Unused time-out time from the double elimination matches is lost.

T18. At the start of each match, machines may be placed in any orientation within the designated starting area, without touching other machines, the 4x4 boundary, or the fence

T19. If, in an attempt to remove an opponent's balls from the field, a part of your machine drops out-of-bounds, your machine will be disabled. Any points scored will count.

T20. If a machines goes out-of-bounds to the point that it has to apply power to any out-of-bounds surface to rejoin play, its control system will be disabled. Any points scored will count.

T21. If one team intentionally moves another machine out-of-bounds, the machine out-of-bounds will be disabled for the remainder of the match. Points scored will count.

T22. Balls which are knocked out-of-bounds or popped will be placed back in play next to the fence near the exit point without undue delay. Additional balls will be available for substitution.

T23. It is not the responsibility of the referees if they damage trapping devices while attempting to retrieve balls. Please design your machine so that balls may be retrieved quickly and easily after a match is over.

T24. **We strongly encourage you to develop and wear team uniforms, including identifying hats and t-shirts that display company and high school team names and/or logos. This will help the audience, announcers, judges and spectators identify you and your machine.**

1.4 Game Specific Rules

(see complete list of rules in Appendix B)

P1. Machines will start at equidistant locations, midway along the length of the playing field borders, as shown in Figures 1 & 2.

P2. Each team will start with 8 small balls on the playing field and 4 small balls on the ramp of the player station. The small balls on the field will be arranged in clusters as shown in Figures 1 & 2. The clusters will be distributed at equidistant locations around the central goal at a distance of 4 feet from the flat side of the base of the goal.

P3. Each team will start with 1 large ball on the side of the goal and 1 large ball on the playing field. The large balls on the goal will start atop the three triangular frames on the upper portion of the central goal. The large balls on the surface of the playing field will be distributed at equidistant locations around the central goal at a distance of 4 feet from the flat side of the base of the goal, as shown in Figures 1 & 2.

P4. Each match will last for two minutes. It will begin when the control system is enabled and end when it is disabled, unless whistled dead by the referees.

P5. Final scoring will begin when all balls come to rest or upon a referees' decision. Students and coaches will not be allowed onto the field until all scoring is complete.

P6. Upon reaching the scoring stage, each small ball in or above the central hexagonal area of the goal is worth 3 points for the owner. Each large ball in or above the central hexagonal area of the goal is worth 10 points for the owner. Each large ball on or above the triangular frames at the three corners of the goal is worth 5 points for the owner. Ball position will be determined by the geometric center of the ball as estimated by the referees.

P7. The winner of each match is the team with the highest score. Ties will be won by the team owning the higher large ball in or above the hexagonal portion of the goal. If all teams that are tied have no large ball in or above the hexagonal portion of the goal, the tie will be won by the team with the large ball closer to the center of the field.

P8. During a match, five members per team (two "drivers", two "coaches", and one "player") are allowed in the designated areas next to the field. Operator badges will be supplied by U.S. FIRST at each event and must be worn by these team members for field access. Of these five team members, at least three must be students from team partner pre-college school(s).

P9. During a match, machines must be operated from the team operator area next to the field by two students from the pre-college team partner school(s). The coaches must also remain within the team operator area during the match.

P10. Each team will be allowed to use one human player. Human players will be stationed at equidistant locations just outside the perimeter of the playing field, as shown in Figure 1 & 2.

P11. The player must be a student from a pre-college team partner school, and must sit at the player station during the match.

P12. Human players will be secured at each station by a seat-belt-like strap.

P13. A human player may remove balls from the playing field by passing them over or under the horizontal bar at the player station, or around the outside of the vertical posts. A human player may also catch flying or bouncing balls.

P14. If a human player returns a ball to the playing field by passing it under the horizontal bar, or after the end of the match, it will result in disqualification for the match, and any points scored by the team will be forfeited.

P15. A human player may choose not to return balls to the playing field. However, any balls which leave the player's station, such as by rolling off the side, will be returned to the playing field near the player's station without undue delay.

P16. For safety reasons, the player stations are not considered part of the playing field for the machines. Machines may not drive onto the ramps at the front of any player station, nor may they attempt to retrieve balls from any player station. Any machine which does so will be disabled. Any points scored will count.

P17. For safety reasons, no part of a machine may pass through, around, or over the PVC posts at each player station or in any way touch the human players. If this occurs due to an intentional act, the machine causing the safety hazard will be disqualified and any points scored will be forfeited. If this occurs by accident, the machine causing the safety hazard will be disabled, and any points scored will count. The referees will decide whether the violation was intentional or an accident.

P18. For safety reasons, no machine may launch a projectile of any sort, including balls, toward the player station or team drivers and coaches, with the one exception noted below. If this occurs due to an intentional act, the team causing the safety hazard will be disqualified and any points scored will be forfeited. If this occurs by accident, the machine causing the safety hazard will be disabled, and any points

scored will count. The referees will decide whether the violation was intentional or an accident.

- It is acceptable for a machine to launch balls, but no other types of projectiles, toward the player station assigned to the same team as the machine.

P19. For safety reasons, no player may intentionally touch any machine. If this happens, the player's team will be disqualified and any points scored will be forfeited.

P20. All field dimensions shown in Figures 1 through 6 are ± 1" non-cumulative. The large balls have a diameter of 24" ± 2". The small balls have a diameter of 8" ± 1". Both types of balls will be inflated to size, not pressure.

1.5 Competition Structure

Seeding Rounds

Each team will compete in 4 to 6 matches in order to determine the seeding order of the teams. The play order will be pre-determined based on teams registered for the event. A list of the seeding rounds will be distributed to each team on practice day. No team will play another team more than once, and no team will be scheduled to play in two consecutive matches during the seeding rounds.

Seeding order will be determined as follows:

- The winner of a seeding match will receive 3 seed points.
- The runner-up of a seeding match will receive 1 seed point.
- Seeding order will be determined by the total seed points accumulated. The team with the most seed points will be the number 1 seed. The runner-up will be the number 2 seed, and so on.
- Ties will be won by higher total (non-seed) score, higher last match (non-seed) score, or flip of a coin, in that order.

Double-Elimination Rounds

Each team will start off in the double-elimination tree according to their seed. The tree structure will be pre-determined based on the number of teams registered for the event. Copies of the tree will be distributed to each team after the conclusion of the seeding rounds.

The winning team advances to the next round, and the losing teams move to the losing bracket. Every team will be able to lose at least two matches before being eliminated. The double-elimination rounds will end when there are only 8 teams left.

Finals Rounds

The quarter-finals, semi-finals, and finals follow the double elimination rounds. In these rounds, teams will play in 1-on-1, best 2-of-3 matches. At this level, teams which win the 2-of-3 matchup will advance and team which lose will be eliminated.

2. AWARDS

2.1 Chairman's Award

The Chairman's Award is presented to the team which is judged to have created the best partnership effort between team partners: pre-college school(s), universities and/or businesses. All teams participating in the 1996 Competition are eligible for this award. The recipient of this award is decided by an independent panel of judges at the National Championship.

While U.S. FIRST continues to leave this award without specific criteria, there have developed certain themes which seem to best illustrate the partnerships efforts which stand out above others. In 1994, the team efforts continued to progress and develop beyond what we could have predicted so that the judges for the first time named finalists. The entries which were among that group consistently showed the impact that this program had on all team members and their families.

Documentation may consist of any combination of the following:

- Video footage in VHS format, 15 minute maximum length
- Photos
- Written chronicle
- Electronic document (one file only) on 3.5" disk in one of the following formats:
  - Microsoft Word for Windows 2.0
  - Microsoft Word for Macintosh 5.1
  - ASCII Text with no more than 80 characters per line

The computer used to view the electronic documentation may not have any multimedia capabilities, such as digital audio or motion video, or other applications, such as spreadsheets. Do not embed any sound, video, or links to other applications in the document. Embedded images are acceptable.

This material need not be professionally produced, but should clearly convey the effort made to develop a successful school/university or school/business partnership. The recipient will be announced at the National Championship during the Awards Ceremony on Saturday, April 20, 1996.

ALL DOCUMENTATION MUST BE IN U.S. FIRST OFFICES NO LATER THAN 5:00 PM ON WEDNESDAY, MARCH 27, 1996.

The Chairman's Award will be presented at the Awards Celebration on Saturday evening, April 20, 1996. The team carries home a traveling trophy–a high-tech, custom crafted Dean Kamen Clock, which the *New York Times* called "Art That Ticks."

Chairman's Award Materials: Tips

- Avoid going into great detail on the game itself. Use your valuable video time and written space to tell the judges about your partnership.
- If your team submits a video be sure it is of good visual and audio quality. It does not need to be professional but it is imperative that the judges see and hear your message.

2.2 Founder's Award

Each year U.S. FIRST presents this award to honor a company, university or individual that has contributed significantly to the growth of the competition through year-round efforts.

Last year's winner, Walt Disney World, will pass on the trophy clock to the '96 winner at the Awards Celebration in Orlando.

2.3 Judges' Awards

On Saturday evening, April 20, 1995, U.S. FIRST will hold an awards celebration at the Innoventions Fountain at Epcot Center. At this event, a special judging panel will present the following awards:

- Chairman's Award
- 1996 National Champion
- Most Creative Design
- Best Offensive Round
- Outstanding Defense
- Best Play of the Day
- Best Team Spirit Display
- Best Sportsmanship
- Number One Seed
- Most Photogenic
- The Procter & Gamble Creativity Award
- Motorola Quality Award
- Honeywell Leadership in Control Award
- Autodesk Excellence in Engineering Creativity and Communication Award
  (Determined by a special Autodesk judging panel prior to the event)
- Rookie All-Stars (3)

A regional series of judges awards is also planned.

2.4 Animation Competition

Information about the Autodesk Animation Competition is located in Appendix C.

3. MACHINE DESIGN, CONSTRUCTION & OPERATION

3.1 Safety Rules

(see complete list of rules in Appendix B)

S1. Safety first. Due to the nature of the event in which electrical equipment, springs and tools are used, safety will not be compromised.

S2. Any machine which is determined to be a safety hazard by the referees at any time during the Competition must be sufficiently modified to the referees' satisfaction or it will be disqualified and not allowed to compete.

S3. No energy stored in a rubber band may be used to launch any projectile. This does not apply to the latex tubing provided in the kit. However, competition balls are the only projectiles the latex tubing may be used to launch.

S4. Projectiles must have a frontal area greater than or equal to 10 square inches and be shaped to avoid eye injury.

S5. Do not tamper with the power supply, batteries, chargers, battery boxes, joysticks, or any other control system component except as noted in the control system rules. Tampering could result in failure or malfunction of the control system.

S6. Safety glasses must be worn by all team members in the team boxes and player stations during matches, and in the pit area when working on machines. They are also highly recommended if your neighbor(s) in the pit are working on their machine.

S7. Remove batteries from the holders while making adjustments to your machine. Due to the strength of the motors in the kit, it is important to keep fingers away from the gears while your machine is connected to a power supply.

S8. The batteries may deliver more than 100 Amperes. Do not let the wires come into contact with any metal surfaces. Route wires carefully to avoid damage and short circuits, which may cause serious burns and/or fire.

3.2 Design & Operation Rules

(see complete list of rules in Appendix B)

M1. The energy used by the machines in the Competition must come solely from:

- electrical energy derived from the onboard battery packs
- storage achieved by deformation of springs or the latex tubing provided in the kit
- compressed air (or vacuum) stored in the air accumulator
- a change in the altitude of the device's center of gravity.

M2. Machines must fit, unconstrained, inside a 36" cube with one face of the cube flat on the surface of the playing field. The weight of the machine including batteries may not exceed 120.0 pounds.

Size ≤ 36" x 36" x 36"; Weight ≤ 120.0 pounds

Although UPS offers complimentary shipment of machines to and from competition sites, they will not ship packages as large as a full machine. Many teams have found it helpful to make ease of disassembly and reassembly one of the design goals.

M3. All machines will be weighed and measured during the practice day at each Competition event and may be re-inspected anytime during an event. If

modifications to your machine are necessary to meet the above requirements, they must be completed before seeding matches begin.

M4. **Teams are expected to design and build machines to withstand vigorous amounts of interaction with other machines.** *(See also rule T7.)*

M5. Until the controls are enabled at the beginning of each match, machines and any appendages, extensions or projectiles must remain unconstrained within the 36"x36"x36" starting size. Once a match begins, machines may extend beyond that limit under their own power.

M6. Machines must be designed to operate by reacting against the surface of the playing field, the innermost face of the curb, the goal, the balls, the other machines, and the air. *(See Section 2.2 for Field Diagrams.)*

M7. Machines must display their team company and school names and/or logos. The judges, referees, and announcers must be able to identify them by name.

M8. During a match, machines may be manipulated only by the normal operation of the wireless control system.

M9. Gaining traction by using adhesives or by damaging the surface of the playing field or the balls is not allowed.

M10. No substitute machines are permitted; however, functionally identical replacement parts are allowed.

M11. During any Competition event, any mechanism which will alter the operation of the machine may not be added or removed after the first match of the seeding rounds unless mandated by the judges for rule compliance reasons. *(See also Section 5.3.)*

M12. Only items listed under the PNEUMATICS section of the kit list may be used to store, generate, or transmit compressed air or vacuum, with the following exceptions:

- Suction cups may be fabricated from legal kit parts, as define in rule K1 below.
- Pneumatic fittings from Small Parts, Inc. may be used.

Custom-made pneumatic fittings, air cylinders, pumps, air accumulators, and so forth are not allowed, even if they are created from components included in the kits. Also, valves, syringes, tubing, and so forth from SPI or outside sources may not be used for pneumatics.

3.3 Control System Rules

(see complete list of rules in Appendix B)

C1. The control system is provided to allow wireless control of the machines. The transmitter box, receiver/relay box, servos, speed controllers, RNETs, antennas, batteries, battery chargers, battery holders, power supply and joysticks may not be tampered with, modified, adjusted or marked in any way, with the following exceptions:

- the dip switches on the transmitter may be set for custom operation.
- the speed controllers may be calibrated as described in the Tekin REBEL Owner's Manual.
- 1/4" bolts may be used (as self-tapping screws) in the recesses of the battery holders.

Tampering includes drilling, cutting, machining, gluing, rewiring, etc. All items listed in Rule C1 must be mounted without alteration. Do not write on or otherwise mark control system components.

C2. Do not attach tape, stick-on hook & loop fasteners, glue, or other adhesives to control system components. We will re-use many of these components, and these items can be difficult to remove. Instead, use clamps, straps, or existing holes for mounting. The one exception to this rule is:

- Tape may be used to secure the position of the trimmers on the Joysticks in order to prevent accidental changes in calibration.

For mounting control system components, use mechanical fasteners, such as cable ties, straps, or brackets. Do not use tape, stick-on hook & loop fasteners, glue, or other adhesives.

C3. The black project box is intended to serve as a mounting point for the rocker switches and to enclose the associated wiring. You may modify the black project box in any manner to accommodate your needs. It may not be used on the vehicle.

C4. All motors and electrical devices connected to the receiver must be connected with the supplied wire and connectors.

- You must use 12 gauge wire for connections from the batteries to the speed controller and from the speed controller to the drill motor.
- You must use 16 gauge jacketed cable for connections to Delco seat motors, McCord-Winn air pumps and Numatics air valves.

C5. Do not tamper with the battery holder harness. You may not shorten the battery holder wires.

C6. The 12V batteries must be inserted directly into the battery holders. You may restrain them in their holders by means of straps, rubber bands, etc.

C7. RNETs may not be used in the Pit Area at any Competition event. A tether must be used for bench testing.

C8. The Milwaukee drill motors and Tekin speed controllers, if used on your machine, must be used together as sets. Drill motors may not be powered from the receive/relay boxes. Delco seat motors, McCord-Winn air pumps, Numatics air valves, and the fan may not be powered from the speed controllers.

C9. Two 0.1µF capacitors, included with each speed controller, must be installed in each drill motor as described in the Tekin REBEL Owner's Manual.

C10. One 20A circuit breaker (provided in the kit) must be installed in series with each drill motor. The circuit breaker must be accessible for inspection at each Competition event.

C11. Only the 9 volt power supply included with the kit should be used to power the transmit box. If you experience any problems with the 9 volt power supply, contact U.S. FIRST for a replacement. Use of an alternate power supply could damage the transmit box or RNET and is therefore prohibited.

C12. Do not connect power or any other signals to the switch inputs (P1, P2) on the relay board.

3.4 Materials Usage & Limitations

(see complete list of rules in Appendix B)

K1. Each machine must be constructed exclusively from materials provided in the Kit of Parts ("the kit") supplied by U.S. FIRST, with the following additions and exceptions:

- 2' x 4' x 1" ROHACELL ™ structural foam shipped to each team from the U.S. FIRST.
- Material available from outside sources, as explained below:

  Additional Hardware

  A specific list of materials and quantities is provided with the List of Components.

  Small Parts, Inc. Catalog

  Each team receives an account with a $425 credit balance which will be debited for the actual purchases you make. You may go beyond this dollar limitation for prototyping or to purchase spare parts, but your team is responsible for paying the balance on the account. See Rule K3 and the Appendix for more details on accounting and ordering.

  Up to $425 worth of materials purchased from Small Parts, Inc. may appear on your final machine. You may use any component from the Small Parts catalog up to the $425 limitation.

  Fasteners (rivets, screws, welds, nails, cable ties, etc.), washers, and adhesives are not included in your $425 limit on Small Parts Inc. equipment on your machine if used as fasteners.

  It has been brought to our attention that the actual prices of components purchased from Small Parts, Inc. may not match the prices printed in the catalog. Please use the catalog prices when calculating the cost of machine components from SPI for compliance with the $425 limit.

  If you use only a portion of what you buy from Small Parts, you may prorate the dollar amount used to the smallest quantity listed for purchase in the catalog. For example, if you buy 5' of rod which could have been purchased by the foot, but end up using only 6", you may calculate the amount used as the purchase price for one foot.
- Fasteners, washers and adhesives from outside the kit may be used for joining and fastening purposes only.
- Adhesive tape may be used only as an electrical insulator.
- Lubricants may be used only to reduce friction within your own device.
- The kit container, part packaging, and any documentation in the kit container may not be used to build the device.
- Teams may purchase as much shrink wrap tubing of any diameter as they wish. However, shrink wrap must be used for electrical insulation only. It may not be used as a fastener.

K2. Many of the materials in the kit are raw materials. They are intended to be used for manufacturing structural or mechanical parts for your machine.

K3. There is no restriction on the total amount of sprockets/pulleys and chain/belt on your machine, whether bought or machined from official Kit parts. However, there is a restriction on the amount which can be obtained from outside sources–see the *Additional Hardware List* and *Rule K4* for an explanation.

K4. Due to the high power output of the drill motors, each team may purchase from a source outside of the Official Kit of Parts (such as a bike shop or hardware store) additional sprockets (not gears) and/or pulleys and additional chain and/or belt, with the following conditions:

- On your final machine, you may use no more than a combined total of 4 sprockets and/or pulleys from outside sources.
- On your final machine, you may use no more than a combined total of 10' of chain and/or belt from outside sources. There are no restrictions regarding pitch or width of chain and/or belt. However, you may not purchase a wide belt, slice it lengthwise, and use more than a 10' length in the final machine.
- These components must be "commercially available," strictly *off-the-shelf* only. No custom or special orders.
- These components must be used in a power train. Power train is defined as components transmitting mechanical power to any of the vehicles' mechanisms, including propulsion, arms, projectiles, etc.

