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# FIRST

## The COMPETITION

### 1997

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## The RULES

## 1. THE GAME

### 1.1 Game Description

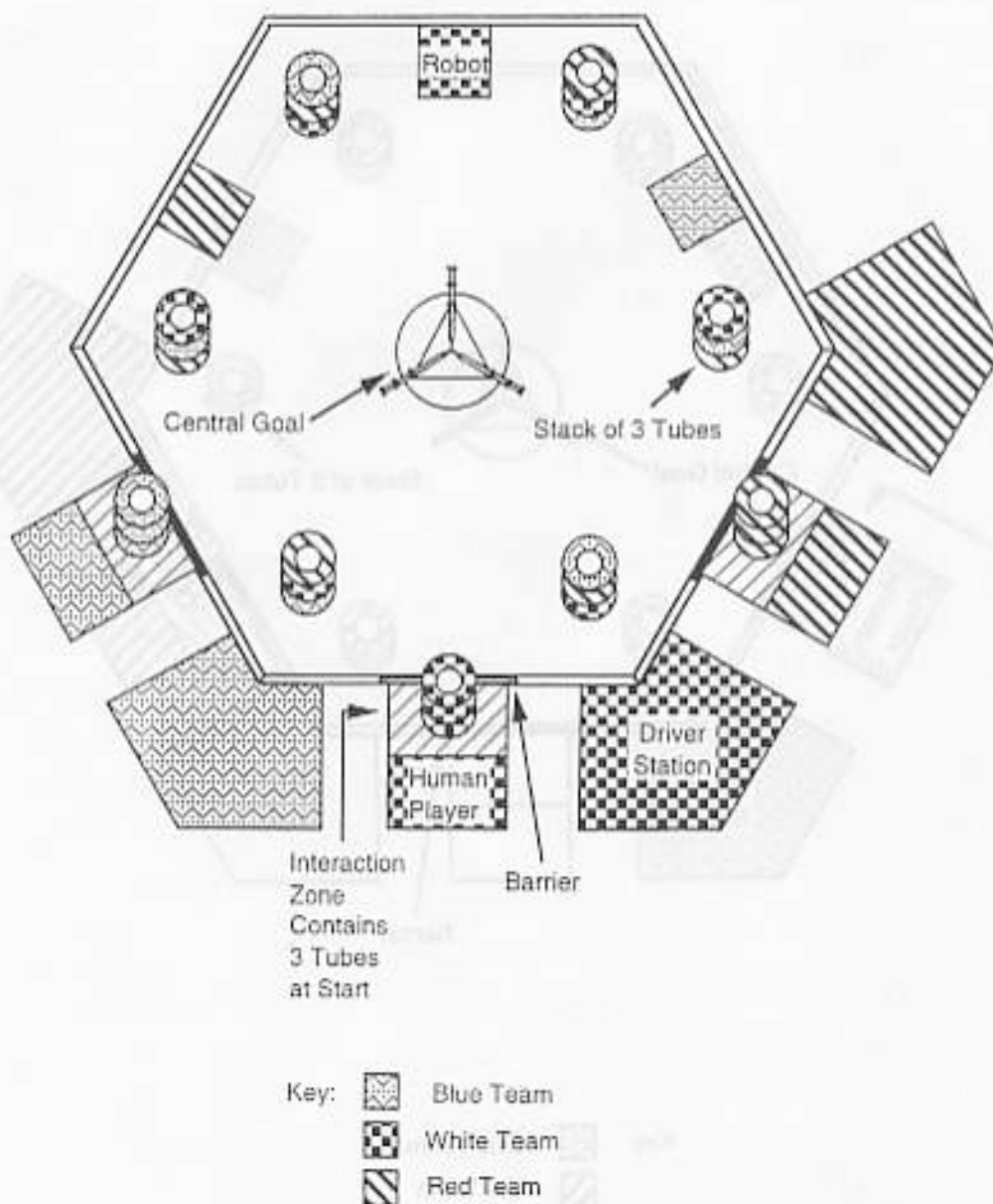
Teams must design and built robots to collect, transport, and lift inner tubes. In addition to a robot, each team will be allowed to use a human player to interact with the tubes. The robots will compete within a hexagon-shaped playing field with an 8 foot tall, freely-rotating central goal, while the players will be located at stations just outside the playing field. Starting locations of the tubes, robots, and players are shown in Figures 1.1 & 1.2. The goal will be given a spin by hand in a random direction at the start of each match.

Each team will have 9 tubes which can be placed on pegs on the central goal, or on or over the top of the central goal, to score points. The tubes will be color-coded to identify team ownership. Points will be awarded to teams with tubes located on pegs or on top of the goal at the conclusion of each two minute match.

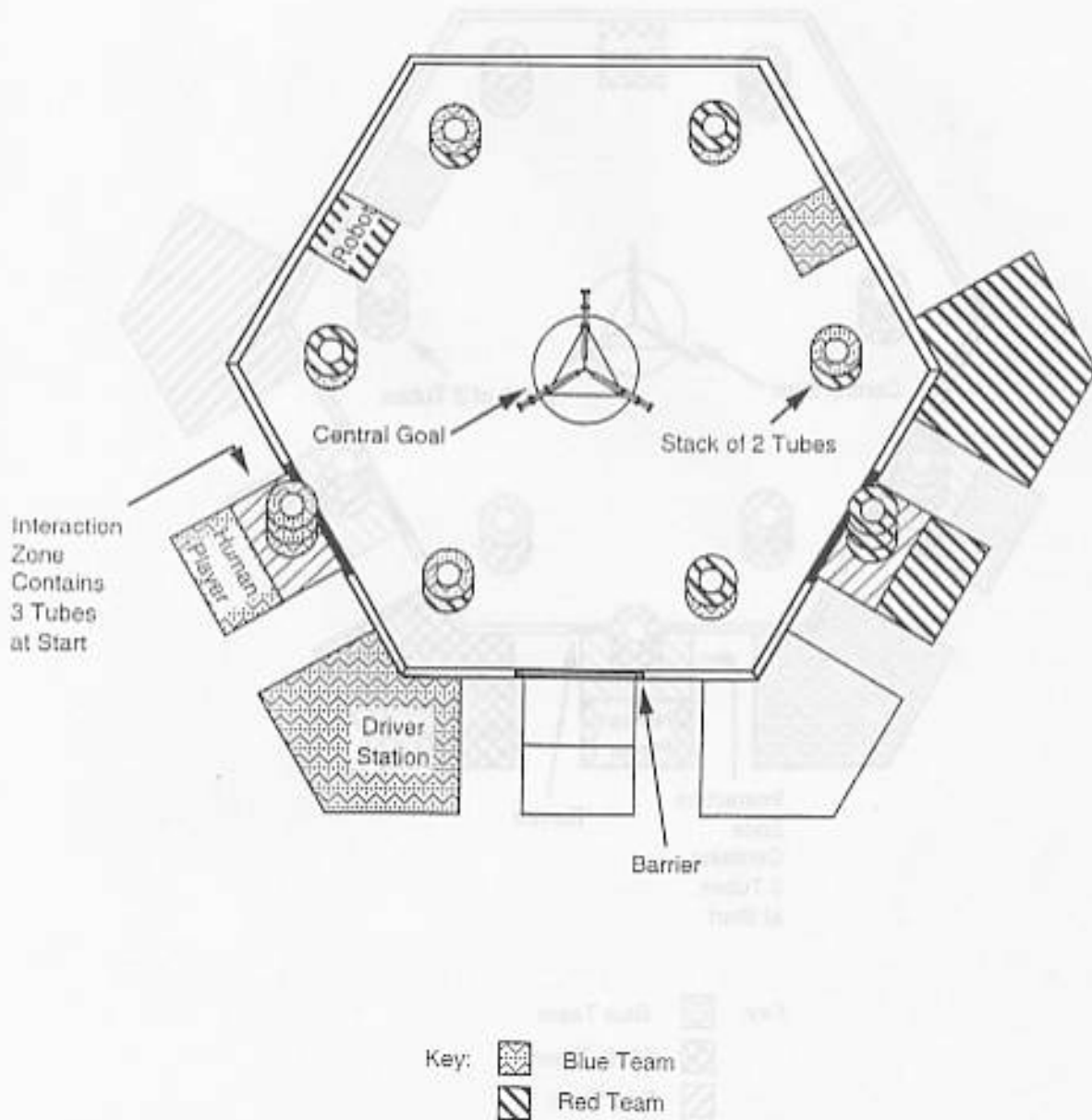
Each tube in a scoring position will be worth 1 point. In addition, certain configurations of tubes will double the score. Each tube on or over the top of the goal will double the score. For each set of 3 tubes that forms a vertical row on the pegs on a corner of the goal, the score will double. It is possible to have more than one row per corner, and rows on more than one corner.