K5. Gears (not sprockets) may be obtained only by machining them from official Kit parts or by purchasing them from Small Parts.

K6. You may purchase one of the types of wood listed on the *Additional Hardware List*, in a 1/2" thickness with a total area of 4' x 4'. In addition, you may use any or all of the wood samples provided in the kit.

K7. Fasteners may not be used as structural members or power transmission components except as pins in a linkage or as hinge pins.

K8. Net material is allowed; however, if it is used to entangle opponents' machines, the referees may disallow it.

K9. You may only use "off-the-shelf" springs, such as compression, tension, torsion, constant force; spring washers; and, the latex tubing provided in the kit. Springs in addition to those provided in the kit may be purchased only from Small Parts, Inc. You may not fabricate your own.

K10. Pipe fittings (tees, reducers, elbows, and angles) may be purchased only to join pipe and may be used without limit in linking sections of these materials. Endcaps may also be used.

K11. A limited number of replacement parts will be made available by U.S. FIRST upon justified request. Otherwise, lost or damaged kit materials may be replaced only with identical components of the same material, dimensions and treatment at the team's cost.

K12. 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
- resin and hardener may be mixed to produce epoxy.

K13. The balls provided in the kit may not be used during any Competition event.

K14. All unused parts and materials must be returned to U.S. FIRST for proper recycling.

K15. The control system is the property of U.S. FIRST and certain components must be returned at the conclusion of the competition. The control system is not for sale. Teams wishing to borrow the control system for a limited amount of time after the competition may do so by following the procedures outlined in Section 5.5. For teams that wish to operate their machines after this period, U.S. FIRST can provide

basic instructions on how to refit the machines to use off-the-shelf remote control systems.

3.5 Kit of Parts

The following pages are a detailed packing list for all Components which make up the official Kit of Parts. A checklist has been included in your Kit which you should use as you go through the kit to be sure you have received all parts. This checklist should be signed by a team member and returned to a U.S. FIRST staff member as you leave the Kickoff Workshop. Any materials you did not receive will be shipped to you as soon as possible.

List of Components

Bearings

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
2 Bolt Self-Aligning Flange		Bearing Bag	8	The Torrington Company
Radial Ball Bearing w/Spherical OD	1/2" i.d., self locking collar	Bearing Bag	4	The Torrington Company
Single Row Radial Flanged Ball Bearing	1/4" i.d.	Bearing Bag	4	The Torrington Company
Single Row Radial Flanged Ball Bearing	3/8" i.d.	Bearing Bag	4	The Torrington Company

Control System

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
15 Pin Cable	DB15 Male to Female, 6'	Loose	1	Brevan Electronics
15 Pin Connector	DB15, solder cup, female	Electronics Bag	2	Brevan Electronics
15 Pin Connector	DB15, solder cup, male	Electronics Bag	2	Brevan Electronics
2 Conductor Jacketed Wire	15', #16 AWG	Loose	1	General Cable
2 Conductor Jacketed Wire	#24 AWG	Loose	20'	General Cable
2 Pin Power Connector	Black, European style header	Electronics Bag	2	Augat RDI
2 Pin Power Connector	Green, European style header	Electronics Bag	1	Augat RDI
3 Conductor Shielded Wire	#24 AWG	Loose	20'	General Cable
6 Pin Connector	European style header	Electronics Bag	1	Augat RDI
9 Pin Cable	DB9 Male to Female, 6'	Loose	1	Brevan Electronics
9 Pin Ribbon Cable	12", DB9 Male to Female	Electronics Bag	1	Brevan Electronics
9 Pin Tether Adapter	DB9 F-F, pins: 5->5, 2->3,3->2	Electronics Bag	1	Brevan Electronics
Battery Box	Battery Charger Case	Loose	2	Assembled by Nova Biomedical
Battery Charger		Loose	2	Milwaukee Electric Tool Corp.
Black Project Box		Loose	1	Serco
Circuit Breaker	12 volt, 20 Amp, auto-resetting	Electronics Bag	2	Snap-Action, Inc.
Delco Motor Wiring Harness	5', #16 AWG	Loose	4	Assembled by Nova Biomedical
Diode	1 Amp max	Electronics Bag	2	Brevan Electronics
Flightstick Joystick	7 ft cable with Male DB15	Loose	2	CH Products
Heat Shrink Tubing	3/4"Ø x 1', Black, 2:1 Shrink	Electronics Bag	1	Raychem Corporation
Heat Shrink Tubing	3/8"Ø x 2', Black, 2:1 Shrink	Electronics Bag	1	Raychem Corporation
Jack Screw with Lock Washer	3 screws per bag	Electronics Bag	12	Honeywell - Microswitch Division
Limit Switch	Faint printing on side	Electronics Bag	4	Honeywell - Microswitch Division
Limit Switch	White printing on side	Electronics Bag	4	Honeywell - Microswitch Division
Muffin Fan	12 vdc, 0.90 A	Loose	1	Digital Equipment Corporation
Plastic Hood for 15 Pin Connector	fits DB15	Electronics Bag	3	Brevan Electronics

List of Components

Power Connector for Valves		Pneumatics Bag	3	Numatics
Power Supply	9 Volts DC, 1.2 Amps max	Loose	1	Golden Pacific Electronics, Inc.
Receiver Box		Loose	1	Assembled by Nova Biomedical
Rechargable Battery	12 Vdc	Loose	4	Milwaukee Electric Tool Corp.
Reed Switch	Normally open	Electronics Bag	4	CP Clare
Relay Box		Loose	1	Assembled by Nova Biomedical
RNET 9600slm + Antenna		Loose	2	Motorola
Rocker Switch		Electronics Bag	4	Honeywell - Microswitch Division
Rocker Switch Cover	Blue	Electronics Bag	1	Honeywell - Microswitch Division
Rocker Switch Cover	Green	Electronics Bag	1	Honeywell - Microswitch Division
Rocker Switch Cover	Red	Electronics Bag	1	Honeywell - Microswitch Division
Rocker Switch Cover	White	Electronics Bag	1	Honeywell - Microswitch Division
Servo	Hitec/JR-style connector, 42	Electronics Bag	2	Hitec RCD, Inc.
Servo Arms & Mounting Hardware	Fits HS300 Servo	Electronics Bag	2	Hitec RCD, Inc.
Servo Extension Cable	Hitec/JR-style, 36" long	Electronics Bag	2	Hitec RCD, Inc.
Servo Y Cable	Hitec/JR-style, 24" long	Electronics Bag	2	Hitec RCD, Inc.
Spade Connector	female, 22-18 AWG	Electronics Bag	20	Thomas & Betts Corp.
Spade Connector	male, 22-18 AWG	Electronics Bag	20	Thomas & Betts Corp.
Speed Controller	7.2 - 12 vdc, Reversing	Loose	2	Tekin Electronics, Inc.
Terminal Strip	6 channel, tubular screw	Electronics Bag	2	Thomas & Betts Corp.
Transmitter Box		Loose	1	Assembled by Nova Biomedical
Wire	#12 AWG, Black	Loose	12'	General Cable
Wire	#12 AWG, Red	Loose	12'	General Cable
Wire Nut	for 12 AWG wire	Electronics Bag	10	Home Depot
Wiring Harness for Air Pumps	fits Textron pumps, 6" leads	Pneumatics Bag	2	McCord Winn Textron

Documentation

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Kent™ Connect Flyer		Loose	1	Value Plastics, Inc.
Numacalc	manual and software for IBM	Loose	1	Numatics
Numatics Training Manual		Loose	1	Numatics
Small Parts Catalog		Loose	2	Small Parts, Inc.
Spec Sheets for Constant Force Spring		Loose	1	Associated Spring Raymond
Spring Hinge Instructions	comes with Spring Hinge	Hardware Bag	1	Stanley Hardware

List of Components

Fasteners

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
5 Minute Epoxy Gel	resealable 1 oz. dual syringe	Small Parts Bag	1	McMaster-Carr Supply Company
Cable Tie	11.10" x 0.140"	Small Parts Bag	20	Thomas & Betts Corp.
Cable Tie	7.00" x 0.091"	Small Parts Bag	20	Thomas & Betts Corp.
Cable Tie Mounting Base	self-adhesive, holes for #8	Small Parts Bag	25	Thomas & Betts Corp.
Chuck Screw	left handed thread, Torx P20	Drill Bag	2	Milwaukee Electric Tool Corp.
Helical Plastic Wire Wrap	1/4" Ø x 24"	Small Parts Bag	1	McMaster-Carr Supply Company
Hook & Loop Fastener	1" x 2', stick-on	Small Parts Bag	1	McMaster-Carr Supply Company
Mushroom-Head Fastener	1" x 2', stick on	Small Parts Bag	1	McMaster-Carr Supply Company
Rubber Band, Large	3-1/2" x 1/4" wide	Small Parts Bag	5	Alliance Rubber Company
Rubber Band, Small	3-1/2" x 1/8" wide	Small Parts Bag	5	Alliance Rubber Company
Velcro Back Pack Strap		Velcro Bag	1	Velcro USA, Inc.
Velcro Heavy Duty Hold It		Velcro Bag	1	Velcro USA, Inc.
Velcro Pen /Pencil Holders		Velcro Bag	1	Velcro USA, Inc.
Velcro Plant Ties		Velcro Bag	1	Velcro USA, Inc.
Velcro Self Gripping Discs		Velcro Bag	1	Velcro USA, Inc.
Velcro Self Gripping Discs		Velcro Bag	1	Velcro USA, Inc.
Velcro Sticky back Hook & Loop Tape		Velcro Bag	1	Velcro USA, Inc.
Velcro Trunk Strap		Velcro Bag	1	Velcro USA, Inc.

Field Components

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Inflation Needle for 4-Square Ball	fits bicycle tire pump	Loose	1	Sport Fun, Inc.
U-Bolt Wire Rope Clip	for 3/16" Ø rope, galvanized	Hardware Bag	1	McMaster-Carr Supply Company

Motors & Pumps

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Delco Seat Motor	12 vdc motor w/ socket for	Loose	4	Delco Electronics Corporation
Drill Gear Shift Link		Drill Bag	2	Milwaukee Electric Tool Corp.
Drill Gearbox	1000/300 RPM transmission	Drill Bag	2	Milwaukee Electric Tool Corp.
Drill Housing, Left Half	Holds motor and gearbox	Loose	2	Milwaukee Electric Tool Corp.
Drill Housing, Right Half	Holds motor and gearbox	Loose	2	Milwaukee Electric Tool Corp.
Drill Motor	12 V DC	Drill Bag	2	Milwaukee Electric Tool Corp.
Drill Shell Screws	5/8" x 4-20 sheet metal screw	Drill Bag	16	U.S. FIRST
Drill Shifter Button		Drill Bag	2	Milwaukee Electric Tool Corp.

List of Components

Drill Shifter Spring	large	Drill Bag	4	Milwaukee Electric Tool Corp.
Drill Shifter Spring	small	Drill Bag	2	Milwaukee Electric Tool Corp.
High Output Lumbar Pump MWT Motor	12 vdc, 22 psi max, 3/16" o.d.	Pneumatics Bag	1	McCord Winn Textron
Low Output Lumbar Pump Johnson	12 vdc, 4 psi max, 3/16" o.d.	Pneumatics Bag	1	McCord Winn Textron

Other

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Carpet Sample	12" x 12"	Loose	1	
Co-Polymer Gutter Guard	6" x 24"	Loose	1	Home Depot
Fiberglass Matting	4' x 4' x up to 1/8"	Additional	1	TEAM
Kent™ Connect Key Ring Kit		Pneumatics Bag	1	Value Plastics, Inc.

Pneumatics

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Adapter Fitting	1/4" NPTF male to 1/8" NPTF	Pneumatics Bag	1	Sprague Fluid Connectors
Air Cylinder	1-1/16" bore, 4" stroke	Loose	1	Numatics
Air Cylinder	7/16" bore, 12" stroke	Loose	1	Numatics
Barbed Fitting	1/8" i.d. to 1/8 NPTF	Pneumatics Bag	4	Numatics
Barbed Fitting	1/8" i.d. to 10-32 UNF	Pneumatics Bag	12	Numatics
Barbed T-Connector	1/8" Ø barbs	Pneumatics Bag	2	Value Plastics, Inc.
Check Valve	1/8" Ø barbs	Pneumatics Bag	2	Air Logic
Detachable Barbed Reducing Connector	3/16"Ø to 1/8"Ø	Pneumatics Bag	2	Value Plastics, Inc.
Double Solenoid Valve	12 VDC, 10-32 UNF-3B	Pneumatics Bag	1	Numatics
Numatrol Tubing	1/4" o.d., 1/8" i.d., 15'	Pneumatics Bag	1	Numatics
PIAB Suction Cup	53 mm Ø, 1/8" NPSF	Pneumatics Bag	1	PIAB, U.S.A.
Plug for Air Accumulator	1/4" NPTF	Pneumatics Bag	1	Sprague Fluid Connectors
Plug for Valves	10-32 UNF	Pneumatics Bag	5	Numatics
Polyeurethane Tubing	3/16" i.d., 5/16"o.d. x 4'	Pneumatics Bag	1	Value Plastics, Inc.
Pressure Switch	1/8" Ø barb	Pneumatics Bag	2	Numatics
Single Solenoid Valve	12 VDC, 10-32 UNF-3B	Pneumatics Bag	1	Numatics
Syringe	140 cc, Luer Lock Tip	Pneumatics Bag	1	Lowell Medical Instrument
Volume Chamber	approximately 1 liter volume	Loose	1	American Cylinder Company, Inc.

Rods & Shafts

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Aluminum Rod	1/2" Ø x 12"	Tube	1	McMaster-Carr Supply Company
Aluminum Rod	1/2" Ø x 24"	Tube	1	McMaster-Carr Supply Company

List of Components

Brazing Rod	1/16" Ø x 18"	Tube	6	McMaster-Carr Supply Company
Brazing Rod	1/8" Ø x 18"	Tube	2	McMaster-Carr Supply Company
Delrin (Acetal) Rod	1/4" Ø x 24"	Tube	1	McMaster-Carr Supply Company
Drill Rod	1/2" Ø x 18"	Tube	2	New Hampshire Industrial
Drill Rod	1/4" Ø x 18"	Tube	2	McMaster-Carr Supply Company
Drill Rod	3/8" Ø x 18"	Tube	2	McMaster-Carr Supply Company
Drill Rod	5/16" Øx 18"	Tube	2	McMaster-Carr Supply Company
Flexible Motor Shaft	13.5" long, Fits Delco Seat	Loose	4	Delco Electronics Corporation
LDPE Rod	1" Ø x 24"	Tube	1	McMaster-Carr Supply Company
Threaded Rod with 8 Hex Nuts	1/4" Ø x 24", 20 pitch coarse	Tube	1	McMaster-Carr Supply Company
Wooden Dowel	1/4" Ø x 12"	Tube	1	McMaster-Carr Supply Company
Wooden Dowel	1/4" Ø x 24"	Tube	1	McMaster-Carr Supply Company

Sheets & Boards

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Aluminum Plate	1/4" x 3" x 12"	Loose	1	McMaster-Carr Supply Company
Aluminum Sheet	1/16" x 12" x 18"	Loose	1	McMaster-Carr Supply Company
Chipboard - Sample	1/2" x 6" x 12"	Loose	1	Home Depot
HDPE Block	1" x 2" x 6"	Loose	1	McMaster-Carr Supply Company
Masonite Board	12" x 18"	Loose	1	Home Depot
Particle Board - Sample	5/8" x 6" x 12"	Loose	1	Home Depot
Pine Board - Sample	1" x 1-1/2" x 9"	Loose	1	Home Depot
Pine Board - Sample	1" x 2-1/2" x 9"	Loose	1	Home Depot
Pine Board - Sample	1" x 3-1/2" x 9"	Loose	1	Home Depot
Plywood	1/4" x 6" x 12"	Loose	1	Home Depot
Plywood - Sample	1/2" x 6" x 12"	Loose	1	Home Depot
Polycarbonate Sheet	1/16" x 12" x 12"	Loose	1	Plastic Supply Inc.
Rohacell© P170 Structural Foam	1" x 24" x 49"	Loose	1	Richmond Aircraft Products
Rubber Sheet, Black	3/32" x 6" x 18"	Loose	1	McMaster-Carr Supply Company
Rubber Sheet, Red	1/16" x 6" x 18"	Loose	1	McMaster-Carr Supply Company

Small Parts

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Assorted Brass Screws	comes with Spring Hinge	Hardware Bag	1	Stanley Hardware
Cabinet Catch Magnet w/ Plastic Case		Hardware Bag	1	Stanley Hardware
Double Magnet Cabinet Catch		Hardware Bag	1	Stanley Hardware

List of Components

Flexible Shaft Coupling	Black	Small Parts Bag	4	U.S. FIRST
Folding Table Brace w/ screws	9-1/2"	Hardware Bag	4	Stanley Hardware
Hinged Hasp	3" Strap	Hardware Bag	1	Stanley Hardware
Pivot for Steel Track		Hardware Bag	2	Stanley Hardware
Rectangular Magnet		Small Parts Bag	4	Radio Shack
Roller Guide for Steel Track	7/8" Ø x 1/4" wheel	Hardware Bag	4	Stanley Hardware
Side Release Buckle	Fits 3/4" Strap	Small Parts Bag	1	McMaster-Carr Supply Company
Steel Hinge w/ screws	3-1/2" x 3-1/2"	Hardware Bag	2	Stanley Hardware
Steel Track w/Endstop	2'	Loose	2	Stanley Hardware
Trantorque Coupling	3/8" i.d, 3/4" o.d.	Small Parts Bag	2	Small Parts, Inc.
Utility Draw Pull Latch	1-3/4" high x 3-9/32" wide,	Hardware Bag	1	McMaster-Carr Supply Company
Wheelchair Wheel	6" Ø, 5/16" i.d. bearings, 1-1/2"	Loose	2	Skyway Recreation Products
Wheelchair Wheel	8" Ø, 5/16" i.d. bearings, 1-1/2"	Loose	2	Skyway Recreation Products

Springs

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Compression Spring	0.600" o.d. x 3" long x 0.059"	Small Parts Bag	1	Associated Spring Raymond
Constant Force Spring, Large	1.02" i.d.	Small Parts Bag	2	Associated Spring Raymond
Constant Force Spring, Medium	0.85" i.d.	Small Parts Bag	1	Associated Spring Raymond
Constant Force Spring, Small	0.51" i.d.	Small Parts Bag	2	Associated Spring Raymond
Latex Tubing	1/4" i.d., 3/8" o.d., 5'	Loose	1	Totalmed
Small Tension Spring	0.650" o.d. x 2.875-3.000"	Small Parts Bag	1	Associated Spring Raymond
Snugger (Spring for Steel Track)		Hardware Bag	4	Stanley Hardware
Spring Loaded Hinge	4" x 4", 30 in/lb max	Hardware Bag	1	Stanley Hardware

Sprockets & Pulleys

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
Pulley with Fixed Eye	1" Ø, for 5/16" Rope	Hardware Bag	3	Stanley Hardware

Tools

Part Name/Description	Dimensions	Location	Qty /Kit	Product Supplier
5/32" Allen Wrench	comes with Spring Hinge	Hardware Bag	1	Stanley Hardware
Torx L-Key	Torx T20 Heads, 3-3/4" Length	Hardware Bag	1	McMaster-Carr Supply Company

4. CONTROL SYSTEM MANUAL

4.1 Introduction & General Description

(see controls rules in section 3.3)

Please read the following section carefully. Failure to configure your control system properly could result in personal injury, damage to the control system, or damage to your machine.

In this section you will find:

- descriptions of the control system components
- configuration options
- wiring diagrams
- hook-up instructions
- rules for usage

If, after reading this section, you have problems configuring the control system, please contact U.S. FIRST for assistance. We will be happy to answer any questions you may have. See section 5.1 for information on how to contact U.S. FIRST.

The heart of the control system consists of two main units: the Transmitter, and the Receiver/Relay box. The Receiver/Relay box contains both the Receiver board and the Relay board. Most of the other control system components connect directly to one of these three boards.

The transmitter reads up to 8 proportional or switched inputs, and passes the corresponding signals to the receiver via a pair of RNET radios (or a tether). Although some of the input devices listed in the next section are intended as sensors to be used on your machine, any of them may be connected as input devices to the transmitter.

The receiver generates 8 pulse-width-modulated (PWM) control signals, which are used to control the servos, speed controllers and relay board. The speed controllers in turn provide power to the Milwaukee drill motors.

The relay board receives up to 6 channels of PWM signal from the receiver, and provides up to 6 channels of non-proportional, bi-directional (forward-off-reverse) power for the pnuematic pumps, valves and Delco seat motors. In addition, sensors mounted on your machine can be connected directly to the relay board to activate or deactivate, independently, a particular direction of a particular channel on the relay board.

4.2 Control System Components

The kit contains a wide variety of input devices:

- two CH Products three-axis proportional joysticks with trigger and thumb switches
- four Honeywell Microswitch rocker switches
- eight Honeywell Microswitch limit switches
- four CP Clare reed switches.
- two Air Logic pressure switches

The limit switches, reed switches, and pressure switches are intended for use as feedback sensors on your machines, but may also be used as part of the user interface on the transmitter end.

There is also a variety of output devices:

- two Hitec servos
- two Tekin reversing speed controllers
- two Milwaukee cordless drill motors
- four Delco seat motors
- two McCord-Winn Textron air pumps
- two Numatics pneumatic valves.

The servos and speed controllers are controlled directly by the PWM output of the receiver; the drill motors are driven by the speed controllers. All other output devices are driven the relay board, which converts PWM signals and sensor inputs to relay outputs. A summary of all control system components is shown in Table 4.1.

Attempting to drive the drill motors directly with the receive/relay box, or attempting to drive other devices with the speed controllers could damage the control system and is therefore prohibited.

If you wish to activate both speed controllers, both servos, and all 6 channels of the relay board (a total of 10 output channels), two of the channels from the receiver board must be split by using the two included servo Y connectors to create two sets of paired outputs. Alternately, some channels of the relay board may be activated solely by the feedback sensors on your machine.

Table 4.1: Control System Components

Transmitter Side	Receiver Side
Motorola RNET radio	Motorola RNET radio
Transmit box	Receiver/Relay box
9V power supply	2 Tekin speed controllers
2 Flightstick joysticks	2 Hitec servos
4 rocker switches	2 Battery boxes, each with an internal 30A circuit breaker
9 pin molded cable	4 Milwaukee 12V batteries
15 pin molded cable	2 Milwaukee drill motors plus gearheads
9 pin tether adapter	4 Delco seat motors
Black project box	2 McCord Winn air pumps
15 pin female connector	2 air valves
	8 Limit Switches
	4 Reed Switches
	2 Pressure Switches
	2 20A circuit breakers
	2 Six channel terminal strips
	9 pin ribbon cable
	#12 wire, black, red
	2 conductor #24 cable
	3 conductor #24 cable
	2 servo Y connectors
	2 servo extension cables
	Spade Connectors

4.3 Power Distribution

The two battery boxes must be wired in parallel to the terminal strips, from which the 12V power must be distributed, using #12 AWG wire where indicated in Fig. 5.1 (See also Fig. 4.5). Use red wire for +12V and black wire for GND. All boxes are clearly marked +12V and GND. Please note that you will be required to pay for replacement or repairs due to any improper wiring.

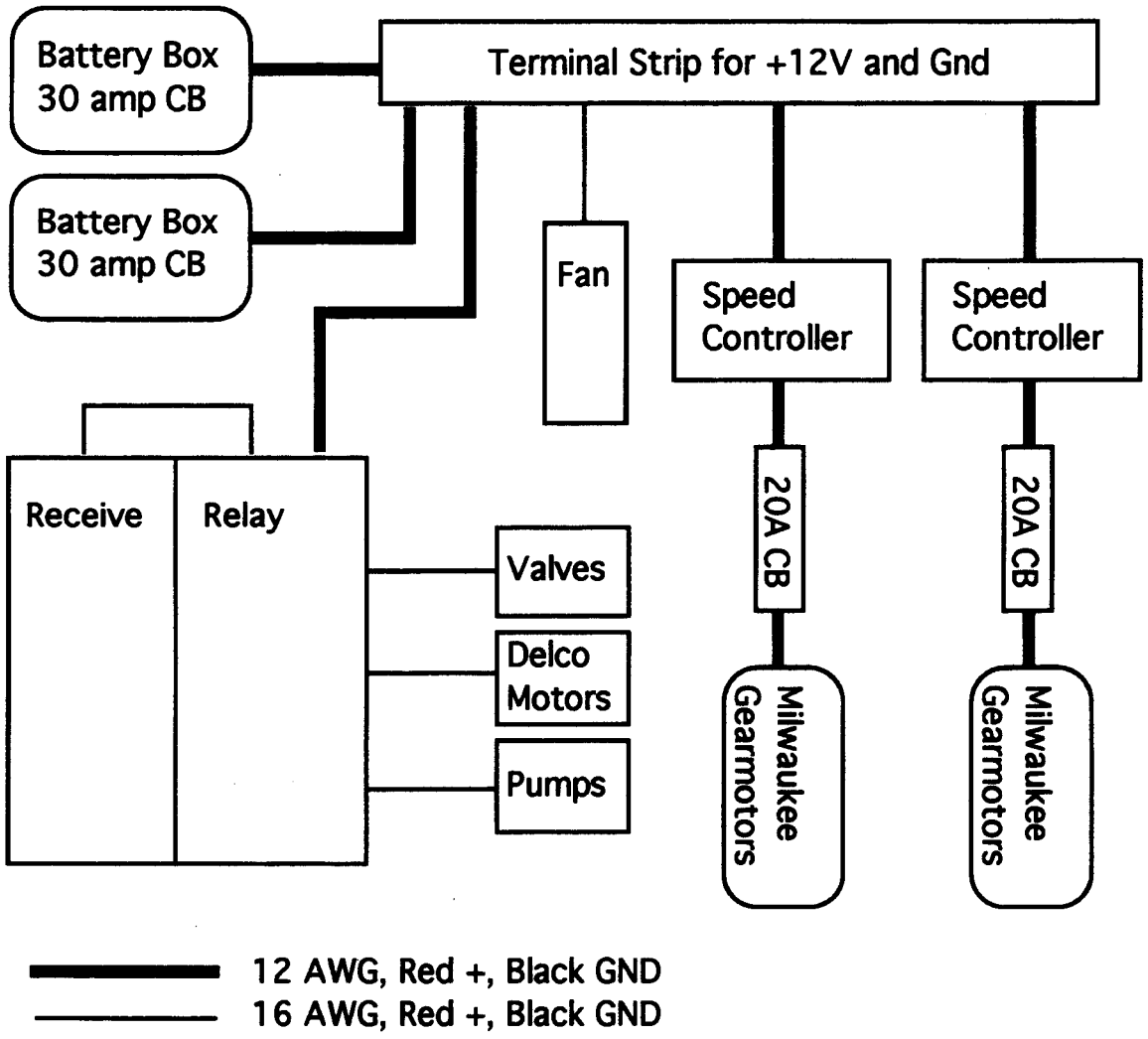


Figure 4.1 Power distribution

The wires and cables included in the kits are intended for specific uses. Table 4.2 shows the minimum wire sizes allowed for hookup of the various control system devices.

Table 4.2: Minimum Wire Size by Device Type

Device	Wire Type
Drill Motors, Battery Boxes, Speed Controllers (power & motor leads), Relay Board (power)	12 AWG Red & Black
Receiver Box (power), Delco Motors, Pumps, Valves	16 AWG, 2 Conductor
Limit Switches, Reed Switches, Pressure Switches, PWM Cables, Rocker Switches	24 AWG, 2 or 3 Conductor

The control system cables containing 3 wires or less may be shortened or lengthened as needed as long as the following conditions are met:

- Proper insulation (electrical tape, wire nuts, or shrink wrap) must be used.
- Proper wire type, as specified above, must be used.

The spade connectors in the kit may be used only for connections between multiple segments of 24 AWG wire and the switches.

4.4 Transmitter Box

The connection diagram for the Transmit Box is shown in Figure 4.2.

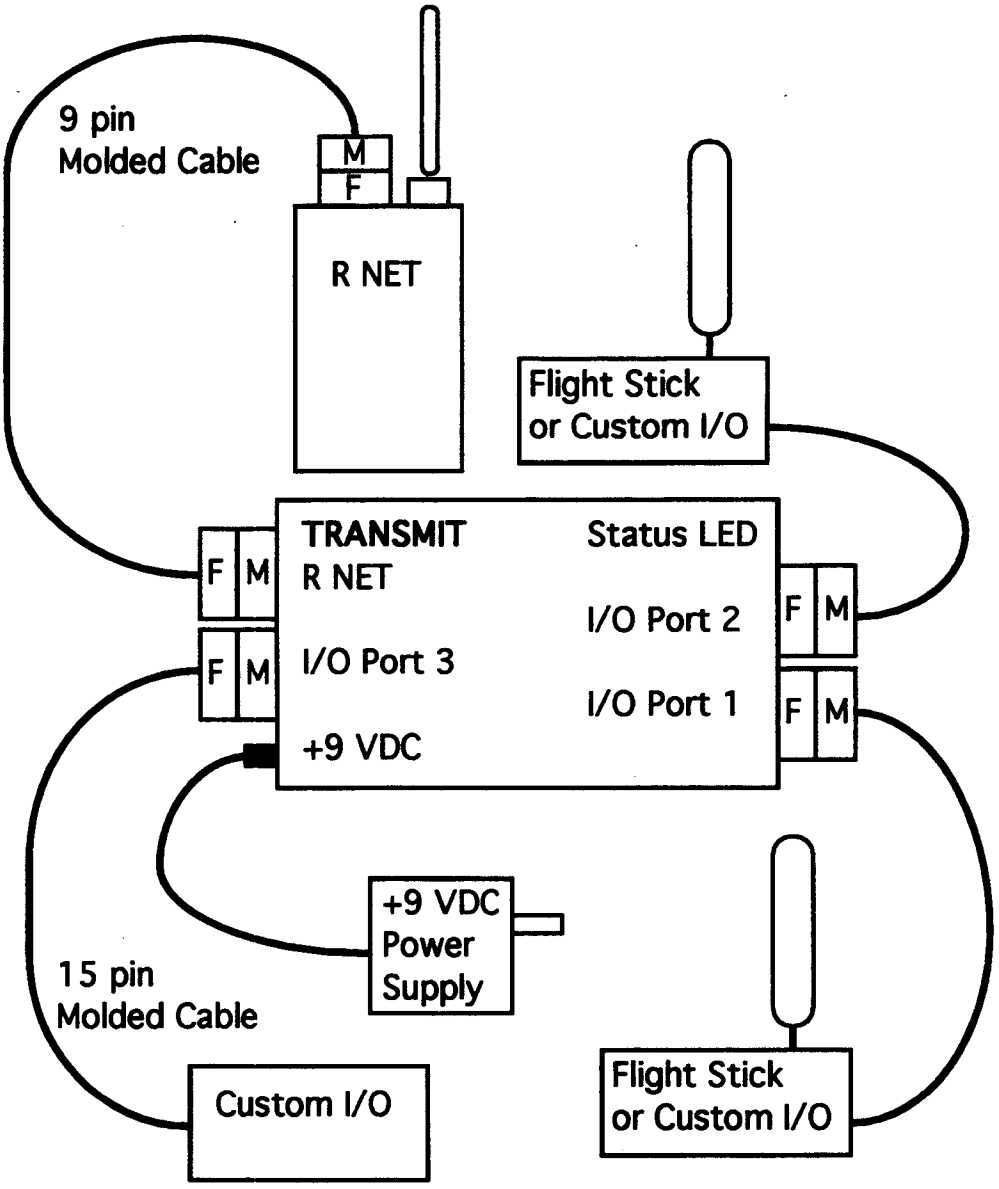


Figure 4.2 - Connection Diagram for Transmit Box

Warning

Only the 9 volt power supply included with the kit should be used to power the transmit box. If you experience any problems with the 9 volt power supply, contact U.S. FIRST for a replacement. Use of an alternate power supply could damage the transmit box or RNET and is therefore prohibited.

The RNET radio should be connected to the transmit box by the 6ft. nine-pin cable. The transmit box reads both proportional input devices (joysticks) and non-proportional input devices (switches), encodes the signals, and sends the data to the receive box via the RNET radio link or tether. There are 8 proportional input channels, and 4 non-proportional, bi-

directional input channels. Table 4.3 shows the input channel pin assignments for each input port.

Table 4.3: Input Port Pin Assignments

	I/O Port 1	I/O/Port 2	I/O/ Port 3
Pin	Input Channel	Input Channel	Input Channel
1	Power	Power	Ground
2	SW3 (forward)	SW1 (forward)	SW3 (forward)
3	A5	A1	SW4 (forward)
4	Ground	Ground	A7
5	Ground	Ground	A3
6	A6	A2	SW1 (reverse)
7	SW3 (reverse)	SW1 (reverse)	SW2 (reverse)
8	Power	Power	Power
9	Power	Power	Ground
10	SW4 (forward)	SW2 (forward)	SW3 (reverse)
11	A7	A3	SW4 (reverse)
12	Ground	Ground	Ground
13	A8	A4	SW1 (forward)
14	SW4 (reverse)	SW2 (reverse)	SW2 (forward)
15	Power	Power	Power

Notes:
- SW1 through SW4 denote non-proportional, bi-directional switch inputs.
- There are separate input lines for each switch direction.
- Switch inputs should be switched to Ground.
- A1 through A8 denote analog (proportional) inputs.
- Analog inputs measure a variable resistance between the input line & Power.
- The X & Y axes of the Flightsticks are connected to A1,A5 & A2,A6, respectively.
- The momentary switches on the Flightsticks are connected to SW1 & SW3.
- The throttle wheels on the Flightsticks are connected to A4 & A8.

Although there are 12 available input channels, only 8 may be used at once. This limitation exists because the receive box only provides 8 output channels. Therefore, the input devices best suited to control your machine must be selected, and the transmit box configured accordingly. A good start is to use the channels available from the Flightsticks.

Two options exist for the processing of joystick signals. The default option assigns output channel 1 to A1, which is the X-axis of the joystick connected to input port 2, and channel 2 to A2, the Y-axis of the joystick connected to input port 2. Similarly, channels 3 and 4 are

assigned to the X (A5) and Y (A6) axes of the joystick connected to input port 1, respectively. The Coordinated joystick option is intended for driving a machine with a single joystick by commanding speed with the Y axis and commanding turning rate with the X axis. This option may be selected by setting DIP switches 1 and 2 located inside the transmit box. To activate Coordinated mode, set DIP switch 1 for a joystick on input port 2, and DIP switch 2 for a joystick on input port 1.

The remaining 4 output channels may be configured by setting DIP switches 5 through 8 located inside the transmit box; refer to table 4.4.

> **Attention: Before opening the transmit box, remember to disconnect the power supply. While the transmit box is open, be careful to avoid static discharges to the circuit board or connectors. Also, make sure not to let any foreign particles, especially metal fragments, get inside the enclosure or onto the circuit board. It is best to open the unit in a clean environment away from where your machine is being worked on. Never operate the transmitter with the cover off.**

Figure 4.3 shows the location of the DIP switches on inside the transmit box. To access the DIP switches, the cover of the transmit box must be removed. To remove the cover, unscrew the four Phillips head screws on the underside of the transmit box.

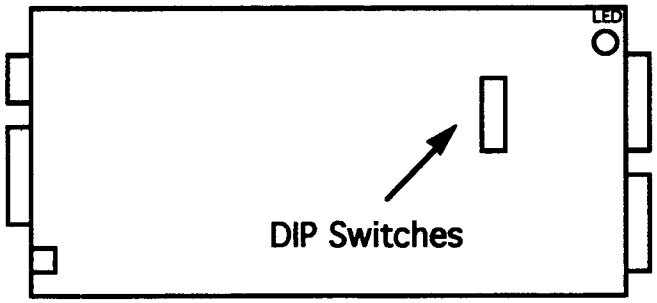


Figure 4.3: Location of DIP Switches Inside Transmit Box

Table 4.4 shows the how to map the various input channels on the transmitter to the output channels on the receiver, and the corresponding DIP switch settings.

Table 4.4: Transmit Box DIP Switch Settings

Input Configuration								DIP Switch Settings			
CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	5	6	7	8
A1	A2	A5	A6	A4	SW1	A8	SW3	0	0	0	0
A1	A2	A5	A6	SW2	SW1	A8	SW3	1	0	0	0
A1	A2	A5	A6	A4	A3	A8	SW3	0	1	0	0
A1	A2	A5	A6	SW2	A3	A8	SW3	1	1	0	0
A1	A2	A5	A6	A4	SW1	SW4	SW3	0	0	1	0
A1	A2	A5	A6	SW2	SW1	SW4	SW3	1	0	1	0
A1	A2	A5	A6	A4	A3	SW4	SW3	0	1	1	0
A1	A2	A5	A6	SW2	A3	SW4	SW3	1	1	1	0
A1	A2	A5	A6	A4	SW1	A8	A7	0	0	0	1
A1	A2	A5	A6	SW2	SW1	A8	A7	1	0	0	1
A1	A2	A5	A6	A4	A3	A8	A7	0	1	0	1
A1	A2	A5	A6	SW2	A3	A8	A7	1	1	0	1
A1	A2	A5	A6	A4	SW1	SW4	A7	0	0	1	1
A1	A2	A5	A6	SW2	SW1	SW4	A7	1	0	1	1
A1	A2	A5	A6	A4	A3	SW4	A7	0	1	1	1
A1	A2	A5	A6	SW2	A3	SW4	A7	1	1	1	1

Note: 0 = open, 1 = closed

The default configuration is all DIP switches set to open.

DIP switches 3 and 4 should always be set to open.

DIP switches 3 and 4 must always remain open. DIP switches 5 through 8 may be modified to select which input channels the transmitter will read and send to the receiver.

The default configuration of the transmit box is to read all proportional axes and switches available on the two Flightstick joysticks. This yields a total of 6 proportional channels, and 2 non-proportional, bi-directional channels.

The Flightsticks can be connected directly to input ports 1 and 2. The rocker switches, limit switches, reed switches, and pressure switches can be connected via input port 3.

The black project box included in the kit is intended to serve as both a mounting point and a wiring box for devices connected to input port 3. However, other kit materials may be used to mount these devices. For the instructions below, it is assumed that you are using the project box.

Input devices other than the joysticks should be wired to the 15 pin female soldercup connector. This connector should be mounted on the side of the project box. From there, use the 15 pin cable to connect to input port 3 on the transmit box.

4.5 Receiver/Relay Box

The receiver/relay box contains both the receive board and relay board. Each board provides unique functions, as described below.