The winner of a match is the team with the highest score. In the event of a tie, the team with the highest tube in a non-scoring position breaks the tie. If no non-scoring tubes are above the surface of the playing field, the non-scoring tube closest to the center of the base of the goal wins. If there are still any unresolved ties, the referees will flip a coin.

Playing Field - Top View  
 Seeding/Double Elimination Rounds  
 Figure 1.1



Playing Field - Top View  
 Seeding/Double Elimination Rounds  
 Figure 1.2



## 1.2 General Tournament Rules

(see complete list of rules in Appendix A)

- T1. Referees have ultimate authority during The Competition--their rulings are final.
- T2. If a team is disqualified by a referee, their robot is turned off for the remainder of the match, the human player must cease interacting with tubes at the player station, and any points scored during that match will be forfeited.
- T3. If a robot is disabled by a referee, the robot is turned off for the remainder of the match, and any points scored during that match will count. The human player may continue to interact with tubes at the player station.
- T4. A team 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' robots are not in the spirit of The Competition and will not be allowed. Turning over an opponent's robot 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. Robot shoving will be allowed and is expected to be quite common; however, if you damage opponents' robots, referees may take action against your team. Possible actions include, but are not limited to: stopping the match to allow the damaged robot to be repaired before resuming play, a complete rematch after repairs have been made, or disqualification of your team and forfeiture of any points scored.
- T7. If a team's robot 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 robot, it may result in disqualification. However, if the damaged team's robot is considered too flimsy to begin with, the other team may not be disqualified. The ultimate determination will be with the referees.
- T9. Deliberately damaging the playing field, controls, or tubes (using spiked wheels, for example) is strictly illegal and may result in disqualification.
- T10. If a robot damages the playing field, barriers, tubes, or another robot, even inadvertently, and the referees feel that further damage is likely to occur, the referees may decide that corrective measures (such as eliminating a sharp edge) are required to allow the robot to continue competing.
- T11. A robot may not intentionally contaminate the playing field, tubes, goal, or another robot with lubricants.

- T12. After a match, team members are not allowed on the playing field until referees have completed the scoring procedure.
- T13. The barriers in front of the player stations are safety features, not part of the playing field. Robots should not be designed to react against them. Incidental contact with the barriers is acceptable. Pushing a tube against a barrier to allow pickup of the tube is acceptable if the forces applied are not sufficient to damage the barrier or otherwise deform the playing field.
- T14. Robots which become entangled in the barriers or goal will not be freed until after the match has finished, unless the entanglement represents a safety hazard.
- T15. If a robot goes out-of-bounds to the point that it has to apply force to any out-of-bounds surface to rejoin play, its control system will be disabled.
- T16. If one team intentionally moves another robot out-of-bounds, the robot out-of-bounds will be disabled for the remainder of the match.
- T17. Tubes which are knocked out-of-bounds will be placed back into play next to the field border near the exit point without undue delay. Tubes returned to play will not be fed directly to a robot or human player.
- T18. Tubes which are popped will be replaced without undue delay. If a tube pops while being held by a robot, the referees may opt to pause the match and place the replacement tube in the hold of the robot.
- T19. It is not the responsibility of the referees if they damage trapping devices while attempting to retrieve tubes. Please design your robot so that tubes may be retrieved quickly and easily after a match is over.
- T20. No remote communication devices, such as air phones, walkie-talkies, cellular phones, etc., may be used by teams during a match. The wireless communications systems used by FIRST staff have been carefully checked to insure that they do not interfere with the robot control systems.
- T21. During The Competition, 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 robots on the field and a maximum of one minute to remove all robot parts from the playing field following a match. You will have at least 4 minutes before your next scheduled match.
- T22. If a team is not ready to setup their robot 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 inform the field coordinator that they are invoking 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 robot is still not ready at the end of the time-out period, the team will forfeit the match.
- T23. During the finals matches (quarter-finals on), each team may take up to 10 minutes (cumulative) of time-outs which can be used to delay the start of

a match if their robot 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.

- 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 robot.