Receive Board

The receive board decodes the transmitted data and converts it to pulse width modulated (PWM) signals. There are eight output channels available.

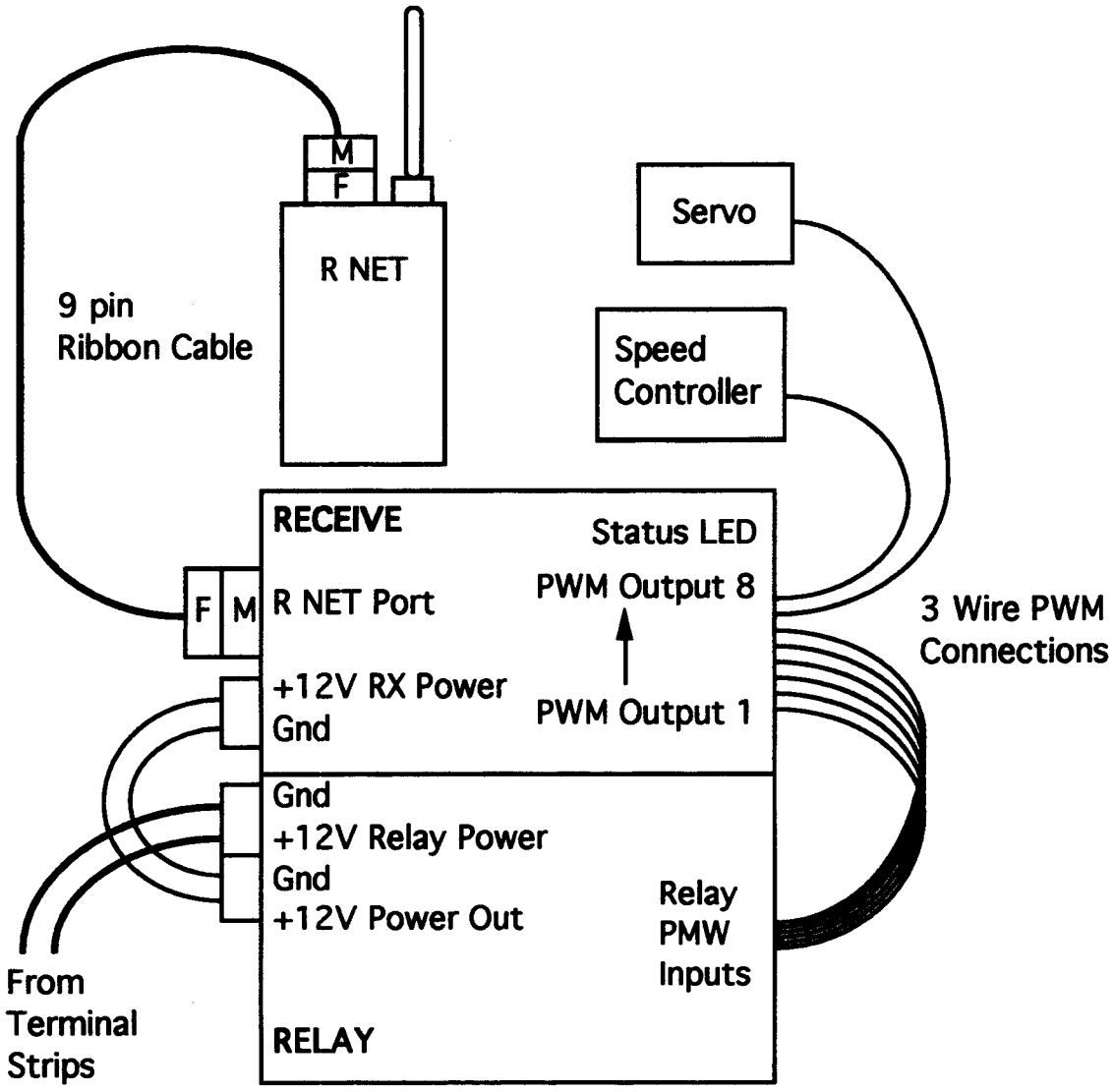


Figure 4.4: Receive/Relay Box Connections

The RNet is connected to the receive board by the nine pin ribbon cable. Avoid bundling it with the battery or motor wires. Shielding is not necessary and has caused problems in the past. Locate the RNET so the antenna is not shielded by metal objects. At the contest you will be required to return your RNET pair and will be using units dedicated to the contest fields. For this reason make your RNET accessible so it can be installed and removed quickly during the competition. The hook and loop fastener is installed on the RNET in the same location that it will be installed at the contest. However, we recommend a secondary means of attachment because the RNETs have broken loose in the past.

The PWM outputs connect to the three wire PWM cables from the servos, speed controllers, and relay board only. Except the servos, they do not drive any motors directly. These are signal wires only.

To connect the transmitter to the receiver using the tether adapter, connect one end of the tether adapter to the RNET port on the transmitter box. Connect the other end of the tether adapter to the male end of the 6 foot, 9 pin molded cable. Connect the molded cable in series with the ribbon cable. Connect the other end of the ribbon cable to the RNET port on the receiver box. Figure 4.5 illustrates this concept.

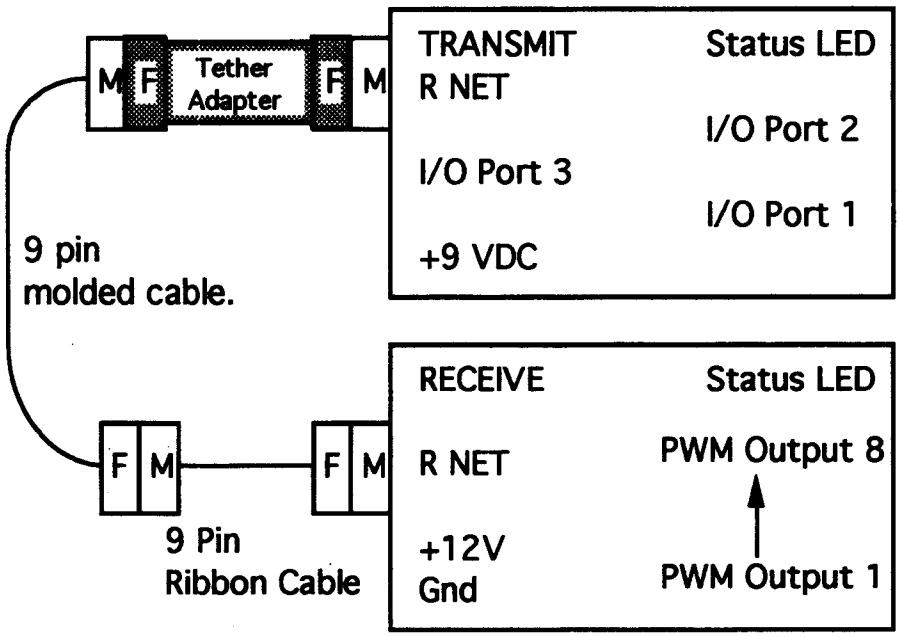


Figure 4.5: Use of the Tether Adapter

Relay Board

The relay board decodes the PWM signals and switch inputs and activates or deactivates the relay outputs accordingly. The relay outputs will drive the McCord Winn air pumps, Numatics air valves, and Delco seat motors. At least one PWM input needs to be connected to the receive box for it to operate at all. Table 4.5 correlates the relay outputs with PWM and sensor inputs.

The PWM inputs connect to the PWM outputs on the receive box.

The sensor inputs on Input Port 1 and Input Port 2 are asserted when they are connected to RTN. Table 4.6 describes the pin assignments on these ports. Use the 2 conductor jacketed cable and the 15 pin female connectors to make the connection between the switch inputs and the switches.

Do not connect power or any other signals to these switches or switch inputs. Be careful to observe the polarity of the power inputs when wiring the control system. You will be required to pay for replacement or repair of devices damaged due to improper wiring.

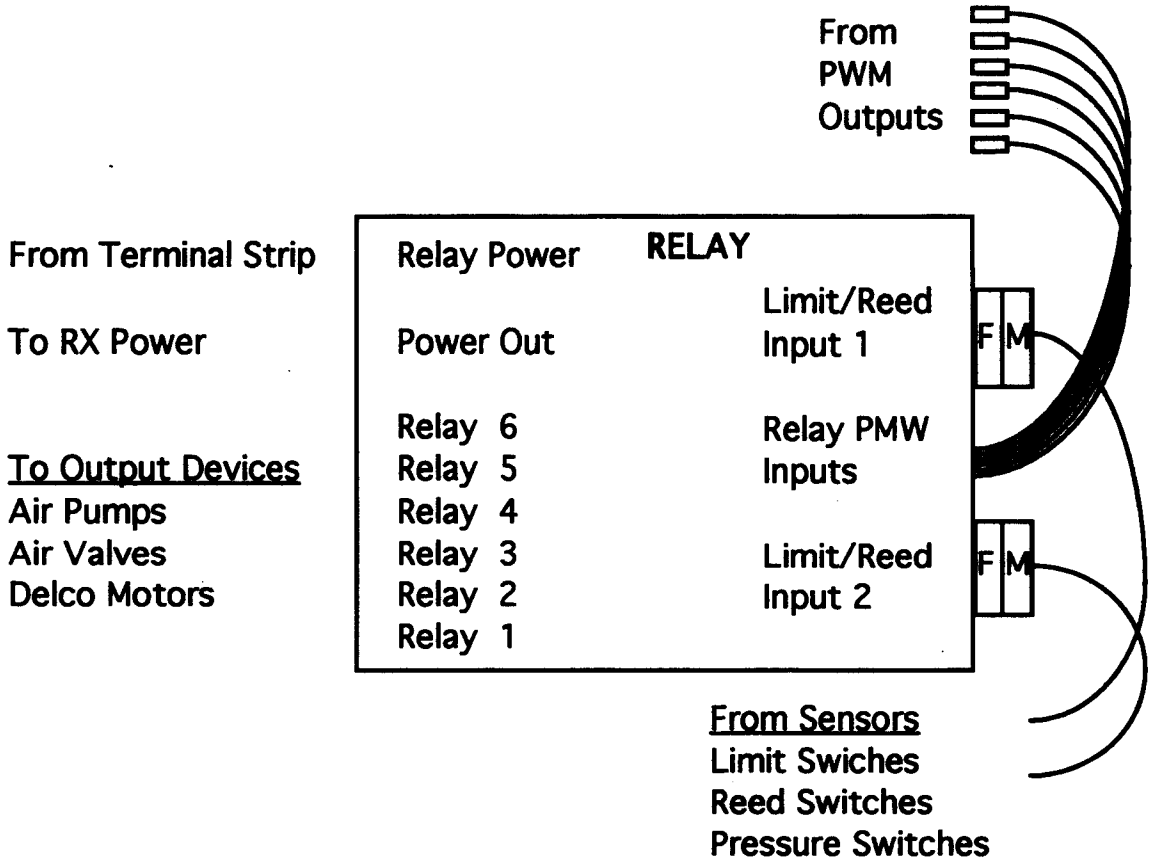


Figure 4.6: Relay board connections

Table 4.5: Relay Board Truth Table

PWM input	GOFWD	STOPFWD	GOREV	STOPREV	OUTPUT
Forward					Forward
Forward		X			Off
Off					Off
Off	X				Forward
Off			X		Reverse
Reverse					Reverse
Reverse				X	Off
Note: X is asserted All other input combinations will be decoded as Off.					

Table 4.6: Input Port 1 and Input Port 2 Pin Assignments

P1 pin #	Switch Contact		P2 pin #	Switch Contact
1	GOFWD1		1	GOFWD4
2	GOREV1		2	GOREV4
3	RTN		3	RTN
4	STOPFWD2		4	STOPFWD5
5	STOPREV2		5	STOPREV5
6	GOFWD3		6	GOFWD6
7	GOREV3		7	GOREV6
8	RTN		8	RTN
9	STOPFWD1		9	STOPFWD4
10	STOPREV1		10	STOPREV4
11	GOFWD2		11	GOFWD5
12	GOREV2		12	GOREV5
13	RTN		13	RTN
14	STOPFWD3		14	STOPFWD6
15	STOPREV3		15	STOPREV6

Example

Stop channel 1 from moving forward when a switch is asserted and initiate channel 3 reverse when a different switch is asserted. Figure 4.7 shows the proper wiring for this condition. Note that switches are shown in the non-asserted condition.

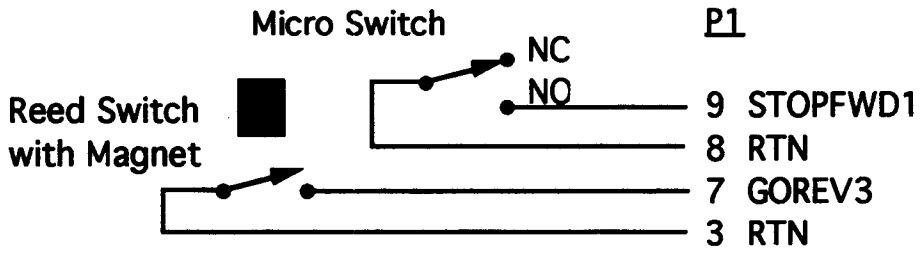


Figure 4.7: Example sensor wiring.

For example, a motor connected to the relay board powers a mechanism with a limited range of travel. By mounting a limit switch in such a position that it is triggered when the mechanism reaches one of the ends of travel, the limit switch can disable the motor from trying to travel further in that direction without preventing it from moving back in the other direction. This can prevent binding or damage to the mechanism, and can save energy by preventing the motor from operating in a stall condition.

PWM Cables

Some of the PWM cables in the kits have Hitec/JR style connectors while others have Futaba J-style connectors. The Hitec/JR style cables have yellow, red, and black wires, while the Futaba style cables have white, red, and black wires. The PWM connectors should be plugged into the receiver box with the black wire on the bottom, and the yellow or white wire on top. In order to use the Futaba style connectors, you may need to shave off the external tab to gain a proper fit. See the figure below for details.

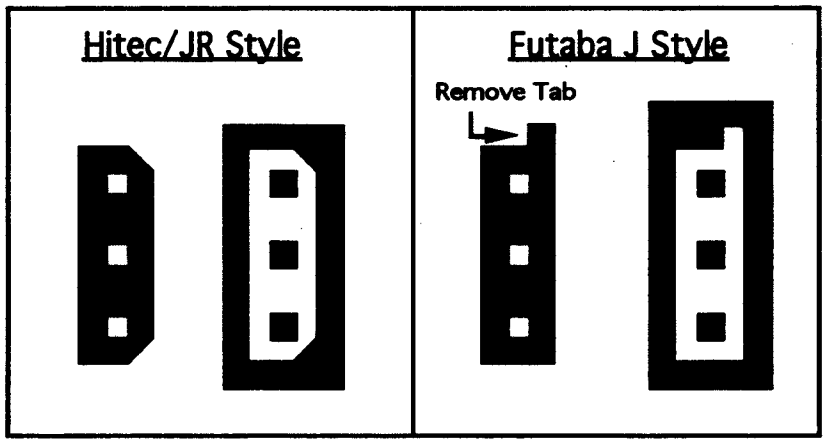


Figure 4.8 : Hitec and Futaba-Style PWM Connectors

4.6 Output Devices

Milwaukee Gearmotors and Tekin Speed Controllers

Refer to the Tekin REBEL Owner's Manual for connection of the speed controller to the battery and motor. Two capacitors, included with each speed controller, must be installed on each drill motor as described in the Owner's Manual. We have provided a screw and solder lug on each motor for this purpose, because soldering to the motor housing is difficult. Please secure the motor wires carefully to avoid breaking the capacitor leads.

One 20A circuit breaker must be installed in series with each drill motor to protect both the drill and the speed controller. Do not disable the circuit breaker by connecting its terminals together. Please insulate the terminals of this circuit breaker separately, as in Figure 4.9, so inspectors at the competition can verify correct installation. If the circuit breaker trips during use, you should use a higher gear reduction ratio. The circuit breaker usually resets in less than one second.

If the speed controller shuts off due to overheating during use, you may need to use a higher gear reduction ratio, or you may be running it continuously in reverse. The speed controller runs hotter in reverse than it does in forward. The speed controller usually takes 30 seconds or more to reset. An optional 12V muffin fan has been included in the kit primarily for added protection against overheating of speed controllers and/or drill motors. You should install this fan to direct cooling air over the power components that run the hottest. You may provide power to the fan from the 12V power distribution terminal blocks directly. Note that the fan is not reversible.

The drill motors and gearboxes snap together for convenient handling during assembly of a drill; this motor-gearbox sub-assembly cannot support normal loads by itself. The gearshift lever on the gearbox and the gears actuated by it cannot withstand large gear-shifting forces, especially while operating. All parts to assemble the complete gearshift mechanism, including a gearshift button, three springs, and gearshift link are provided in the Drill Bag in the kit. We recommend that you use the plastic drill shell to support the motor, gearbox and shift mechanism, and provide ample speed reduction between the drill and its load. See Figure 4.10 for proper installation of the gearshift button, springs and link.

The drill components were designed for drilling small holes and driving small screws, not for propelling a 120 pound machine or launching huge balls several feet into the air. Please remember this when designing and operating your machine. Align mechanical power transmission components accurately. If you couple the spindle to another shaft, support the shaft with two bearings and use a suitable flexible coupling. If you mount a gear, pulley, or sprocket to the gearbox spindle, use the largest pitch diameter possible to minimize side loads resulting from transmitting torque. Note the tradeoff between side loads and available gear ratio. A small pulley on the spindle allows a good gear ratio, but results in excessive side loads. Consider seriously the possible need for two stages of speed reduction between the drill and its load. If the drill shows signs of overloading, such as clutch disengagement, improve your design. When you get out on the playing field, failures will be far more likely than they were during practice.

Figure 4.11 shows performance curves for one drill motor installed in the drill shell with its gearbox, powered from one battery through a speed controller at full forward "throttle," and battery voltage as a function of battery current.

Delco Seat Motors

The Delco seat motors contain one worm gear reduction stage and a positive temperature coefficient (PTC) thermistor for overload protection. As the motor becomes warm from use, the resistance of the PTC device increases, thereby reducing the motor current and output torque. Operation at or near stall continuously will reduce the output torque to near zero until the motor has been allowed to cool. To prevent overheating, take care to couple the output shaft in a manner that does not impose large side loads, use an appropriate gear ratio, and minimize the internal friction of the mechanism driven. Figure 4.12 shows dimensions and operating characteristics of the Delco seat motors.

Mechanical Power Transmission

One of the most common problems teams have experienced in past competitions is mechanical power transmission failure. Typical torques at the final stage of your propulsion power transmission assembly are large enough to cause serious problems for most conventional means of fixing gears, pulleys or sprockets to shafts. Set screws almost always fail. Pins offer better torque transmission, but can cost you valuable time if one breaks. Be careful not to use a pin so large that it occupies so much if the original shaft cross-section that the shaft breaks. Consider carefully the use of good clamping type couplings, even though they may be expensive. We have included two 3/8 in. bore Trantorque collet type couplings in the kit, and recommend that you use them on the drill spindles. Although the Trantorque is intended for use on a smooth shaft, it has been used successfully on the threaded spindle. You should bore the component to be mounted a few thousandths of an inch smaller than the recommended 0.750 in. to compensate for the spindle diameter, which is slightly under 0.375 in. Be careful to avoid interference with other machine parts when installing the Trantorque coupling (see Figure 4.13).

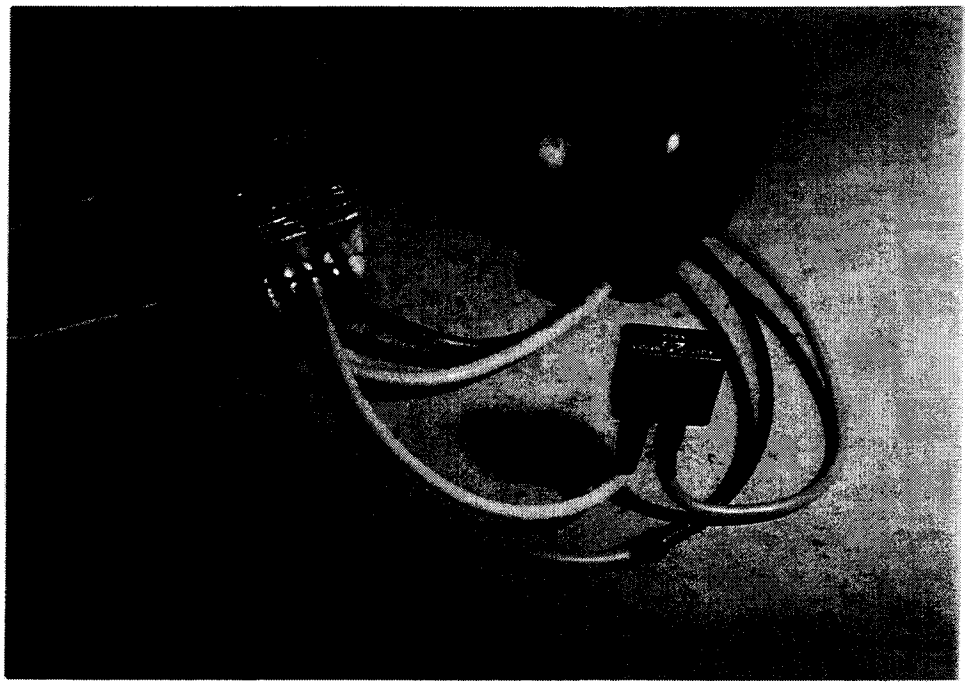


Figure 4.9: Installation of 20A circuit breaker.

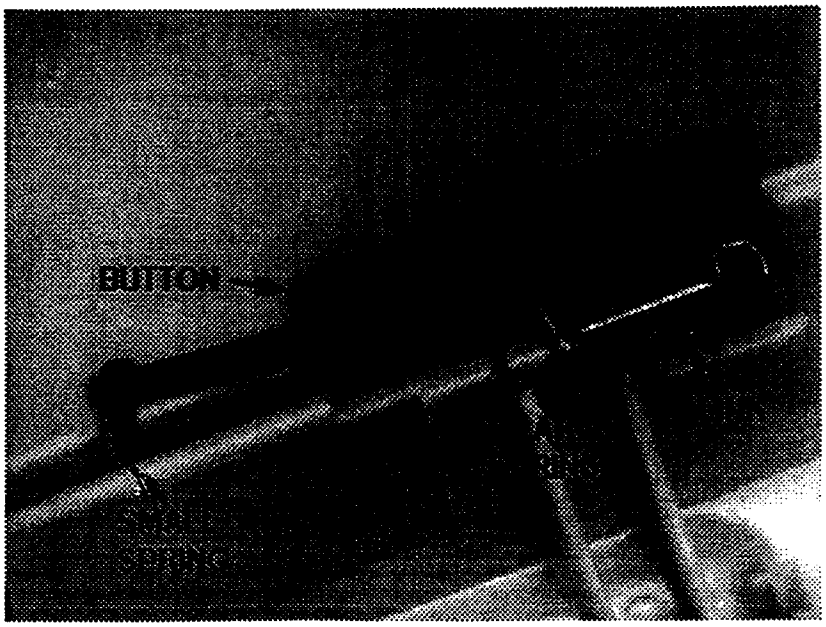


Figure 4.10 : Installation of the gearshift button, 3 springs and gearshift link in drill shell.

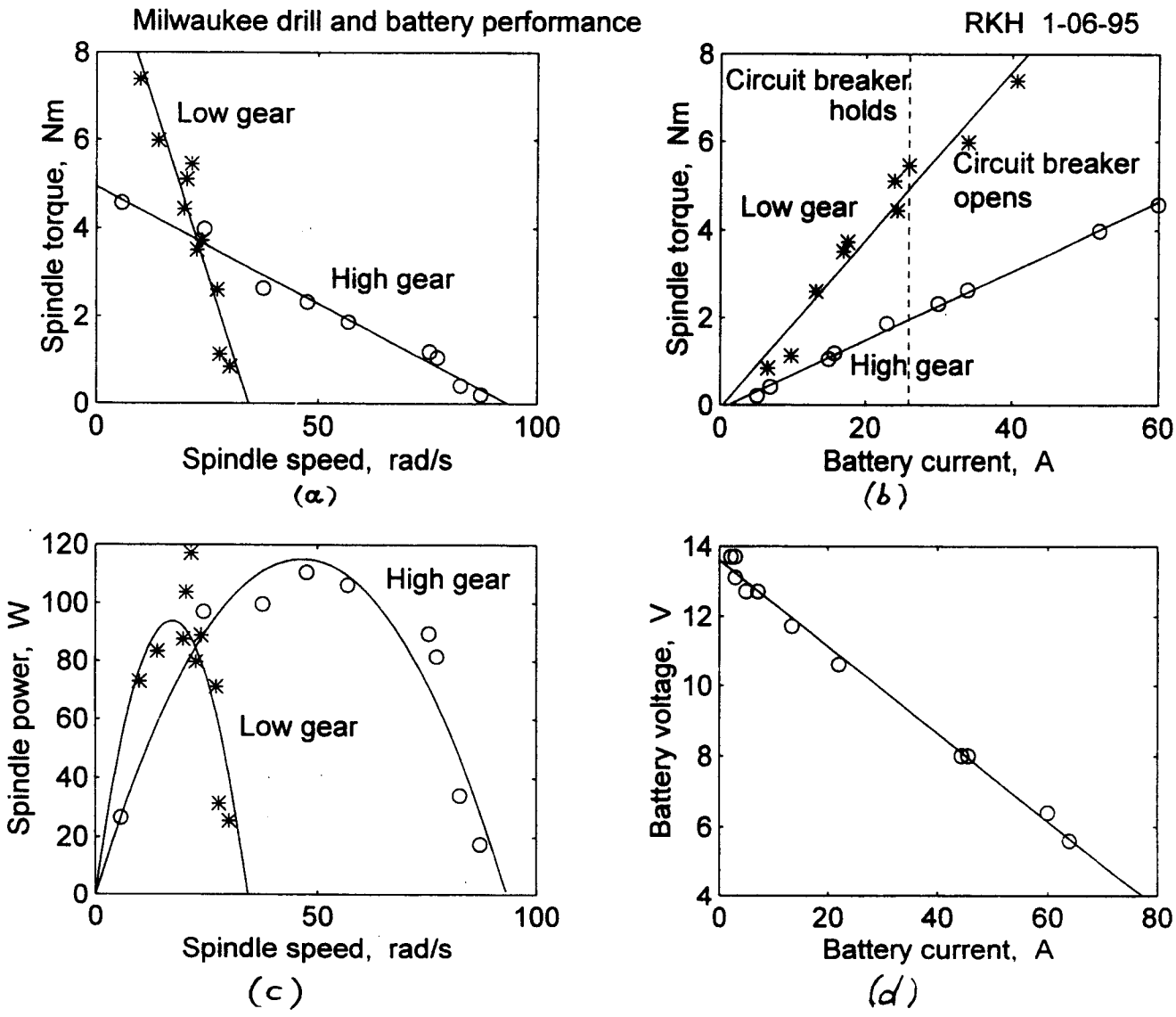


Figure 4.11: Performance curves for one drill motor with its gearbox, powered by one battery through a speed controller. (a) Torque vs. speed, (b) Torque vs. current, (c) Output power vs. speed, (d) Battery voltage vs. battery current.

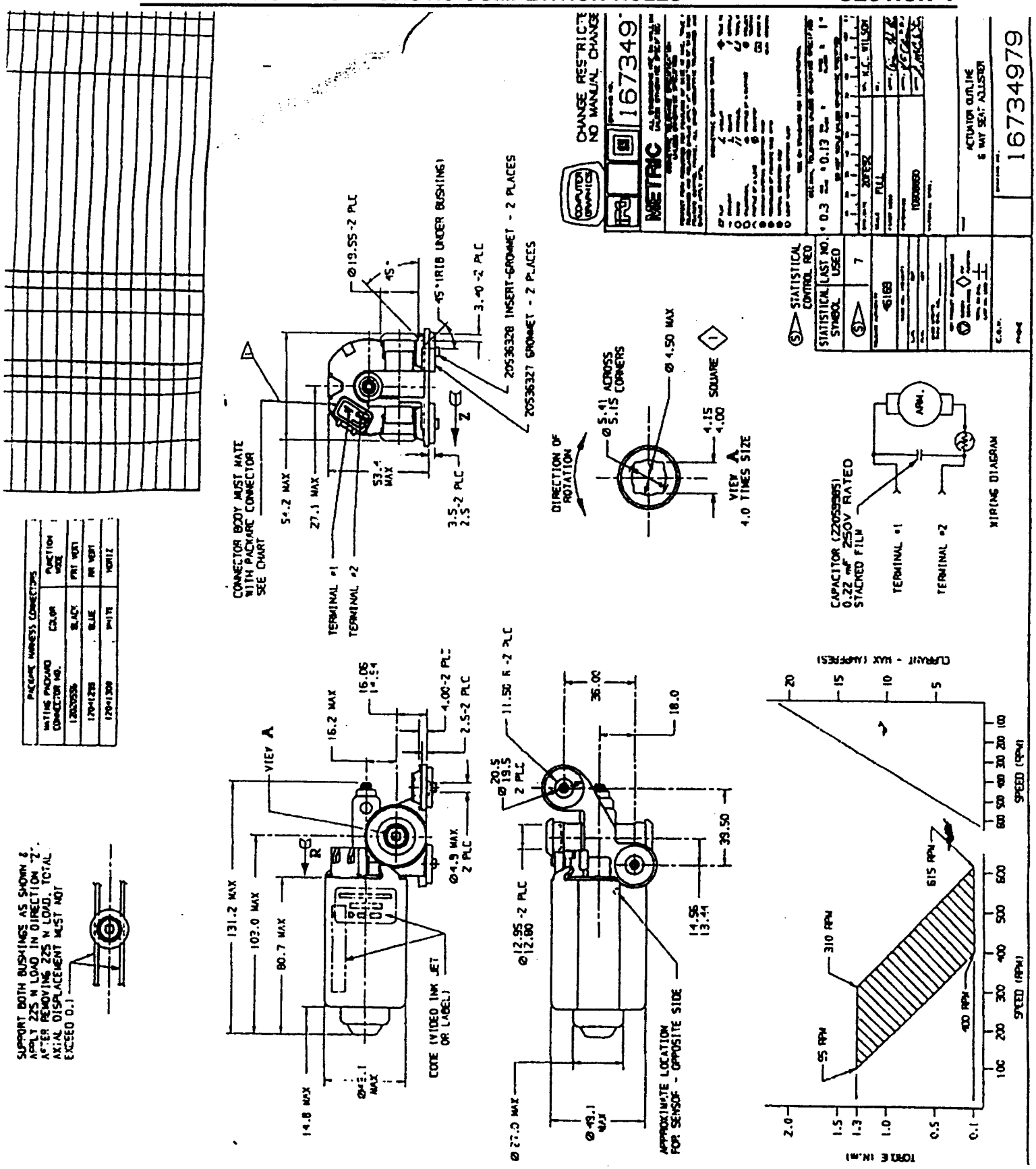


Figure 4.12: Dimensions and operating characteristics of the Delco seat motors.

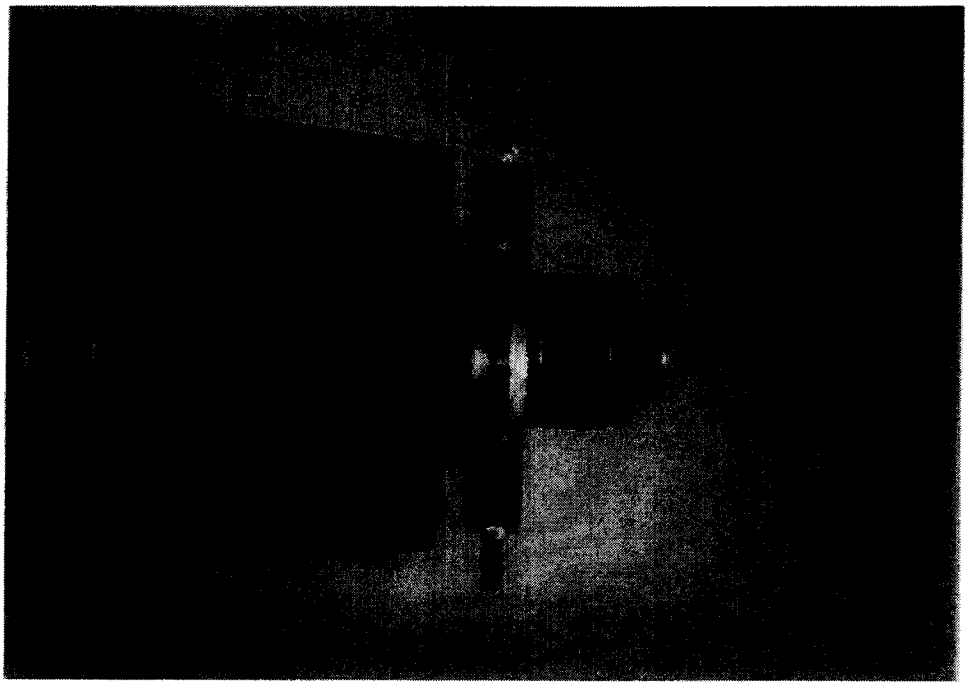


Figure 4.13: Sprocket mounted to drill spindle using Trantorque coupling

Numatics Air Valve

The double acting solenoid valve has two solenoids. Exciting either solenoid pulls the valve into its corresponding state. Wiring the valve with two diodes per Fig 4.14 will allow you to use the relay board outputs to control it in both states with only one channel.

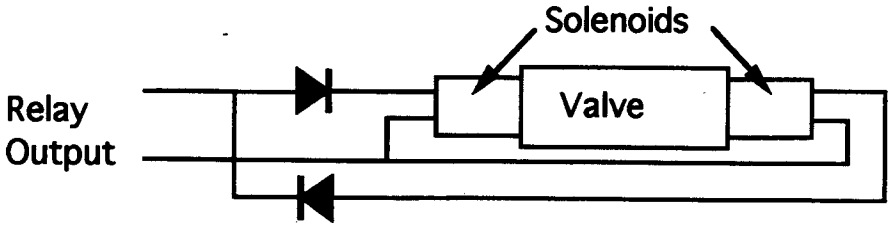


Figure 4.14

4.7 Batteries & Chargers

The battery chargers use a temperature sensor to terminate charging. A warm battery must be allowed to cool before the charger will begin 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 will cause serious damage to the battery, which may leak toxic liquid as a result.

Be careful to avoid shorting the batteries. Short-circuit current exceeds 100A and can cause fire, serious injury, and leakage of toxic materials. If you have a battery that you know to be damaged, please do not put it in the trash. Turn it in to us and tell us that it is damaged, so we can recycle it properly.

Freshly charged batteries will be provided at the competition for teams who have not had time to charge a pair fully for their next match. The best strategy when working in the pit is to trade one set of batteries at the U.S. FIRST charging station for a fresh set a few minutes prior to your next match and "top them off" with your own charger. Use the other set for testing in the pit.

Two batteries with an average load of 10A each will run for at least five minutes. Figure 5.11 shows the voltage of one fully charged battery as a function of discharge current.

Do not alter the battery boxes. You may mount battery boxes to your machine using 1/4"-20 screws, which will fit tightly into the holes on the bottom of the battery box.

5. ADMINISTRATIVE DETAILS

5.1 How to contact U.S. FIRST

U.S. FIRST Can be reached via phone, fax, mail, email, or the Competition BBS.

Mailing Address and Telephone/Fax Numbers

U.S. FIRST

340 Commercial Street

Manchester, NH 03101

603-666-3906

603-666-3907 (fax)

Technical And Judicial Hotline

If at any point in the design process you run into technical difficulties or need clarification of any of the rules, please contact:

Eric Rasmussen

ear@usfirst.org

All questions and answers about the rules will be made public in a periodic series of faxes to the teams, and on posts to the BBS. However, the identity of teams submitting the questions will not be made public unless they are posted by the team on the BBS.

Administrative Questions or Concerns

Sally Washburn	or	Susan Howland
sally@usfirst.org		howland@usfirst.org

Sponsorship Questions or Concerns:

Susan Howland	or	Dia Stolnitz
howland@usfirst.org		dia@usfirst.org

U.S. FIRST BBS

U.S. FIRST has established a computer bulletin board system which will be on-line for the duration of the 1996 Competition. The BBS is intended to serve as a means of encouraging information exchange among teams and U.S. FIRST staff, and is not intended for use by the general public. Items such as travel arrangements, rule clarifications or technical questions and answers will be posted there.

The U.S. FIRST BBS can be reached by modem at 603-666-5431 or by Telnet to usfirst.org on the Internet. Modem users should set their connection to 8 bit, no parity, 1 stop bit, and use either VT100 or ANSI terminal emulation. Currently, the maximum modem speed supported is 14,4k baud. However, we hope to upgrade this to 28.8k real soon now.

To setup an account on the BBS, connect via modem or Telnet and follow the instructions at the login prompt. If you experience any problems, please contact Eric Rasmussen.

5.2 U.S. FIRST Web Site

U.S. FIRST has a site on the World Wide Web. You can visit us at http://www.usfirst.org. This site is intended to provide information about U.S. FIRST to the general public. As such, it will not provide rules updates or other information intended for teams only.

The web site also provides links to home pages setup by Teams involved in the U.S. FIRST Competition. If you have a web page that is not listed, please send email to webmaster@usfirst.org.

5.3 New England Tournament 3/28-3/30

Location

The New England Tournament will be held at New Hampshire College. The full address is:

New Hampshire College
2500 North River Road
Manchester, NH 03104

Hotels

Below are some suggestions on where to stay if you will need overnight accommodations for the New England Tournament.

Crowne Plaza -
2 Somerset Parkway
Nashua, NH 03063
603-886-1200
$68 up to quad occupancy
Cut off 3/1/96

Nashua Marriott Hotel
2200 Southwood Drive
Nashua, NH 03063
603-880-9100
$67 single/double
Cut off 3/6/96

Days Hotel/Manchester
55 John E. Devine Drive
Manchester, NH 03103
603-668-6110
$59 single/double/triple/quad
Cut off 3/11/96

Sheraton Tara Wayfarer Inn
121 South River Road
Bedford, NH 03110
603-622-3766
$74 single/double
Cut off 2/27/96

Highlander Hotel
200 Highlander Way
Manchester, NH 03103
800-548-9248
$75 single
Cut off 3/18/96

Suisse Chalet
860 Porter Street
Manchester, NH 03101
800-524-2538
$49.70 single/double
Cut off 3/6/96

Please note that all rooms are first come, first served. The rates quoted here can only be guaranteed until the "cut off date" listed for each facility.

5.4 National Championship 4/18 - 4/20

The National Championship will be held at Walt Disney World's Epcot Center. For directions and information about overnight accommodations, please see appendix H.