#### 1.4 Game Specific Rules

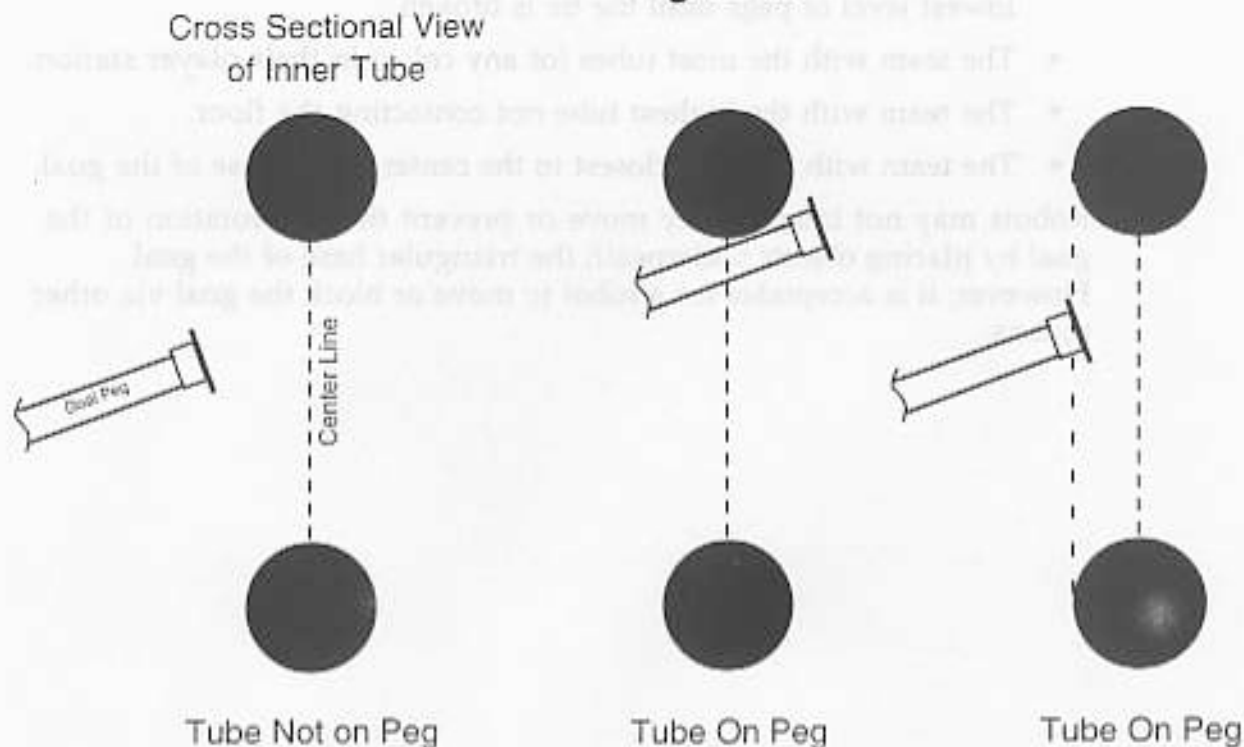
(see complete list of rules in Appendix A)

- P1. Prior to the start of each match, teams will be assigned a color: Red, White, or Blue. This color will be used to determine the placement of the robot, human player, and drivers & coaches around the playing field. Figures 1.1 & 1.2 show the color-based layout of the playing field.
- P2. During setup for each match, robots may be placed in any orientation within the designated starting area, but may not touch the 4x4 boundary.
- P3. 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 FIRST at each event and must be worn by these team members for field access.
- P4. The two drivers and human player must be students from a pre-college team partner school.
- P5. During a match, the robots may only be operated the drivers and/or by software running in the on-board control system.
- P6. The drivers and coaches must remain at the driver stations during the match, and may not reach over the playing field or player stations.
- P7. Human players must remain at the player stations during a match, and may not reach over the playing field or team operator areas.
- P8. Inside the player station, adjacent to the playing field, is a three foot interaction zone. Although this is part of the player station, players may not apply weight (stand, sit, kneel, etc.) to this portion of the player station during a match. Reaching and/or leaning over the interaction zone, such as to grab or throw tubes, is ok.
- The interaction zone is intended as a safety feature to help prevent potentially dangerous contact between robots and humans. Please exercise caution when reaching into the interaction zone.
- P9. The player stations are not considered part of the playing field, and are thus off limits to the robots. (See rule T15.)
- P10. For safety reasons, no part of a robot may touch the human players. If this occurs due to an intentional act, the team causing the safety hazard will be disqualified. If this occurs by accident, the robot causing the safety hazard

- will be disabled. The referees will decide whether the violation was intentional or an accident.
- P11. For safety reasons, no robot may launch a projectile of any sort, including tubes, toward the player stations or driver stations, with the one exception noted below. If this occurs due to an intentional act, the team causing the safety hazard will be disqualified. If this occurs by accident, the robot causing the safety hazard will be disabled. The referees will decide whether the violation was intentional or an accident.
- It is acceptable for a robot to launch tubes, but no other types of projectiles, toward the player station assigned to the same team as the robot.
- P12. During a match, no team member may intentionally touch any robot, except for reasons of personal safety. If this happens, the team will be disqualified.
- P13. During a match, no driver or coach may intentionally touch a tube, except for reasons of personal safety. If this happens, the team will be disqualified.
- P14. A human player may choose not to return tubes to the playing field. However, any tubes which leave the player's station, such as by rolling or being pushed out of the boundaries, will be returned to the playing field near the player's station without undue delay.
- P15. Human players may use only their bodies to interact with the tubes. Special clothing and/or equipment will only be allowed for those who demonstrate a need based on a physical disability.
- P16. Each team will start with 3 tubes in the interaction zone at their player station, and 6 tubes on the playing field. The tubes on the playing field will be arranged in stacks as shown in Figures 1.1 & 1.2.
- P17. 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.
- P18. Final scoring will begin when all tubes come to rest or upon a referees' decision. Team members will not be allowed onto the field until all scoring is complete.
- P19. Final Scoring - Phase I
- Each tube on any peg is worth 1 point. A tube will count as "on a peg" if any part of the peg, including the end flange, passes through the hole at the center of the peg. See Figure 1.3 for an example.
  - Each tube on or above the center of the top of the goal is worth 1 point. A tube will be considered "on or above the center of the top of the goal" if the rotational axis of the goal passes through the open middle of the tube, and the tube is above the bottom of the apex bracket.



Figure 1.3



## P20. Final Scoring - Phase II

- Each tube on or above the center of the top of the goal doubles the score.
- Each vertical row of tubes doubles the score. A "vertical row" occurs when a team has at least one tube on every peg on one corner of the goal. Separate vertical rows may be achieved on separate corners. Alternately, if a team has at least two or three tubes on every peg on one corner of the goal, they will achieve two or three vertical rows, respectively.

P21. All decisions regarding scoring will be made by the referees.

P22. The winner of a match is the team with the highest score.

P23. In the event of a tied score the following tie breaking conditions will be applied in the order below until the tie is won:

- The team with the highest tube in a scoring position wins the tie. To be considered highest, it must be the highest tube on or above the center of the top of the goal. If no tubes are in that position, it is the tube on the highest level of pegs. Subtle variations in height for a given level of pegs will not be considered.

- The team with the most tubes in scoring position in the highest level of the goal. This starts at the top level of pegs and progresses to the lowest level of pegs until the tie is broken.
- The team with the most tubes (of any color) in their player station.
- The team with the highest tube not contacting the floor.
- The team with the tube closest to the center of the base of the goal.

P24. Robots may not intentionally move or prevent the free rotation of the goal by placing objects underneath the triangular base of the goal. However, it is acceptable for a robot to move or block the goal via other means.



121. Each tube on or above the center of the top of the goal doubles the score.

122. Each vertical row of tubes doubles the score. A "vertical row" occurs when a team has at least one tube on every peg on one corner of the goal. Separate vertical rows may be achieved on separate corners. Alternatively, if a team has at least two or three tubes on every peg on one corner of the goal, they will achieve two or three vertical rows, respectively.

123. All decisions regarding scoring will be made by the referee.

124. The winner of a match is the team with the highest score.

125. In the event of a tied score the following tie-breaking conditions will be applied in the order below until the tie is won:

- The team with the highest tube in a scoring position wins the tie. To be considered highest, it must be the highest tube on or above the corner of the top of the goal. If no tubes are in that position, it is the tube on the highest level of pegs. Slight variations in height for a given level of pegs will not be considered.

## 2. THE PLAYING FIELD

### 2.1 Playing Field Description

The playing field is a carpeted, hexagon-shaped area with a freely rotating central goal. Around the perimeter of the field are three stations for human players, and three stations for drivers and coaches. At the start of each match, inner tubes are placed in various starting locations around the playing field and at the player stations, as shown in Figures 1.1 and 1.2.

### 2.2 Playing Field Construction

Section 2.2 presents the information necessary to replicate the playing field and tubes.

#### Border

The perimeter of the field is defined by three sections of a curb of 4x4 lumber, resting directly on the carpet, and three barriers which join these sections.

#### Player Stations

There are three player stations located outside the perimeter of the playing field. The stations are centered on three adjacent sides of the hexagonal field border. There are breaks in the usual 4x4 border of the playing field at the interfaces between the field and the player stations. A special barrier, designed to allow tubes to be pushed into the player station without allowing robots in, is used at these interfaces. Aside from these barriers, the player stations have no physical structure. Player station borders are represented by tape on the floor.

Each player station is 5 feet wide (parallel to the field border), and 6 feet long (extending out perpendicular to the field border). Each station is divided into two areas, an area where the player can sit/stand/kneel/etc., and the interaction zone. The interaction zone extends outward from the playing field border for a distance of 3 feet. The remaining area extends a further 3 feet from the interaction zone. The exact dimensions and locations of the player stations are indicated on the Playing Field blueprint provided by FIRST.

The special barrier is constructed from 2"Ø metal pipe and fittings, and is mounted to the tops of the 4x4 border by pipe flanges. Small sections of 2x4 are mounted to the outside of the 4x4 border to provide sufficient width to mount the pipe flanges. In addition, an oak 1x4, which rests on top of the playing field rug, is used to provide a rigid connection for the sections of 4x4 that make up the field border. This board is attached to recesses in the bottom of the 4x4 border such that it does not raise the 4x4s off the rug. The exact dimensions of the barrier are indicated on the blueprint.

#### Driver Stations

The driver stations are located outside the playing field to the right of the player stations. Driver stations have no physical structure other than a shelf on which the Transmitter and associated control system equipment can be placed. The

borders of the driver stations are represented by tape on the floor. The exact dimensions and locations of the driver stations are indicated on the blueprint.

### Goal Assembly Procedure:

The goal consists of a triangular wooden base upon which is bolted a pyramid shaped vertical structure fabricated from steel pipe, metal castings, and a connecting bracket at its top called an apex bracket. The entire unit is mounted on three, fixed caster wheels which allow the goal to rotate as a unit about its vertical centroidal axis. A short vertical, central steel stub shaft and ball bearing assembly, bolted to a large plywood disk that rests on the playing field floor (floor disk mount) keeps the goal located in the center of the playing field while allowing it to rotate due to moments it may be subject to by robots and inner tubes touching it during a competition round.

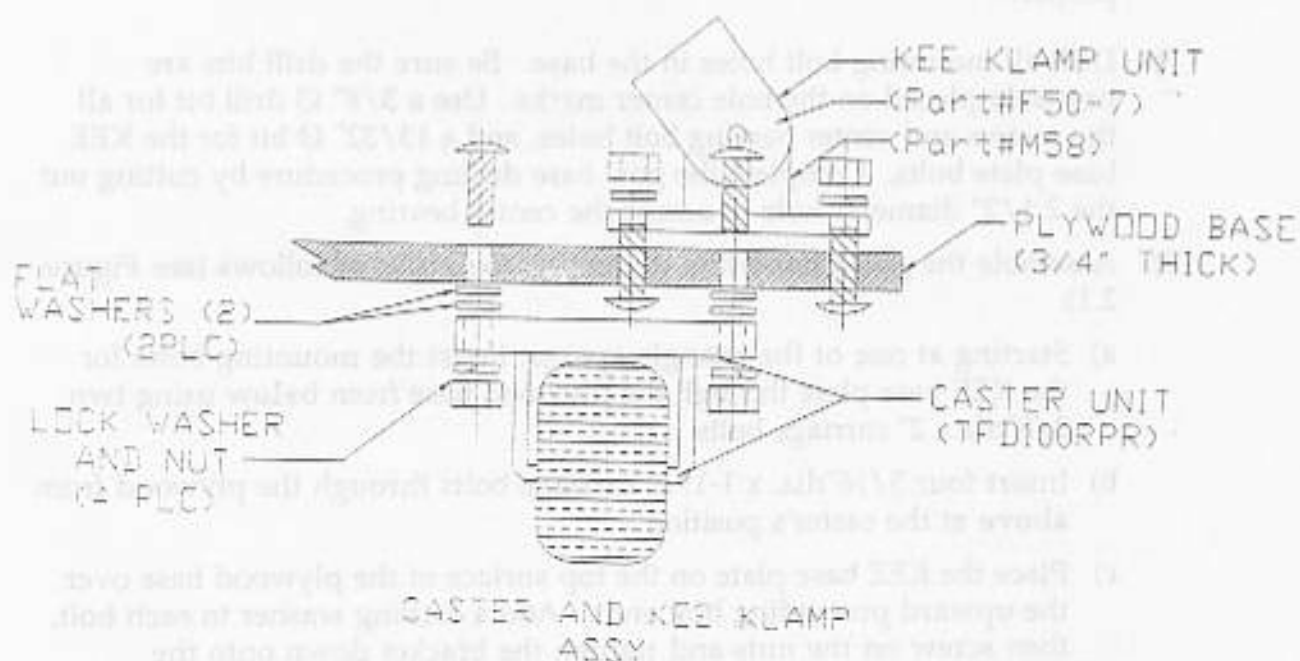
It is important that this procedure be carefully followed when fabricating the goal base and assembling the metal parts to it. **Read through this procedure in its entirety and plan it out before starting the assembly process.** Carry out the steps in numerical order, and carefully measure and lay out all dimensions as indicated. The various metal fittings used in this year's game design have been sourced from the Kee Industrial Products Co. Refer to the Playing Field blueprint provided by FIRST and the drawings herein, and review to the KEE KLAMP fittings catalog provided in the kit of parts.