5.5 Schedule of Events

New England Tournament

Day 1	•	team arrival, Registration and Practice, Official Weigh-in
	•	U.S. FIRST final field and technical check
Day 2	•	Seeding Matches
	•	Celebration Party (following seeding matches)
Day 3	•	Double Elimination Tournament & Finals
	•	Awards Ceremony

National Championship

Day 1	team arrival, Registration and Practice, Official Weigh-in
	U.S. FIRST final field and technical check
Day 2	Seeding Matches at American Gardens Stage
Day 3	Double Elimination Tournament & Finals
	Awards Ceremony at Innoventions Fountain
	Wrap Party at Future World West

Registration

At each event, teams will need to register in the Pit Area by noon on the first day, or Practice Day, of the event. At this time you will:

- surrender both of your RNETs and two of your batteries
- sign-up for your practice times
- receive an orientation packet to the event site and your pit station
- inform U.S. FIRST where the machine will be after the Competition. See Section #, *Administrative Details*, for more details.

Once you have unpacked, a U.S. FIRST staff member will be around to photograph your machine. These photographs will be used by the judges, referees and event staff to identify teams and their machines while on-site at the event.

Practice

In order to make the most of practice time, two fields run at the same time with three teams on a field during an assigned practice slot. It is strongly recommended that each team is respectful of the others sharing the field during this time. Friendly interaction between

machines is acceptable if both/all teams are willing. Unsportsmanlike conduct on the part of a team at any time during the Competition could result in penalty or disqualification.

Everyone will receive at least two half-hour practice slots based on the time you register. The earlier you check-in, the earlier your practice times will be. If additional time is available, an announcement will be made and one additional time slot per team will be assigned on a first-come, first-served basis.

If you need to change a practice slot because of the need for additional prep or repair time, you will be responsible for finding a team with which to switch practice. The staff in the Pit Area will help you locate a team; however, if you cannot arrange the change, that practice slot may be forfeited.

Practice days are:

New England Tournament	afternoon	Thursday, March 28, 1996
National Championship	afternoon	Thursday, April 18, 1996

Official Inspection

Before competing in the Seeding Matches, every machine must pass an inspection for rules compliance. U.S. FIRST staff will be on-site all day to inspect your machine.

Seeding Matches

Each team will compete between 4 and 6 times, and will accumulate points towards its seeding rank. Since these matches are pre-set, lists will be distributed to each team during the practice day. From each match, based on the score the winner will receive 3 seeding points, second place will receive 1 seeding point and the third place will receive no points.

After all matches, teams will be ranked by place totals (not points); ties will be determined by total score, last match score, and flip of a coin, in that order. Results of seeding will determine the first round matches of Saturday's competition.

Seeding matches are on:

New England Tournament	all day	Friday, March 29, 1996
National Championship	all day	Friday, April 19, 1996

Double Elimination Tournament & Finals

Each team will start off in the double-elimination tree according to their seed. The winning team advances to the next round, and the losing teams move to the losing bracket. Every team will be able to lose at least two matches before being eliminated. Competition concludes when there are only four teams left.

The Finals follow the Double Elimination Tournament. The final four will play 1-on-1, best 2-of-3.

Tournament and Final matches are on:

New England Tournament	all day	Saturday, March 30, 1996
National Championship	all day	Saturday, April 20, 1996

Shipping Deadlines

To provide every team, regardless of events in which they participate, approximately the same number of design and build days, the following shipping regulations and dates apply:

New England Tournament (Manchester, NH) Competitors

1. Teams may either ship or bring their machines with them to the tournament.

2. After the tournament, all teams competing in the National Championship will have five days to make repairs and/or changes to their machines, within all rules outlined in this document.
3. **By end-of-business on Friday, April 5,** machines must be picked up by a shipper for transport. This will give all New England teams five additional days to work on their machines.

National Championship participants only

1. Teams must ship their machines by end-of-business on Tuesday, April 2, 1996.
2. This will give all teams competing in only the National Championship an equal number of days to work on their machines as teams competing in both events.

5.6 Submission Deadlines

Team Profiles

U.S. FIRST will publish short profiles on each team in the event programs. By **Friday, March 8, 1996** please send or fax us your profile--you may use the following questions as guidelines when you write your description. Please keep in mind that we are on a deadline and that late submissions run the risk of not being included.

Important: please spell out the following as you would like them printed:

Company/University:

School(s):

Team and/or vehicle nickname:

You may send us a copy of your team logo (black & white, camera-ready if possible, no larger than 8 1/2 x 11)

1) How many students and engineers are involved in your effort? How is it organized?
2) What is unique about your team?
3) Give a brief history of how your team has gone about working on the project.
4) Describe any special aspects of your design or intended design that you want the event audience to appreciate (this will remain confidential until the first day of the competition).

This is your team's chance to tell the world who you are and what makes you great. Team profiles should be 200 words or less. Please review pages 11-19 of the 1995 national event program for a look at team submissions for Ramp 'n' Roll.

Chairman's Award Materials

Must be received at the U.S. FIRST OFFICE NO LATER THAN 5:00 PM ON WEDNESDAY, MARCH 27, 1996.

5.7 Shipping & Transportation of Machines

Shipping & Transportation of Machines

UPS is offering complimentary shipping via 2nd Day Air service. Machines shipped to the National Championship must leave your facility by the end-of-business on the dates outlined above. Remember, however, you do not need to go the expense of rush shipments--there are approximately two weeks between events.

1. All machines competing in the National Championship must be shipped to Freeman Decorating, 2300 Principle Row, Orlando, FL 32837-8337, ATTN: U.S. FIRST (Epcot). The phone number is (407) 857-1500.
2. When shipping, batteries must be unplugged and packaged separately from the rest of the machine. A small box inside of your crate is acceptable. This is a federal law.
3. For packages weighing under 70 pounds, corrugated, double wall cardboard of at least 200 pounds bursting strength is required. For packages between 100 and 120 pounds, 275 pound bursting strength is required. For packages between 120 and 150 pounds, 500 pound bursting strength is required. Wood crates should only be utilized if the machine can be bolted to the wood and there are no moving pieces inside the crate. Wood crates should also have handles screwed to the outside to ease lifting. It is recommended that a duplicate address label be placed inside each box before being sealed. Florida is a humid state and moisture could be a concern to moisture sensitive equipment. Please take necessary precautions.
4. The machines may not leave a Competition event site until the conclusion of the that event. If repairs are required, they must be performed on site, unless accompanied by a U.S. FIRST staff member to an off-site designated machine shop.

UPS Packaging Guidelines

1. Weight limit — 150 pounds per package
2. Size limit — Up to 130 inches in length & girth combined
   Up to 108 inches in length

(Girth is the perimeter in the plane perpendicular to the longest dimension.)

3. Follow the guidelines in the "Package With Care" brochure.

You can get your package to UPS in one of several ways:

1. Drop off at any UPS facility.
2. Drop off at a UPS Authorized Shipping Outlet such as Mail Boxes, Etc. or Pak Mail.
3. Call 1-800-PICK-UPS (1-800-742-5877) to arrange for a pick up.
4. Schedule a pick up through on line services such as Prodigy (JUMP UPS) or CompuServe (GO UPS). Visit the UPS home page at: http://www.ups.com to track your package and get information on UPS services.

Call 1-800-PICK-UPS for the location of the nearest UPS facility or Authorized Shipping Outlet.

5.8 Before You Come to the Competition

Pit Area

Each team will have a table and power outlet in the pit area. We suggest you bring an extension cord (heavy duty and at least 25') and a power strip to make best use of your power drop. Machines which have been shipped to the Competition site will be delivered to your station; otherwise, you will be responsible for bringing your machine there.

No team displays or team/personal audio systems will be allowed in the Pit Area. U.S. FIRST staff make frequent important announcements which all teams need to hear.

U.S. FIRST reserves the right to limit the number of team members in the pit area. If the pit area may becomes too crowded for machines and teams to safely and quickly move back and forth the to the field, we will request that some team members leave the area. In the event that additional assistance from another team member is necessary, let us know.

Warm Clothing

If your team attends the New England Tournament, please be sure to bring warm clothing. New England weather can be unpredictable and it is often very cold. There may be snow and ice on the ground. It is strongly recommended that you bring warm gloves, boots, hats and jackets.

5.9 Before You Leave the Competition

Return Unused Kit Parts and the Kit Container

Before you leave the Competition for the final time, please return your **unused** kit parts and the kit container to the Pit Registration Area. We must recycle some of these parts and we use the containers from year-to-year. Thanks, in advance, for your help with this.

Take your Machine home

U.S. FIRST encourages teams to take their machines back home with them. U.S. FIRST robots have appeared in pep rallies, parades, corporate annual meetings and even anti-gang assemblies!

Return the Control System

If you would like to take your machine back for educational, display or recruiting purposes, let us know prior to the last event you will be attending. At that time, you will be asked to provide U.S. FIRST with a deposit of $1,500 which will cover the lending of a remote control system that can be picked up after the Competition (since RNETs will be confiscated). The control system remains the property of U.S. FIRST and the $1,500 deposit is to cover possible damage to the control system. Your deposit will be returned once we receive the control system back. This deposit can be a check or purchase order which will be held until the return of the system. At that time the deposit will be canceled and returned to you. The U.S. FIRST control systems is not for sale.

APPENDIX B - COMPLETE LIST OF RULES

T1. Referees have ultimate authority during the competition--their rulings are final.

T2. If a machine is disqualified by a referee, that machine is turned off for the remainder of the match, and any points scored during that match will be forfeited.

T3. If a machine is disabled by a referee, that machine is turned off for the remainder of the match, and any points scored during that match will count.

T4. A machine may not win a match through an advantage gained by breaking a rule, even accidentally. The effect of the infraction on the outcome will be decided by the referees.

T5. Strategies aimed solely at the destruction, damage, or entanglement of opponents' machines are not in the spirit of the tournament and will not be allowed. Turning over an opponent's machine is not considered damaging and will be allowed, but stabbing, cutting, etc., is illegal. If a breach of this rule occurs the contestant's control system may be disabled by the referees.

T6. Limited amounts of machine shoving will be allowed; however, if you damage opponents' machines, referees may take action against your team. Possible actions include, but are not limited to; stopping the match to allow the damaged machine to be repaired before resuming play, a complete rematch after repairs have been made, or disqualification of your machine and forfeiture of any points scored.

T7. If a team's machine is damaged to the point that it cannot complete a round on a fair basis, that team may be eligible for a rematch. This decision will be up to the referees.

T8. If one team intentionally damages another team's machine, it may result in disqualification. However, if the damaged team's machine is considered too flimsy to begin with, the other team may not be disqualified. The ultimate determination will be with the referees.

T9. The playing field carpet will be directly on the floor.

T10. Deliberately damaging the playing field, controls, or balls (using spiked wheels, for example) is strictly illegal and may result in disqualification.

T11. A machine may not intentionally contaminate the playing field, balls, goal, or another machine with lubricants.

T12. After a match, team member are not allowed on the playing field until referees have completed the scoring procedure.

T13. The fence is a safety feature, not part of the playing field. Therefore, no part of any machine may react against it.

T14. No remote communication devices, such as air phones, walkie-talkies, cellular phones, etc., may be used by teams during a match.

T15. During the tournament, teams will be notified of their field positions at least two minutes prior to the start of their match in the staging area. Teams will be allowed a maximum of one minute to set up their machines on the field and a maximum of one minute to remove all machine parts from the playing field following a match. You will have at least 4 minutes before your next scheduled match.

T16. If a team is not ready to setup their machine on the field, and the two minute notification period is about to expire, and they do not wish to forfeit the match, then they must call a time-out. Each team may take up to 10 minutes (cumulative) of time-outs during the double-elimination rounds. The duration of a single time-out

may not exceed 5 minutes. If a machine is still not ready at the end of the time-out period, the team will forfeit the match.

T17. During the finals matches (quarter-finals on), each team may take up to 10 minute (cumulative) of time-outs which can be used to delay the start of a match if their machine is not ready. The duration of a single time-out may not exceed 5 minutes. Unused time-out time from the double elimination matches is lost.

T18. At the start of each match, machines may be placed in any orientation within the designated starting area, without touching other machines, the 4x4 boundary, or the fence

T19. If, in an attempt to remove an opponent's balls from the field, a part of your machine drops out-of-bounds, your machine will be disabled. Any points scored will count.

T20. If a machines goes out-of-bounds to the point that it has to apply power to any out-of-bounds surface to rejoin play, its control system will be disabled. Any points scored will count.

T21. If one team intentionally moves another machine out-of-bounds, the machine out-of-bounds will be disabled for the remainder of the match. Points scored will count.

T22. Balls which are knocked out-of-bounds or popped will be placed back in play next to the fence near the exit point without undue delay. Additional balls will be available for substitution.

T23. It is not the responsibility of the referees if they damage trapping devices while attempting to retrieve balls. Please design your machine so that balls may be retrieved quickly and easily after a match is over.

T24. **We strongly encourage you to develop and wear team uniforms, including identifying hats and t-shirts that display company and high school team names and/or logos. This will help the audience, announcers, judges and spectators identify you and your machine.**

P1. Machines will start at equidistant locations, midway along the length of the playing field borders, as shown in Figures 1 & 2.

P2. Each team will start with 8 small balls on the playing field and 4 small balls on the ramp of the player station. The small balls on the field will be arranged in clusters as shown in Figures 1 & 2. The clusters will be distributed at equidistant locations around the central goal at a distance of 4 feet from the flat side of the base of the goal.

P3. Each team will start with 1 large ball on the side of the goal and 1 large ball on the playing field. The large balls on the goal will start atop the three triangular frames on the upper portion of the central goal. The large balls on the surface of the playing field will be distributed at equidistant locations around the central goal at a distance of 4 feet from the flat side of the base of the goal, as shown in Figures 1 & 2.

P4. Each match will last for two minutes. It will begin when the control system is enabled and end when it is disabled, unless whistled dead by the referees.

P5. Final scoring will begin when all balls come to rest or upon a referees' decision. Students and coaches will not be allowed onto the field until all scoring is complete.

P6. Upon reaching the scoring stage, each small ball in or above the central hexagonal area of the goal is worth 3 points for the owner. Each large ball in or above the central hexagonal area of the goal is worth 10 points for the owner. Each large ball on or above the triangular frames at the three corners of the goal is worth 5 points for

the owner. Ball position will be determined by the geometric center of the ball as estimated by the referees.

P7. The winner of each match is the team with the highest score. Ties will be won by the team owning the higher large ball in or above the hexagonal portion of the goal. If all teams that are tied have no large ball in or above the hexagonal portion of the goal, the tie will be won by the team with the large ball closer to the center of the field.

P8. During a match, five members per team (two "drivers", two "coaches", and one "player") are allowed in the designated areas next to the field. Operator badges will be supplied by U.S. FIRST at each event and must be worn by these team members for field access. Of these five team members, at least three must be students from team partner pre-college school(s).

P9. During a match, machines must be operated from the team operator area next to the field by two students from the pre-college team partner school(s). The coaches must also remain within the team operator area during the match.

P10. Each team will be allowed to use one human player. Human players will be stationed at equidistant locations just outside the perimeter of the playing field, as shown in Figure 1 & 2.

P11. The player must be a student from a pre-college team partner school, and must sit at the player station during the match.

P12. Human players will be secured at each station by a seat-belt-like strap.

P13. A human player may remove balls from the playing field by passing them over or under the horizontal bar at the player station, or around the outside of the vertical posts. A human player may also catch flying or bouncing balls.

P14. If a human player returns a ball to the playing field by passing it under the horizontal bar, or after the end of the match, it will result in disqualification for the match, and any points scored by the team will be forfeited.

P15. A human player may choose not to return balls to the playing field. However, any balls which leave the player's station, such as by rolling off the side, will be returned to the playing field near the player's station without undue delay.

P16. For safety reasons, the player stations are not considered part of the playing field for the machines. Machines may not drive onto the ramps at the front of any player station, nor may they attempt to retrieve balls from any player station. Any machine which does so will be disabled. Any points scored will count.

P17. For safety reasons, no part of a machine may pass through, around, or over the PVC posts at each player station or in any way touch the human players. If this occurs due to an intentional act, the machine causing the safety hazard will be disqualified and any points scored will be forfeited. If this occurs by accident, the machine causing the safety hazard will be disabled, and any points scored will count. The referees will decide whether the violation was intentional or an accident.

P18. For safety reasons, no machine may launch a projectile of any sort, including balls, toward the player station or team drivers and coaches, with the one exception noted below. If this occurs due to an intentional act, the team causing the safety hazard will be disqualified and any points scored will be forfeited. If this occurs by accident, the machine causing the safety hazard will be disabled, and any points scored will count. The referees will decide whether the violation was intentional or an accident.

- It is acceptable for a machine to launch balls, but no other types of projectiles, toward the player station assigned to the same team as the machine.

P19. For safety reasons, no player may intentionally touch any machine. If this happens, the player's team will be disqualified and any points scored will be forfeited.

P20. All field dimensions shown in Figures 1 through 6 are ± 1" non-cumulative. The large balls have a diameter of 24" ± 2". The small balls have a diameter of 8" ± 1". Both types of balls will be inflated to size, not pressure.

S1. Safety first. Due to the nature of the event in which electrical equipment, springs and tools are used, safety will not be compromised.

S2. Any machine which is determined to be a safety hazard by the referees at any time during the Competition must be sufficiently modified to the referees' satisfaction or it will be disqualified and not allowed to compete.

S3. No energy stored in a rubber band may be used to launch any projectile. This does not apply to the latex tubing provided in the kit. However, competition balls are the only projectiles the latex tubing may be used to launch.

S4. Projectiles must have a frontal area greater than or equal to 10 square inches and be shaped to avoid eye injury.

S5. Do not tamper with the power supply, batteries, chargers, battery boxes, joysticks, or any other control system component except as noted in the control system rules. Tampering could result in failure or malfunction of the control system.

S6. Safety glasses must be worn by all team members in the team boxes and player stations during matches, and in the pit area when working on machines. They are also highly recommended if your neighbor(s) in the pit are working on their machine.

S7. Remove batteries from the holders while making adjustments to your machine. Due to the strength of the motors in the kit, it is important to keep fingers away from the gears while your machine is connected to a power supply.

S8. The batteries may deliver more than 100 Amperes. Do not let the wires come into contact with any metal surfaces. Route wires carefully to avoid damage and short circuits, which may cause serious burns and/or fire.

M1. The energy used by the machines in the Competition must come solely from:

- electrical energy derived from the onboard battery packs
- storage achieved by deformation of springs or the latex tubing provided in the kit
- compressed air (or vacuum) stored in the air accumulator
- a change in the altitude of the device's center of gravity.

M2. Machines must fit, unconstrained, inside a 36" cube with one face of the cube flat on the surface of the playing field. The weight of the machine including batteries may not exceed 120.0 pounds.

Size ≤ 36" x 36" x 36"; Weight ≤ 120.0 pounds

Although UPS offers complimentary shipment of machines to and from competition sites, they will not ship packages as large as a full machine. Many teams have found it helpful to make ease of disassembly and reassembly one of the design goals.

M3. All machines will be weighed and measured during the practice day at each Competition event and may be re-inspected anytime during an event. If modifications to your machine are necessary to meet the above requirements, they must be completed before seeding matches begin.