- 1) Begin fabricating the triangular base by cutting out an equilateral triangle from a sheet of 3/4" thick plywood, the triangle being exactly 48" on each side.
- 2) Locate the exact center of the triangle as follows: bisect each side of the triangle, and pencil in a line from each side's center point to its opposite apex. All three lines should cross exactly at the geometric center point of the plywood base. Drill a small hole (1/16" diameter bit) through this center point. Be sure that the drill is perfectly normal (perpendicular) to the surface of the plywood. Flip the base over, and pencil in reference lines on the bottom surface from each triangle vertex to the drilled center hole. You now have established the important references from which all other measurements will be made when assembling the goal.
- 3) Fabricate a protective skirt for the base by measuring and cutting three appropriate lengths of standard stock 2"x4" lumber (actual dimensions are 1-1/2" x 3-1/2"), and attach the narrow (2") edges of the 2x4s to the plywood base thus forming a protective skirt around it. Use both wood glue and screws, driving 4 evenly spaced 2" long wood screws down through the top of the plywood into the narrow edge of each of the 2x4s, keeping the outer edges of the 2x4s aligned with the vertical edges of the triangular base. Also screw the butt ends of the 2x4s together, while keeping the screws away from the tip areas that will be removed when the triangle's points are cut off. Once the glue has set, saw off the three sharp points of the triangle thus creating a 1" flat on each one. Sandpaper the resulting base to remove any splinters and sharp edges.

- 4) On the top surface of the wooden base, carefully measure and mark the positions of the cast base plate fittings (KEE P.N. M58) at each vertex of the triangle. Mark the locations of the two bolt drill holes of each fitting on the lines previously penciled in step 2) above.
- 5) Flip the base over and carefully measure and lightly mark the four mounting hole locations for each of the three supporting fixed casters. Temporarily position the fixed casters on the bottom surface of the wood base over the mounting hole marks such that the wheel axles are directly over and parallel to the radial reference lines previously marked between the triangle apexes and base's geometric center. Carefully measure and verify the specified distance from the center of the plywood base to the center of each wheel's footprint. Check that there is no interference between the inner edges of the 2x4 skirts and the casters' mounting flanges. Check the positioning of the casters relative to the KEE cast base plate fittings on the top surface of the base. With the exception of the inner bolt holes of the KEE base plates fittings, there should be no overlap between bolt holes and mounting brackets of the casters and those of the base plates. Mark the final locations of the center of each of the mounting bolt holes, and using the caster mounting brackets as templates, pencil the outline of the bracket on the plywood at each apex
- 6) With the base still inverted, mark the locations of the two attachment bolt holes for the self-aligning 1" I.D. bearing at the center of the wood base. These are for the bolts that anchor the flange units (between which the bearing is clamped) that forms the central, vertical pivot of the goal proper.
- 7) Drill all mounting bolt holes in the base. Be sure the drill bits are precisely placed on the hole center marks. Use a 3/8" Ø drill bit for all the casters and center bearing bolt holes, and a 13/32" Ø bit for the KEE base plate bolts. Complete the goal base drilling procedure by cutting out the 2 1/2" diameter hole to accept the center bearing.
- 8) Assemble the goal's hardware to the plywood base as follows (see Figure 2.1):
  - a) Starting at one of the triangle apexes, insert the mounting bolts for the KEE base plate through the plywood base from **below** using two 3/8" dia x 2" carriage bolts.
  - b) Insert four 5/16" dia. x 1-1/2" carriage bolts through the plywood from **above** at the caster's position.
  - c) Place the KEE base plate on the top surface of the plywood base over the upward protruding bolt ends. Add a locking washer to each bolt, then screw on the nuts and tighten the bracket down onto the plywood. Check to be sure that the heads of the bolts have been

drawn up tightly against the underside surface of the plywood base. Repeat this procedure for the other two KEE base plates.

- d) Invert the base and place two flat washers over each of the four protruding wheel mounting bolts. Next, slip the three casters down over the protruding bolts (the flat washers are located between the plywood and the mounting brackets of the casters). Place locking washers over the bolt ends and screw a nut onto each one. Carefully adjust the casters such that their wheel axes are aligned directly over and parallel to the radial lines penciled in step 2) above. This will ensure that the wheels will be exactly tangent to the radius line from the vertical centroidal axis of the goal.
- e) Mount the central bearing onto the **bottom surface** of the plywood base by clamping the bearing between its two holding flanges, and bolt it into position from underneath using two  $5/16" \times 1-1/2"$  carriage bolts. Place a flat washer and a lock washer over the protruding bolt ends, screw on nuts and tighten the assembly.
- f) Mount the three Female Single Sockets (KEE P.N. F50-7) onto the KEE Base Plates as follows: Insert one or more washers as needed in the clearance space between the sides of the Single Sockets and the vertical tab of the Base Plates to achieve a snug fit between them. Bolt each joint together with a  $5/16"$  dia. bolt and nut, and lightly tighten the bolts. We will hereafter refer to this Single Socket / Base Plate assembly as a swivel mount.



- 9) Prepare the pipe segments and assemble the vertical structure of the goal as follows:
- The pipe used for the upper structure is standard iron pipe schedule 40 with an I.D. of 1-1/4", obtainable from most plumbing supply houses. Cut three pieces each 7' 6" long for the canted vertical posts, and nine pieces exactly 2' long for the canted horizontal arms.
  - Slip three of the cast iron Tees over each of the 7' 6" lengths, and carefully determine the positions of the Tees by measuring the specified distances from the top end of the vertical posts. Clearly mark their positions on the pipes for future reference. Place the Tees in their approximate positions on the pipes, and lightly tighten their set screws to temporarily hold them.
  - Place the goal base on a level floor and support it so that its wheels are slightly off of the floor. Place wooden blocks or their equivalent under the 2x4 skirt so that the base will not move. Using a carpenter's level and some wedges as necessary, accurately level the base in both the E-W and N-S directions.
  - Place a stepladder next to the base, and with someone on the ladder to hold the pipes, carefully insert the three long pipe sections into the pipe swivel mounts on the base. Be sure that the pipes are fully seated into the mounts, then tighten the set screws on the Single Sockets to securely anchor the bottom ends of the pipe sections.
  - Move the top ends of the pipes so that they come together approximately over the vertical center of the base forming a pyramid. Sufficiently tighten the bolt and nut fasteners at the base on the pipe swivel mounts (paragraph. 8f above) so that the pipes will remain in their canted positions without being supported at the top.
  - Attach the goal's top triangular shaped Apex Bracket supplied by FIRST. The Bracket consists of three aluminum plates welded into a triangular, Y shaped structure. Each plate has two bolt holes drilled near its outer end, with the holes near the top edge slightly closer to the triangular center than the holes near the bottom edge.
  - Position the Bracket at the top of the vertical pipes such that the top ends of the pipes are approximately aligned with the top edges of the Bracket. The pipes should be positioned such that they lie against the vertical faces of the Bracket on the same sides as the weld beads, with the two drilled holes in each plate falling approximately in the center of the side wall of each pipe. Using three, 6" C-clamps, temporarily clamp each pipe to the Apex Bracket. Place the clamps at the very top of the Bracket so that they are not close to the lower of the two bolt holes in the Bracket's plates.
  - Using a plumb bob on a length of string, drop a plumb line from the exact center of the Bracket down to the center of the vertical bearing

in the goal's base. Working with the Bracket and clamps at the top while observing the plumb bob, carefully adjust the Bracket until it is centered over the bearing, and its top surface is horizontal (not cocked - check it with a small level). This procedure requires a little trial and error, don't rush it!