M4. **Teams are expected to design and build machines to withstand vigorous amounts of interaction with other machines.** *(See also rule T7.)*

M5. Until the controls are enabled at the beginning of each match, machines and any appendages, extensions or projectiles must remain unconstrained within the 36"x36"x36" starting size. Once a match begins, machines may extend beyond that limit under their own power.

M6. Machines must be designed to operate by reacting against the surface of the playing field, the innermost face of the curb, the goal, the balls, the other machines, and the air. *(See Section 2.2 for Field Diagrams.)*

M7. Machines must display their team company and school names and/or logos. The judges, referees, and announcers must be able to identify them by name.

M8. During a match, machines may be manipulated only by the normal operation of the wireless control system.

M9. Gaining traction by using adhesives or by damaging the surface of the playing field or the balls is not allowed.

M10. No substitute machines are permitted; however, functionally identical replacement parts are allowed.

M11. During any Competition event, any mechanism which will alter the operation of the machine may not be added or removed after the first match of the seeding rounds unless mandated by the judges for rule compliance reasons. *(See also Section 5.3.)*

M12. Only items listed under the PNEUMATICS section of the kit list may be used to store, generate, or transmit compressed air or vacuum, with the following exceptions:

- Suction cups may be fabricated from legal kit parts, as define in rule K1 below.
- Pneumatic fittings from Small Parts, Inc. may be used.

Custom-made pneumatic fittings, air cylinders, pumps, air accumulators, and so forth are not allowed, even if they are created from components included in the kits. Also, valves, syringes, tubing, and so forth from SPI or outside sources may not be used for pneumatics.

C1. The control system is provided to allow wireless control of the machines. The transmitter box, receiver/relay box, servos, speed controllers, RNETs, antennas, batteries, battery chargers, battery holders, power supply and joysticks may not be tampered with, modified, adjusted or marked in any way, with the following exceptions:

- the dip switches on the transmitter may be set for custom operation.
- the speed controllers may be calibrated as described in the Tekin REBEL Owner's Manual.
- 1/4" bolts may be used (as self-tapping screws) in the recesses of the battery holders.

Tampering includes drilling, cutting, machining, gluing, rewiring, etc. All items listed in Rule C1 must be mounted without alteration. Do not write on or otherwise mark control system components.

C2. Do not attach tape, stick-on hook & loop fasteners, glue, or other adhesives to control system components. We will re-use many of these components, and these items can be difficult to remove. Instead, use clamps, straps, or existing holes for mounting. The one exception to this rule is:

- Tape may be used to secure the position of the trimmers on the Joysticks in order to prevent accidental changes in calibration.

For mounting control system components, use mechanical fasteners, such as cable ties, straps, or brackets. Do not use tape, stick-on hook & loop fasteners, glue, or other adhesives.

C3. The black project box is intended to serve as a mounting point for the rocker switches and to enclose the associated wiring. You may modify the black project box in any manner to accommodate your needs. It may not be used on the vehicle.

C4. All motors and electrical devices connected to the receiver must be connected with the supplied wire and connectors.

- You must use 12 gauge wire for connections from the batteries to the speed controller and from the speed controller to the drill motor.
- You must use 16 gauge jacketed cable for connections to Delco seat motors, McCord-Winn air pumps and Numatics air valves.

C5. Do not tamper with the battery holder harness. You may not shorten the battery holder wires.

C6. The 12V batteries must be inserted directly into the battery holders. You may restrain them in their holders by means of straps, rubber bands, etc.

C7. RNETs may not be used in the Pit Area at any Competition event. A tether must be used for bench testing.

C8. The Milwaukee drill motors and Tekin speed controllers, if used on your machine, must be used together as sets. Drill motors may not be powered from the receive/relay boxes. Delco seat motors, McCord-Winn air pumps, Numatics air valves, and the fan may not be powered from the speed controllers.

C9. Two 0.1µF capacitors, included with each speed controller, must be installed in each drill motor as described in the Tekin REBEL Owner's Manual.

C10. One 20A circuit breaker (provided in the kit) must be installed in series with each drill motor. The circuit breaker must be accessible for inspection at each Competition event.

C11. Only the 9 volt power supply included with the kit should be used to power the transmit box. If you experience any problems with the 9 volt power supply, contact U.S. FIRST for a replacement. Use of an alternate power supply could damage the transmit box or RNET and is therefore prohibited.

C12. Do not connect power or any other signals to the switch inputs (P1, P2) on the relay board.

K1. Each machine must be constructed exclusively from materials provided in the Kit of Parts ("the kit") supplied by U.S. FIRST, with the following additions and exceptions:

- 2' x 4' x 1" ROHACELL ™ structural foam shipped to each team from the U.S. FIRST.
- Material available from outside sources, as explained below:

  Additional Hardware

  A specific list of materials and quantities is provided with the List of Components.

Small Parts, Inc. Catalog

Each team receives an account with a $425 credit balance which will be debited for the actual purchases you make. You may go beyond this dollar limitation for prototyping or to purchase spare parts, but your team is responsible for paying the balance on the account. See Rule K3 and the Appendix for more details on accounting and ordering.

Up to $425 worth of materials purchased from Small Parts, Inc. may appear on your final machine. You may use any component from the Small Parts catalog up to the $425 limitation.

Fasteners (rivets, screws, welds, nails, cable ties, etc.), washers, and adhesives are not included in your $425 limit on Small Parts Inc. equipment on your machine if used as fasteners.

It has been brought to our attention that the actual prices of components purchased from Small Parts, Inc. may not match the prices printed in the catalog. Please use the catalog prices when calculating the cost of machine components from SPI for compliance with the $425 limit.

If you use only a portion of what you buy from Small Parts, you may prorate the dollar amount used to the smallest quantity listed for purchase in the catalog. For example, if you buy 5' of rod which could have been purchased by the foot, but end up using only 6", you may calculate the amount used as the purchase price for one foot.

- Fasteners, washers and adhesives from outside the kit may be used for joining and fastening purposes only.
- Adhesive tape may be used only as an electrical insulator.
- Lubricants may be used only to reduce friction within your own device.
- The kit container, part packaging, and any documentation in the kit container may not be used to build the device.
- Teams may purchase as much shrink wrap tubing of any diameter as they wish. However, shrink wrap must be used for electrical insulation only. It may not be used as a fastener.

K2. Many of the materials in the kit are raw materials. They are intended to be used for manufacturing structural or mechanical parts for your machine.

K3. There is no restriction on the total amount of sprockets/pulleys and chain/belt on your machine, whether bought or machined from official Kit parts. However, there is a restriction on the amount which can be obtained from outside sources--see the *Additional Hardware List* and *Rule K4* for an explanation.

K4. Due to the high power output of the drill motors, each team may purchase from a source outside of the Official Kit of Parts (such as a bike shop or hardware store) additional sprockets (not gears) and/or pulleys and additional chain and/or belt, with the following conditions:

- On your final machine, you may use no more than a combined total of 4 sprockets and/or pulleys from outside sources.
- On your final machine, you may use no more than a combined total of 10' of chain and/or belt from outside sources. There are no restrictions regarding pitch or width of chain and/or belt. However, you may not purchase a wide belt, slice it lengthwise, and use more than a 10' length in the final machine.

- These components must be "commercially available," strictly *off-the-shelf* only. No custom or special orders.
- These components must be used in a power train. Power train is defined as components transmitting mechanical power to any of the vehicles' mechanisms, including propulsion, arms, projectiles, etc.

K5. Gears (not sprockets) may be obtained only by machining them from official Kit parts or by purchasing them from Small Parts.

K6. You may purchase one of the types of wood listed on the *Additional Hardware List*, in a 1/2" thickness with a total area of 4' x 4'. In addition, you may use any or all of the wood samples provided in the kit.

K7. Fasteners may not be used as structural members or power transmission components except as pins in a linkage or as hinge pins.

K8. Net material is allowed; however, if it is used to entangle opponents' machines, the referees may disallow it.

K9. You may only use "off-the-shelf" springs, such as compression, tension, torsion, constant force; spring washers; and, the latex tubing provided in the kit. Springs in addition to those provided in the kit may be purchased only from Small Parts, Inc. You may not fabricate your own.

K10. Pipe fittings (tees, reducers, elbows, and angles) may be purchased only to join pipe and may be used without limit in linking sections of these materials. Endcaps may also be used.

K11. A limited number of replacement parts will be made available by U.S. FIRST upon justified request. Otherwise, lost or damaged kit materials may be replaced only with identical components of the same material, dimensions and treatment at the team's cost.

K12. 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
- resin and hardener may be mixed to produce epoxy.

K13. The balls provided in the kit may not be used during any Competition event.

K14. All unused parts and materials must be returned to U.S. FIRST for proper recycling.

K15. The control system is the property of U.S. FIRST and certain components must be returned at the conclusion of the competition. The control system is not for sale. Teams wishing to borrow the control system for a limited amount of time after the competition may do so by following the procedures outlined in Section 5.5. For teams that wish to operate their machines after this period, U.S. FIRST can provide basic instructions on how to refit the machines to use off-the-shelf remote control systems.

APPENDIX C - AUTODESK ANIMATION COMPETITION

U.S. FIRST

February 9, 1996

Welcome to the challenge and excitement of the 1996 U.S. FIRST Competition. For the fourth year Autodesk, Inc. is pleased to support the values, attitudes and activities that surround U.S. FIRST.

As a registered team, you are already aware of the Autodesk educational software grants program open to school participants in this year's competition. In addition to the grants program, which provides a $650,000 contribution to your U.S. FIRST efforts, this year Autodesk sponsors a Pre-Kick-Off Technology Workshop on Friday February 9. During this workshop, you will have an opportunity to learn about specific Autodesk software products and collect tips 'n tricks from experienced instructors for incorporating Autodesk technology into this year's competition strategy, as well as into your classroom. You'll leave the technology workshop with new understanding, with print and video resources, and with information on how to get technical assistance as you charge along through the competition design, build, present, and test periods.

Over the past four years, we have attempted to bring value to both school and corporate participants in U.S. FIRST. We have worked to be thoughtful, creative and proactive in our support -- particularly support for students. And this year, we are enthused and proud to increase our support for U.S. FIRST by presenting the first Autodesk Judges Award For Excellence in Engineering Creativity and Communication. This award will be presented at the National Competition in April at Walt Disney World's EPCOT Center.

Attached you will find detailed guidelines about the Autodesk Award. Read them; follow them; and if you have any questions, contact Kaki Leyens, Autodesk, Inc. 415/507-6418.

Remember what U.S. FIRST is about: challenge, excellence, teamwork...and fun! We're glad to be able to support and share in what U.S. FIRST represents. Again, welcome to the '96 Competition. And good luck to you all.

U.S. FIRST • 340 Commercial Street • Manchester, New Hampshire 03101 • (603) 666-3906 • FAX (603) 666-3907

Autodesk.

1996 Autodesk Judges Award
for Excellence in Engineering Creativity and Communication

(known previously as the U.S. FIRST and Autodesk Image and Animation Celebration)

ENTRY RULES AND GUIDELINES

Competition Objective

To clearly and creatively present design solutions for the 1996 U.S. FIRST Competition problem through computer modeling and animation using industry standard software.

1. Entry Requirements

The Competition is open to all teams participating in the 1996 U.S. FIRST Competition. The Competition period is from February 10, 1996 to March 20, 1996.

All Entries (still image and animation) MUST be created using Autodesk software or Autodesk Registered Developer products. Limit one (1) submitted Entry per team. Each Entry (i.e. each image or animation submitted for judging in the contest) MUST be accompanied by its own separate and properly completed Official Competition Entry Form, which includes a signed release agreement for the image or animation entered.

Each individual contributor (collectively, the "Entrant") MUST be represented on the Official Competition Entry Form, including signing the Archive Consent and Release Authorization Form granting to Autodesk, its subsidiaries, associated companies, successor, assigns, agents and employees the right to use the drawing's, image's or animation's computer code, support files, documents or other electronic media files (collectively, the "Files") listed on the Consent Form.

If Entrant's corporate sponsor or school has any rights or claims to the image or animation in an Entry, the Entry Form also MUST be signed by an officer of such employer or parent company and school or the Entry will be disqualified. Entrant and, where applicable, Entrant's corporate sponsor and school represent and warrant that the image and animation in each Entry is owned by the Entrant and/or school and/or corporate sponsor free and clear of any liens or claims of any third party: that they have a legal right to grant the permission given in the Entry Form: and that they indemnify and hold harmless Autodesk, its subsidiaries, associated companies, successors, assigns, agents and employers against liability should any third party claim that the use of the image or animation by the aforementioned violates any right of such third party.

If proprietary information, logos or trademarks appear in an image or animation, Entrant MUST enclose written permission for use from the owner of the logos, trademarks or other proprietary material.

2. Responsibility

Autodesk is not responsible for Entries not delivered to Autodesk's San Rafael CA, office by the DEADLINE, March 20, 1996 (per item 5), or for any lost, late, misdirected, illegible, incomplete or damaged Entries.

3. Prizes and Prize Rules

One (1) U.S. FIRST Judges Award trophy will be presented to the team whose animation best represents the objectives of this competition category for Excellence in Engineering Creativity and Communication.

In addition to the Judges Award trophy, a *limited number* of student contributors on the winning team will receive a copy of Autodesk's 3D Studio® Release 4.

Autodesk reserves the right to substitute, at its sole discretion, another prize of equal or greater value for any prize described herein. No part of any prize is transferable. No substitutions of prizes is permitted except as expressly provided above.

The name of the winning team will be announced during the 1996 U.S. FIRST Competition Awards Ceremony. Software awards will be shipped directly to individual contributors following the competition.

4. Judging

Entries will be judged using criteria such as innovative and imaginative use of the software, story telling, uniqueness, composition, complexity, realism, color, proper use of lighting, and motion. Judging will be conducted by employees or consultants of Autodesk, it's subsidiaries or associated companies. The judges' decisions are final. Judges are not required to award prizes by default.

5. Deadline: 5 p.m., March 20, 1996

The enclosed Official Competition Entry Form and the Archive Consent and Release Authorization Form MUST be completely filled out and accompany your team Entry.

If posted, entry packages MUST be postmarked not later than March 15, 1996, and MUST be received at the Autodesk office in San Rafael, CA no later than 5 p.m. on March 20, 1996.

If delivered by third-party commercial services, or delivered to Autodesk offices other than San Rafael, entry packages MUST be handed over to the third party no later then March 15, 1996, and MUST be received at the Autodesk office in San Rafael, CA no later than 5 p.m. on March 20, 1996.

Hand delivered Entries will not be accepted after the deadline of 5 p.m. on March 20, 1996.

Direct all Entries to the following address:

Autodesk, Inc.
Marketing Support Team - Image Archives
111 McInnis Parkway
San Rafael, CA 94903
Attn: U.S. FIRST JUDGES AWARD

6. Entry Specifications

All submissions MUST be accompanied by a completed Official Competition Entry Form, including a properly signed Archive Consent and Release Authorization Form. All animation MUST also meet the technical specifications outlined below:

☑ Each Entry MUST include 10-15 seconds of animation.

☑ Each Entry MUST be accompanied a representative frame rendered at 1024 x 768 (or higher) and in true color (24 or 32 bit color).

☑ MUST be created using Autodesk or Autodesk Registered Developer software.

☑ MUST be accompanied by written permission from the owner(s) for use of any proprietary information, logos, or trademarks in your image or animation.

☑ Each submission (video, disk or hard-copy print) MUST be clearly labeled with the name of the file(s) submitted, the corporate sponsor, the school, and the name, daytime phone, email address and fax number of your school team's primary contact (please specify if student, instructor or corporate team lead).

Note: Entries will remain the property of Autodesk. No hard copies, digital files, video cassettes, or computer diskettes will be returned.

All Still Images:

☑ If Line Art, MUST be submitted in an Autodesk CAD file format (DWG, SKD or GCD).

☑ If Rendered, MUST be submitted in one of the following file formats: TGA, TIF, JPG. The required resolution is 2048 x 1536 (or higher) with 24 bits (or more) of color.

All Animation:

☑ MUST be submitted as video tape, and the animation MUST be one of the following tape formats: BETACAM SP; 3/4 inch; SVHS; Hi-8; or VHS tape in NTSC format.

☑ MUST include 10-15 seconds (maximum) 3D animation of the Entrant's competition robot.

☑ It is *recommended* that each Entry include the use of background such as scanned images, texture maps, or live video. We're planning to add music to the final video, but if you've already got a soundtrack on yours, please include it.

And:

☑ It is requested, *but not required*, that the Entry be accompanied by the source model(s), in DWG, 3DS, and/or PRJ file format, plus ALL texture maps necessary to re-render the model.

If the Entrant decides to accompany the Entry with the source model(s), all copyrighted geometry, textures, and IPAS, POCO or ADS applications that are required to reproduce an image or animation entry should be omitted from the Entry if the Entrant does not have the necessary rights to them or submitting them violates copyright agreements. The Entrant should, however, list all missing elements, describe where they are required in the image or animation and include information about where the elements can be obtained.

☑ If submitted in "compressed" format, the data MUST be retrievable using PKUNZIP.

☑ If not submitted on standard diskettes, the *requested* data should be submitted on one of the following preferred media:

Colorado tape (120 or 250)
Syquest (44 or 88)
Bernoulli disk (20 or 90)
Sun Unix TAR tape
CD ROM

Please reference your Autodesk Pre-Kickoff Workshop packet for technical support options available to you as an Autodesk grant recipient.

If you have any questions specifically regarding these Entry requirements, please contact Kaki Leyens, Autodesk, Inc. at (415) 507-6418 or fax (415) 507-6113.

Autodesk.

1996 Autodesk Judges Award
for Excellence in Engineering Creativity and Communication

OFFICIAL COMPETITION ENTRY FORM

Information provided on this Entry Form will be used in preparation of awards and other documents. Please record information as you wish it to appear on all documents. Please read the Contest Rules carefully before completing this Entry Form. All Entries MUST also be accompanied by the Archive Consent and Release Authorization Form.