- i) Once the Bracket is properly positioned, securely tighten the bolt and nut fasteners on the pipe swivel mounts at the goal's base.
- j) Drill a  $17/64"$   $\varnothing$  hole through one of the three vertical pipes using the lower hole in the apex bracket-bracket plate as your guide. Run the drill through the hole and penetrate the adjacent pipe wall. **Note**, it is not necessary to drill into the opposite wall of the pipe. Carefully remove the C-clamp from the just drilled pipe, and holding a matching  $1/4"$  nut with your fingers, slide the nut down into the pipe until it aligns with the just drilled hole. Now thread a  $1"$  long  $\times$   $1/4"$   $\varnothing$  hex headed bolt through the plate and drilled hole, into the nut held inside the pipe. While now holding the nut inside the pipe with a small wrench, tighten the bolt securely. This will anchor the top end of the first pipe.
- k) Repeat the above procedure at each of the other two pipe / Bracket lower hole connections.
- l) Finally, using the same procedure as above, drill through each top Bracket bolt hole through the pipe inner wall, and place and tighten the second bolt and nut fastener on each pipe. At this point, the basic structure of the goal should form a rigid, strong pyramid structure.

10) Assemble the canted horizontal members to the vertical posts:

- a) Rotate the three Tees on each vertical pipe until they are roughly pointing radially outward from the center line of the goal. Lightly tighten the dual set screws to temporarily hold the Tees in place. Insert the 2' long horizontal pipe segments into each of the nine Tees, then securely tighten the single set screws that hold the short pipe segments in the Tees.
- b) Working with each horizontal member individually, loosen the two vertical pipe set screws on the Tee, and make final adjustments to the members until each is at its specified vertical position and, pointed exactly radially outward from the center of the goal. This can be done by having someone stand behind the goal, and using the vertical plumb bob line as a reference, sight back through the plumb line to the Tee and instruct another team member to rotate the Tee until the horizontal pipe is properly aligned. Give a final alignment check of all parts of the goal and securely tighten all set screws.

11) Assemble the flanges to the horizontal pipe segments:

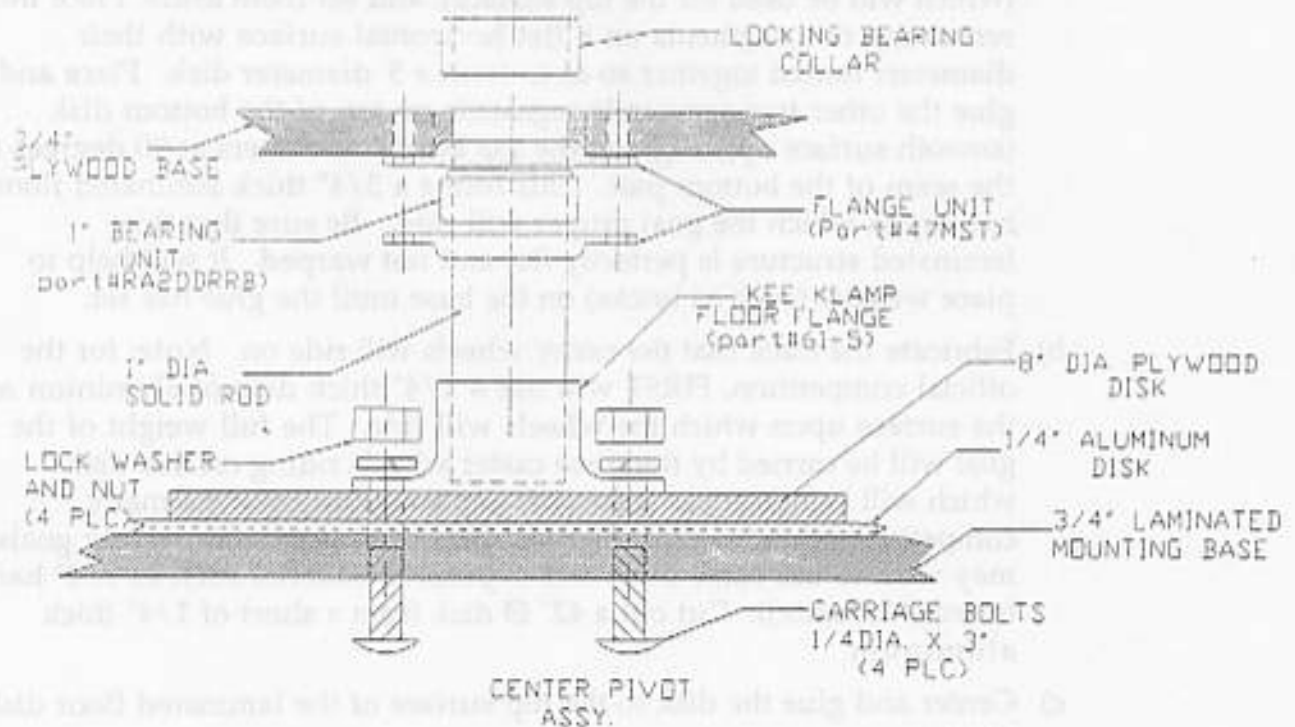
- a) From a sheet of  $1/4"$  plywood, cut out nine disks that are exactly  $3$   $15/16"$  in diameter. Using one of the round Kee Klamp cast iron



flanges as a template, center it over each disk and mark the centers of two (opposite each other) flange mounting holes onto the disks. Using a  $3/16"$   $\varnothing$  bit, drill the two screw holes where marked through each disk. Chamfer (one surface only) each hole to accept a flat headed screw such that the surface of the heads will lie even with the surface of the disk. Attach one disk to the flat mounting surface of each flange using two  $1/2" \times 10/32"$   $\varnothing$  flat headed screws and nuts, placing the screws through the chamfered side of the disks, then the flanges, and thread on the nuts from behind the flange.