Entry Deadline: No later than 5:00 P.M., March 20, 1996

Direct all Entries to the following address:

Autodesk, Inc.
Marketing Support Team - Image Archives
111 McInnis Parkway
San Rafael, CA 94903
Attn: U.S. FIRST - AUTODESK JUDGES AWARD

Entrant Information

Team Name: _____ Team Lead: _____

Corporate Sponsor(s): _____

School Name(s): _____

Primary Contact (school): _____

Address: _____

City, State, ZIP Code: _____

Daytime Telephone: _____ Fax: _____ Email: _____

Individual Student contributor(s) awards, if any, shall be awarded to the following (limit 5 per team):

	Name	Current Physical Address	City, State, ZIP Code	Telephone
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____
5.	_____	_____	_____	_____

Scope of the Project (team development, project development, description of the project's biggest obtstacle and how you resolved it)

_____

_____

_____

_____

_____

Still Image (in digital file format): [ ] 2D [ ] 3D [ ] line art [ ] wireframe [ ] rendered

File name: _____ File Format (see Rules, Item 6): _____ File

Resolution: _____

Created on (hardware) _____ with (Autodesk software/version) _____

Animation (in digital file format): [ ] 2D [ ] 3D [ ] line art [ ] wireframe [ ] rendered

File name: _____ File Format (see Rules, Item 6): _____ File

Resolution: _____

Created on (hardware) _____ with (Autodesk software/version) _____

Video Format (if applicable): Tape: [ ] BETACAM SP [ ] 3/4-inch [ ] SVHS [ ] Hi-8 [ ]VHS

TV Standard: [ ] NTSC [ ] PAL [ ] SECAM

APPENDIX D - SUPPLIER CONTACT INFO

Ms. Christine Gondek Air Logic 5102 Douglas Avenue Racine WI 53402-2097 Phone: 800-558-5950 Fax: 414-639-5996	Mr. David White Regional Sales Manager American Cylinder Co., Inc. 481 Governors Highway Peotone IL 60468 Phone: 708-258-3935 Fax: 708-258-3980
Mr. Jim Aaron Product Manager - Constant Force Springs Associated Spring Raymond P.O. Box 586 1705 Indianwood Circle Maumee OH 43537-0586 Phone: 1-800-458-0867 Fax: 419-891-9879	Ms. Kaki Leyens Autodesk, Inc. Education Department 111 McInnis Parkway San Rafael CA 94903 Phone: 415-507-6418 Fax: 415-507-6113
Mr. Stewart Schuster Brevan Electronics 6 Continental Blvd. Merrimack NH 03054 Phone: 603-429-1900 Fax: 603-429-1001	Ms. Alison Evans Director of Marketing Communications CH Products 970 Park Center Drive Vista CA 92083 Phone: 619-598-2518 Fax: 619-598-2524
Mr. Jim Klemko Delco Electronics Corporation MS 123 700 E. Firmin Street Kokomo IN 46905-9005 Phone: 317-451-3334 Fax: 317-451-3456	Mr. Brian Shaw Hitec RCD, Inc. Suite C 10729 Wheatlands Avenue Santee CA 92071 Phone: 800-669-4672 Fax: 619-449-1002
Lowell Medical Instrument Company, Inc. 55 Church Street, Central Plaza Lowell MA 01852 Phone: 508-459-6101 Fax: 508-454-8631	Mr. Dave Gattuso McCord Winn /Subsidiary of Textron, Inc. 645 Harvey Street Manchester NH 03103 Phone: 603-628-3740
Mr. Bruce Crystal Director of Sales McMaster-Carr Supply Co. 473 Ridge Rd., POB 317 Dayton NJ 08810 Phone: 908-329-6666 Fax: 908-329-3772	Mr. Curt Olsen Director of Marketing and Sales Microsemi Corporation - Scottsdale P.O. Box 1390 8700 East Thomas Road Scottsdale AZ 85252 Phone: 602-941-6300
Mr. John Rushmer Vice President of Engineering Milwaukee Electric Tool Corporation 13135 West Lisbon Road Brookfield WI 53005 Phone: 414-781-3600 Fax: 414-781-8518	Mr. Bob Parker Executive Vice President New Hampshire Industrial Suppliers 8030 South Willow Street P.O. Box 4925 Manchester NH 03108-4925 Phone: 800-244-1803 Fax: 603-626-3454

Mr. David Johnson Training Manager Numatics, Inc. 1450 North Milford Road Highland MI 48357 Phone: 810-887-4111x229 Fax: 810-887-9190	Mr. Charles Weilbrenner President PIAB 65 Sharp Street Hingham MA 02043 Phone: 617-337-6250 Fax: 617-337-8028
Mr. Richard Dutile President Plastic Supply Inc. 735 E. Industrial Park Drive Manchester NH 03109-5610 Phone: 603-669-2727	Mr. Karl Grubb Marketing Communications Planner Potter & Brumfield (A Siemens Company) 200 South Richland Creek Drive Princeton IN 47671-0001 Phone: 812-386-2316 Fax: 812-386-2072
Mr. Jeorg Hübl General Manager Richmond Aircraft Products 13503 Pumice Street Norwalk CA 90650 Phone: 310-404-2440 Fax: 310-404-9011	Mr. Shawn Brady Sales Manager Sanmina - New England 7 Perimeter Road Manchester NH 03103 Phone: 603-623-5775 Fax: 623-2874
Serco, Inc. 612 Commercial Ave Covine CA 91723 Phone: 818-331-0517 Fax: 818-331-8584	Mr. James Edgar Small Parts, Inc. 13980 NW 58th Court Miami Lakes FL 33014 Phone: 305-820-9371 Fax: 800-423-9009
Mr. Robert Kuczynski Snap-Action, Inc. 1260 Route 22 West Mountainside NJ 07092 Phone: 908-654-4380 Fax: 908-654-7322	Mr. Dave Jackson General Manager Sport Fun, Inc. P.O. Box 39150 4621 Sperry Street Los Angeles CA 90039-0150 Phone: 818-240-6700 Fax: 818-502-0399
Mr. Bob Tranfaglia District Sales Manager Sprague Air Controls 65 Sharp Street Hingham MA 02043 Phone: 800-451-1015x542 Fax: 617-331-9815	Mr. Tom Rooney Sprague Fluid Connectors 55 Sharp Street Hingham MA 02043 Phone: 800-451-1031 Fax: 617-335-7397
Mr. Grant McStay Stanley Hardware Division P.O. Box 1308 [H] New Britain CT 06050 Phone: 203-225-5111x55302 Fax: 203-827-5783	Mr. Kevin Orton President Tekin Electronics, Inc. 940 Calle Negocio San Clemente CA 92673-6201 Phone: 714-498-9518 Fax: 714-498-6339

Mr. Ted Rosinski Manager of Marketing Communications The Torrington Company 59 Field Street Torrington CT 06790 Phone: 203-482-9511 Fax: 203-496-3625	Mr. Al Nutter Sales Representative Totalmed 589 Elm Street Manchester, NH 03101 Phone: 603-624-0091 x452 Fax: 603-626-3440
Mr. Will Robertson United Parcel Service 3 Technology Park Londonderry NH 03053 Phone: 603-644-2749	Mr. Moe Cournoyer Customer Service Manager UVEX Safety, Inc. 10 Thurber Blvd Smithfield RI 02917 Phone: 401-232-1200 or 800-343-3411
Value Plastics, Inc. 3350 Eastbrook Drive Fort Collins CO 80525 Phone: 970-223-8306 Fax: 303-223-0953	

APPENDIX F - ORDERING FROM SMALL PARTS

THE 1996 U.S. FIRST ROBOTIC COMPETITION RULES

ORDERING PROCEDURE
FROM THE SMALL PARTS CATALOG

Telephone.....1-800-220-4242 or 305-557-8222
FAX.....1-800-423-9009

Once again, SMALL PARTS INC., has signed on as an Official Gold Supplier to the 1996 Kit of Parts. Their sponsorship is direct to you in the way of an account for each team with a beginning credit balance of $425. The final machine may not contain more than $425 worth of parts from the SMALL PARTS INC. Catalog 16.

If you require more than $425 in parts for prototyping and development of the machine, the balance will be billed directly to your team "Bill-To" (*see FAX form*). This year, SMALL PARTS INC. has also made credit card (AMEX, VISA & MC) billing available. To use Credit Card Billing :

a- If by ***FAX*** - check the box under "Bill-To" and provide the requested information;
b- If by Phone - provide the SMALL PARTS agent with the needed information.

To Place an order

Call or ***FAX*** to the numbers above and have the following information available:

1. TEAM NUMBER given to you at Kickoff Workshop;
2. Name of the TEAM MEMBER ordering;
3. SIP Part Number;
4. Quantity required (use the standard catalog quantities);
5. Complete shipping address, including the person's name receiving the shipment;
6. Daytime telephone number and ***FAX*** number.

If a part is temporarily out of stock

Upon receipt of your order, SMALL PARTS INC will immediately advise you, by ***FAX*** or by phone, when it will be available and provide you with the option of changing the size or part on your order.

To determine the shipping date of an order

1. Orders must be placed before 12:00 noon in your respective time zone;
2. Orders placed after 12:00 noon will be shipped the following business day.

To set the receive date of an Order

1. Second day delivery (excluding Saturday) via UPS Blue Label is complimentary
2. Overnight and Saturday delivery via UPS Red Label and/or Federal Express is available, *at an additional charge, billed directly to your team.*

SMALL PARTS INC.
13980 N.W. 58th Court
P.O. Box 4650
Miami Lakes, FL 33014
Fax: 1-800-423-9009 • Tel: 1-800-220-4242

FAX ORDER FORM

Team No.: _____

Team Member: _____

Day Telephone: _____ Fax: _____

BILL TO: (If Credit Card, fill below)

Company/Institution: _____

Contact: _____

Address: _____

_____

SHIP TO: (If different from BILL TO)

Company/Institution: _____

Contact: _____

Address: _____

_____

Credit Card Information:

☐ Amex ☐ MasterCard ☐ Visa Exp. Date: _____

Card No.: _____

Cardholder Name: _____

Billing Address: _____

_____

Shipping Method:

UPS ☐ BLUE Label (Complimentary) ☐ RED Label

FEDEX Acct. No. _____

☐ Priority Overnight ☐ Standard Ovenrnight

☐ **Saturday Delivery** (excludes UPS BLUE Label)

Qty.	Part Number	Description	Unit Price	Amount
			Total Amount	

APPENDIX G - CALENDAR OF EVENTS & DEADLINES

Hotel Cut Offs:

New England Tournament

Crowne Plaza	3/1/96
Days Hotel	3/11/96
Highlander Hotel	3/18/96
Nashua Marriott	3/6/96
Sheraton Tara	2/27/96
Suisse Chalet	3/6/96

National Championship

All Star Resort	3/17/96

Team logos .....5:00 pm, Friday 3/8/96 at U.S. FIRST
Team Profiles .....5:00 pm, Friday 3/8/96 at U.S. FIRST
Autodesk Award Submission.....5:00 pm, Wednesday 3/20/96 at Autodesk
Chairman's Award Submission.....5:00 pm, Wednesday 3/27/96 at U.S. FIRST
New England Tournament.....March 28-30, 1996
National Championship .....April 18-20, 1996

Ship Robots

Teams competing in National Championship only.....5:00 pm, Tuesday, 4/2/96
Teams competing in both Tournaments.....5:00 pm, Friday, 4/5/96

Shipping destination for robots to the New England Tournament is still to be determined and will be faxed in a team update by March 15, 1996. **Do not** ship to the same address as last year.

Send Team Profiles, Team Logos and Chairman's Award submission to:

U.S. FIRST
340 Commercial Street
Manchester, NH 03101

Send Animation Award Submission to:

Autodesk, Inc.
Marketing Support Team-Image Archives
111 McInnis Parkway
San Rafael, CA 94903
Attn: U.S. FIRST JUDGES AWARD

If you are participating the National Championship ship robot to:

Freeman Decorating
2300 Principal Row
Orlando, FL 32837-8337
ATTN: U.S. FIRST (Epcot)
Phone: 1-407-857-1500

APPENDIX H - NATIONAL CHAMPIONSHIP ACCOMMODATIONS

1996 U.S. FIRST
National Championship

Walt Disney World, Florida

Epcot

U.S. FIRST National Championship
Package Offering

Package Dates: April 17-21, 1996

Three (3) Night Packages

- Three (3) nights' accommodations at Disney's All-Star Sports Resort
- Three (3) days' admission to the Magic Kingdom, Epcot, and Disney-MGM Studios
- Three (3) breakfast coupons for use at Disney's All-Star Resorts Food Court locations
- Three (3) Theme Park counter service lunch coupons
- Unlimited use of our existing Transportation Systems
- One (1) commemorative T-Shirt per person

SINGLE	DOUBLE	TRIPLE	QUAD
$398.57	$267.04	$223.19	$201.27

Four (4) Night Packages

- Four (4) nights' accommodations at Disney's All-Star Sports Resort
- Four (4) days' admission to the Magic Kingdom, Epcot, and Disney-MGM Studios
- Four (4) breakfast coupons for use at Disney's All-Star Resorts Food Court locations
- Four (4) Theme Park counter service lunch coupons
- Unlimited use of our existing Transportation Systems
- One (1) commemorative T-Shirt per person

SINGLE	DOUBLE	TRIPLE	QUAD
$508.76	$333.38	$274.92	$245.69

U.S. FIRST National Championship

Package Offering Information

- Package rates are per person.
- Hotel space is subject to availability and will be reserved upon receipt of your signed agreement. Please make all checks payable to Walt Disney World, Co.
- Walt Disney World ticket media AND price subject to change.
- If the group is scheduled to depart the resort after 2:00 p.m. and does not have luggage storage capability, there will be an additional charge of $87.69 (per team) for storing the team's luggage at the resort until their final departure.
- The luggage service MUST be confirmed with Disney's Leisure Group Department at least SEVEN (7) days prior to the group's arrival at the resort.
- This hotel allows a maximum of four (4) guests to a room and is not connected to the WALT DISNEY WORLD MONORAIL system. CHECK-IN time is 3:00 p.m. and CHECK-OUT time is 11:00 a.m. Special room requests can be noted but not guaranteed.

U.S. FIRST National Championship
WDW Key Information

Group Reservations

- Reservations may begin on Monday, February 12, 1996.
- Please call or fax Monday through Friday, 8:30 AM to 5:00 PM.
  - Phone : 407-327-2989
  - Fax: 407-828-1582

Reservations Mailing Address:

Disney Leisure Groups
Walt Disney Company
ATTN: U.S. FIRST Event
P.O. Box 10,000
Lake Buena Vista , FL
32830-1000

U.S. FIRST Event Information

- General: 407-827-7600
  - Itinerary Information
  - Check-in Locations
  - Shipping of Equipment/Robots
  - Tickets/Credentials
  - Orientations Times and Locations
  - Transportation

Robot Shipping

Freeman Decorating
2300 Principle Row
Orlando, Florida
32837-8337
ATTN: U.S. FIRST (Epcot)
Phone: 1-407-857-1500

U.S. FIRST National Championship

Epcot Event Information

Team Representative Responsibilities

- Designate one (1) representative/contact per group
- Complete and return "Team Planning Sheet" at time of booking
- Coordinate all communications to Leisure Group Sales
- Sign and return Reservation Agreement
- Collect and send one (1) final payment by March 17, 1996
- Send a detailed rooming list with names, addresses, ages, arrivals and departures (airlines) of guests in the group
- Collect and send signed "Consent/Release" form for each individual team member

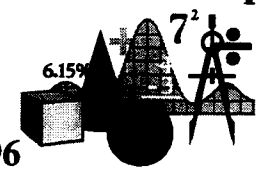
Group Hospitality (tent)

- Will be for U.S. FIRST guests exclusively
- Guests will be able to register and get event information
- Guests will receive packages with tickets and credentials at the hospitality location
- Event Orientations in hospitality location on April 17 and 18th
- Daily breakfast location at the Disney's All-Star Sports Resort
- Hospitality location will be open and staffed daily

Park and Competition Access

- All individuals must show a Park Admission Ticket daily to access the Park and/or competition
- All individuals must have a "Pit Access" pass for pit access (all backstage areas are restricted)

US FIRST National Robotics Competition



April 18-20, 1996

Team Planning Sheet

Team Information

Name of the Team (school) _____

Mailing Address _____

Company name (If affiliated)_____

Phone _____ Fax _____

How many students are on the team?_____Others? _____

Name of specific daily "hometown newspaper"_____

Please include any press release(s) or collateral about your team or school's participation.

Team Travel Arrangements

Will your entire team be traveling together?_____

Will you travel by air or ground transportation?_____

Do you plan to use a van or truck to move your equipment from the resort to the competition site?_____

Will your team be staying at a WDW Resort?_____Disney's All-Star?_____

Robotics Equipment Shipping Information

Description of Item _____

Please note if Package Contains Liquid or Explosives _____

Size of Item? How many? Shipper used?_____

Weight of Package (s)_____Number of crates_____

Climate Control Needs _____

Please Return This Information To:

Alan Devney
Walt Disney World Co.
Program Development
P.O. Box 10,000
Lake Buena Vista, FL 32830-1000

Phone: (407) 934-6735 Fax: (407) 828-2598

For Internal Use Only

Contacted	Shipping	# on Team	Arrival	Departure
			/	

Walt Disney World Co.

CONSENT, RELEASE, HOLD HARMLESS AND AUTHORIZATION TO REPRODUCE PHYSICAL LIKENESS

In consideration of the acceptance of my entry in the 1996 U.S. FIRST COMPETITION (the"Event") at the WALT DISNEY WORLD Resort on April 16-April 20, 1996, I agree to the following:

For Walt Disney World Co.'s photographing me and recording my likeness, voice, and sound and using my appearance at the Event and knowing Walt Disney World Co. will incur substantial expense in reliance upon this Consent, Release, Hold Harmless and Authorization To Reproduce Physical Likeness (the "Consent"), and for other good and valuable consideration, the adequacy and receipt of which is hereby acknowledged, I hereby grant to Walt Disney World Co. and its parent, related, affiliated and subsidiary companies, and their respective successors, affiliates, licensees and assigns, forever and throughout the world, the right to use these photographs and records of my likeness, voice and sounds during my appearance, and to reuse or license the right to reuse such photographs and recordings of my appearance, and my name, likeness and biography, as Walt Disney World Co. may desire, in all media and in all forms, without further compensation to me or any limitation whatsoever. Each such photograph and recording shall be a work for hire and Walt Disney World Co. shall be deemed the sole owner of any copyright and/or trademark rights therein (and all applications, registrations and renewals resulting therefrom). If, however, the work is deemed not to be a work made for hire by a court of competent jurisdiction, then this Agreement shall constitute an irrevocable assignment of the worldwide copyright in the work to Walt Disney World Co.

The undersigned being fully cognizant of the risks in participating in the Event, hereby assumes the risks of bodily injury (including death) and property damage, inherent in such participation. Except to the extent due to the negligence or intentional acts of Walt Disney World Co, or any of its parent, related, affiliated or subsidiary companies or any of the directors, officers, employees and agents of each, to the fullest extent permitted by applicable laws, I hereby waive any claims or causes of action which I may now or hereafter have against any of the aforementioned entities arising out of my participation, and I will indemnify and hold harmless each of them against any and all claims resulting from such participation.

I hereby release Walt Disney World Co. and its parent, related, affiliated and subsidiary companies, and their respective successors, affiliates, licensees and assigns and the directors, officers, employees and agents of each, from all claims, demands, liabilities, damages, costs and expenses (including attorneys' fees and expenses) that I may now or hereafter have against Walt Disney World Co. or them arising in connection with my appearance in the Event and Walt Disney World Co.'s exercise of rights hereby granted, including, without limitation, claims for compensation, defamation, or invasion of privacy, or other infringements or violations of personal or property rights of any sort whatsoever.

In the event I should sustain injuries or illness while a guest at the WALT DISNEY WORLD Resort, I hereby authorize Walt Disney World Co. to administer, or cause to be administered, such first aid or other treatment and medications I may bring as may be necessary under the circumstances, to include treatment by a physician or hospital of Walt Disney World Co's choice.

This Agreement shall be binding upon me and my heirs, personal representatives and assigns, and shall be governed by and construed under the laws of the State of Florida. Venue for any legal action arising out of or in connection with this Agreement shall be in Orange County, Florida, and jurisdiction shall be vested exclusively in the Circuit Court of the Ninth Judicial Circuit in and for Orange County, Florida, or, if appropriate, in the Federal District Court for the Middle District of Florida, Orlando Division. This Agreement constitutes the entire agreement among the parties hereto with respect to the subject matter of this Agreement and supersedes any and all previous agreements among the parties, whether written or oral, with respect to such subject matter.

_____ _____

Signature Date

Name: _____

Address: _____

Phone: _____

Age: _____ Sex: _____

Medical Restrictions/Medication: _____

For those under age 18:
I hereby consent and agree to the above as the Parent/Legal Guardian of _____ (in which case "I", "me" and "my" as used therein shall refer to said minor.)

_____

Parent or Legal Guardian

_____

Print Name