- b) Mount the flanges on their respective horizontal posts. This completes the fabrication of the rotatable upper portion of the goal.
- 12). Fabricate the circular, laminated floor disk mount assembly (see Figure 2.2):
- a) From  $3/8"$  thick sheets of plywood, cut four semicircular segments each having a radius of  $2\ 1/2'$ . Identify the smoothest two segments (which will be used for the top surface), and set them aside. Place the remaining two segments on a flat horizontal surface with their diameters butted together so as to form a  $5'$  diameter disk. Place and glue the other two semicircle segments on top of the bottom disk (smooth surface up), aligning the top butted diameters at  $90$  degrees to the seam of the bottom pair. This forms a  $3/4"$  thick laminated floor base upon which the goal proper will ride. Be sure that this laminated structure is perfectly flat and not warped. It will help to place weights (such as bricks) on the base until the glue has set.
  - b) Fabricate the track that the caster wheels will ride on: **Note:** for the official competition, FIRST will use a  $1/4"$  thick disk of aluminum as the surface upon which the wheels will ride. The full weight of the goal will be carried by the three caster wheels riding on this disk which will be subject to wear with repeated use over the many competition rounds. (For their test purposes, teams fabricating goals may wish to use some other less expensive material such as  $1/4"$  hard board (Masonite)). Cut out a  $42"$   $\varnothing$  disk from a sheet of  $1/4"$  thick aluminum
  - c) Center and glue the disk to the top surface of the laminated floor disk mount
  - d) Cut an  $8"$  diameter disk from a scrap of the plywood and glue it to the center of the top surface of the laminated floor disk mount. (This smaller disk functions both as a support base for the stub shaft and a reinforcement to the floor mount).
  - e) Position the small Kee Flange (P.N. 61-5,  $3/4"$  Round Flange) at the center of the  $8"$  plywood disk and mark the position of the four mounting holes of the flange. Using a  $17/64"$  drill bit, drill each of the holes all the way through the entire base assembly.

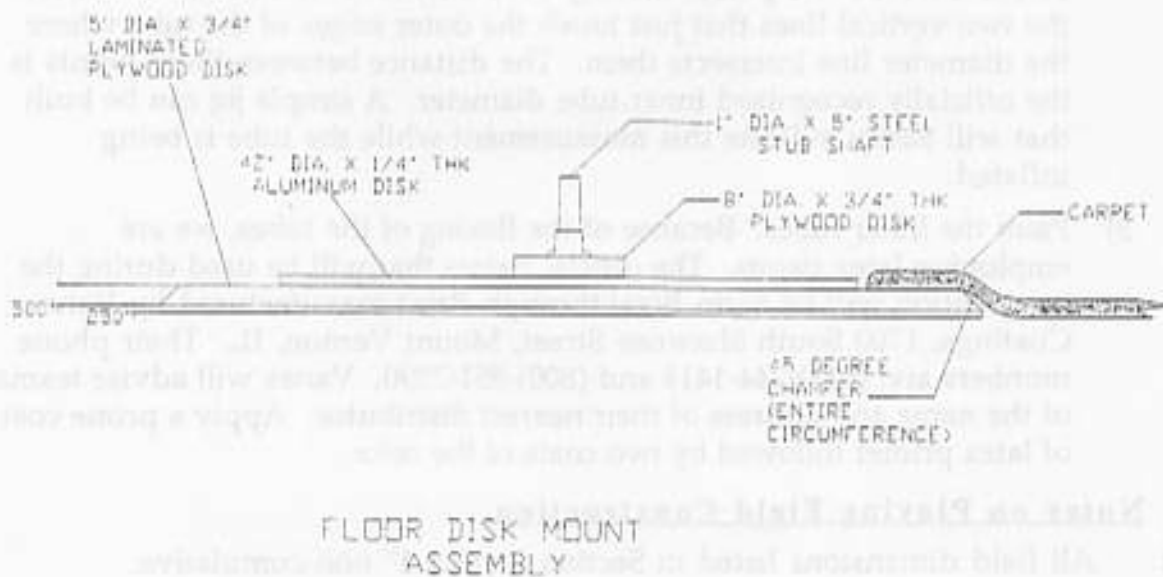
- f) Take the 1" dia. x 5" long steel stub shaft provided in the kit and check its fit with the 1"  $\varnothing$  goal center bearing. The stub shaft should easily slip into the inner bore of the bearing. If it is tight, use some fine emery cloth and light oil, and polish the surface of the shaft until it easily slides in and out of the bearing.
- g) Insert the 1"  $\varnothing$  stub shaft into the small Kee Klamp flange. Securely tighten the set screw on the flange to hold the stub shaft in place. Next place the flange on the center of the 8" plywood disk and floor mount. Check to see that the upward pointing stub shaft is perfectly perpendicular to the surface of the aluminum disk. Place flat washers as shims under the flange if needed to achieve an accurate alignment. Using four, 1/4" x 3"  $\varnothing$  carriage bolts, lock washers and nuts, fasten the flange and 8" disk securely down onto the mount by inserting the bolts from underneath the floor mount and drawing their heads up tightly into the laminated base.



13). Complete the goal assembly and mating with the playing field carpet (see Figure 2.3):

- Cut a 44" diameter hole in the center of the playing field carpet, and position the carpet on the competition playing field.
- Lift up one edge of the carpet, slide the laminated base assembly under it and center the base in the carpet opening. Check the level of the base and place thin shims under it if needed.

- c) Lift the upper portion of the goal, align it over the center of the floor mount, and lower it over the stub shaft to engage the shaft into the bearing on the base. Spin the upper portion to check for any binding of the wheels and vertical shaft bearing. The structure should rotate easily.
- d) Slip the locking collar down the protruding end of the stub shaft until it contacts the bearing, then raise it up  $1/16$ " and securely lock it in place. Check to see that there is no binding against the collar when the goal is rotated.
- e) Finally, give the entire structure a quality assurance check for alignment, and recheck the tightening of all accessible fasteners.
- f) Using a staple gun, staple the edge of the circular opening in the carpet to the laminated base. (If the carpet has been rolled up, let it lay flat for a day or two before stapling it to the base).



#### Inner tube preparation:

Each team will use nine, type KR 14 /15 rubber automobile inner tubes painted the color of the assigned team position. These are standard inner tubes, and are available at most automotive supply stores. For practice purposes, teams should procure only the above type inner tubes designed for use in radial tires. The inner tubes must be prepared for use as indicated below.

- 1) Before painting, the inner tubes must be cleaned to ensure good paint adhesion. The following cleaning procedure is recommended:  
Bring four gallons of water to a boil, remove it from the heat and pour it into a five gallon plastic bucket. Dissolve one cup of TSP cleaner (available at most paint and hardware stores) in the hot water and place three uninflated inner tubes into the solution. Using a long handled brush, agitate the tubes, turning and scrubbing them for several minutes. Repeat this process several times until the tubes have been in the solution for a total of 15 minutes. Remove them from the solution, thoroughly rinse in cool water and let dry. Repeat this procedure with the rest of the tubes. It will be necessary to use a fresh TSP solution for each batch of tubes as the cleaner will quickly darken with material dissolved from the rubber.
- 2) Inflate the tubes before painting them. Fill them with air until they reach 25 3/4" in (outer) diameter measured as follows: Lay the tube to be measured on a horizontal surface. Locate the diameter line that runs across the tube and passes directly over the tube's air filler stem. Locate the two vertical lines that just touch the outer edges of the tube where the diameter line intersects them. The distance between these points is the officially recognized inner tube diameter. A simple jig can be built that will easily indicate this measurement while the tube is being inflated.
- 3) Paint the inner tubes. Because of the flexing of the tubes, we are employing latex paints. The official paints that will be used during the competition will be Satin Breakthrough Paint manufactured by Vanex Coatings, 1700 South Shawnee Street, Mount Vernon, IL. Their phone numbers are: (618)-244-1414 and (800)-851-7390. Vanex will advise teams of the name and address of their nearest distributor. Apply a prime coat of latex primer followed by two coats of the color.

#### Notes on Playing Field Construction

- F1. All field dimensions listed in Section 2 are  $\pm 1"$  non-cumulative.
- F2. Tubes will be inflated to size, not pressure. All tube dimensions listed in Section 2 are  $\pm 1"$ .
- F3. The playing field carpet will rest directly on the floor except where otherwise noted.
- F4. The central goal will rest directly on the floor. The carpet will overlap the circular disk by three inches, and will be attached to the disk via heavy duty staples.

## 3. ROBOT DESIGN, CONSTRUCTION & OPERATION

### 3.1 Safety Rules

(see complete list of rules in Appendix A)

- 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. Safety glasses must be worn by all team members in the driver stations and player stations during matches, and in the pit area when working on robots. They are also highly recommended if your neighbor(s) in the pit are working on their robot.
- S3. Any robot which causes a safety hazard during a match will be disabled.
- S4. If at any time the referees determine that a robot is likely to cause safety hazards in future matches, the robot must be modified to the referees' satisfaction or it will not be allowed to compete.
- S5. 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, the inner tubes are the only projectiles the latex tubing may be used to launch.
- S6. Projectiles must have a frontal area greater than or equal to 10 square inches and be shaped to avoid eye injury.
- S7. Do not tamper with the power supply, batteries, chargers, speed controllers, 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, and lead to a safety hazard or damage to the robot.
- S8. Remove batteries from the robot while making adjustments to your robot. Due to the strength of the motors in the Kit, it is important to keep fingers away from the gears while your robot is connected to a power supply.
- S9. 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, fire, and/or permanent destruction of the batteries.

### 3.2 Design & Operation Rules

(see complete list of rules in Appendix A)

- M1. The energy used by the robots 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.
  - storage achieved by deformation of springs purchased from Small Parts, Inc. (SPI) Latex tubing from SPI may not be used as a spring.
- M2. Robots must sit, unconstrained, inside a 36" square footprint and be no more than 48" high at the start of a match. The weight of the robot, including batteries and control system, may not exceed 120.0 pounds.
- Size  $\leq$  36" long x 36" wide x 48" high; Weight  $\leq$  120.0 pounds**

*Keep in mind that these are maximum dimensions. It is recommended that robots be designed for slightly smaller dimensions and weights in order to allow a degree of tolerance for oversized/overweight mechanisms and differences in measurement between the team and the official inspection. Many teams have discovered the hard way that reducing size and weight while preserving functionality is no easy task after the robot has been constructed.*

*Also, many shippers such as UPS will not ship packages as large as a full robot. Many teams have found it helpful to make ease of disassembly and reassembly one of the design goals.*

- M3. All robots 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 robot are necessary to meet the above requirements, they must be completed before seeding matches begin.
- M4. **Teams are expected to design and build robots to withstand vigorous amounts of interaction with other robots.** (See also rules T6-8.)
- M5. Until the controls are enabled at the beginning of each match, robots and any appendages, extensions or projectiles must remain unconstrained within the 36"x36"x48" starting size. Once a match begins, robots may extend beyond that limit under their own power.
- M6. Robots must be designed to operate by reacting against the surface of the playing field, the innermost face of the 4x4 field border, the goal, the tubes, the other robots, and the air. (See Section 2.2 for Field Diagrams.)
- M7. **Robots must display their team company and school names and/or logos. The judges, referees, and announcers must be able to easily identify them by name. In addition, team numbers must be displayed on at least two opposite sides (180 degrees apart) of the robot. Numbers should be at least 3 inches high and clearly visible from a distance of not less than 50 feet.**
- M8. During a match, robots may be manipulated only by the normal operation of the wireless programmable control system.
- M9. Gaining traction by using adhesives or by damaging the surface of the playing field or the tubes is not allowed. (See also Rules T9-10.)
- M10. During any Competition event, any mechanism which will alter the operation of the robot may not be added or removed after the first match of the seeding rounds unless mandated by the judges for rule compliance reasons. However, mechanisms existing on the robot may be reconfigured

between matches. Also, the control system may be reprogrammed as described in the control system rules between matches.

- M11. No substitute robots are permitted; however, functionally identical replacement parts are allowed.
- 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 defined 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 A)

- C1. The control system is provided to allow wireless control of the robots. The Transmitter box, Receiver box, servos, speed controllers, RNetS, antennas, batteries, battery chargers, 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 and Receiver may be set for custom operation.
  - the user programmable code in the Receiver may be customized.
  - the speed controllers may be calibrated as described in the Tekin REBEL Owner's Manual.
  - The connectors on the ends of the 12 AWG wires on the Tekin REBEL Speed Controllers must be removed. Do not remove the connector on the 24 AWG, 3 wire PWM cable.

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 only exceptions to this rule are:
- Tape may be used to secure the position of the trimmers on the Joysticks in order to prevent accidental changes in calibration.
  - Stick-on hook & loop fasteners may be used to attach the speed controllers.

- 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/almond project box is intended to serve as a mounting point for the rocker switches and potentiometers and to enclose the associated wiring. You may modify the project box in any manner to accommodate your needs. It may not be used on the vehicle.
  - C4. **Only the wire supplied in the Kit may be used to conduct electricity.** Additional wire is not permitted.
  - C5. Electrical devices may only be wired as described in Section 4. Some important facts are listed here in Section 3.3.
  - C6. The 12 gauge wire must be used for connections from the batteries to the speed controllers, from the speed controllers to any motors, and from the batteries to the Receiver box.
  - C7. The 16 gauge jacketed cable must be used for any device connected to a relay output.
  - C8. The 22 and 24 gauge wire may only be used for connecting sensors (limit switches, reed switches, rocker switches, air pressure switches, potentiometers) to inputs or for extending the PWM cables.
  - C9. **Relay outputs may not power more than one device per output.** (The double-solenoid valve is considered one device, because the diodes may be used to route power to only one solenoid at a time.)
  - C10. **Only the Receiver, speed controllers, and muffin fan may be connected directly to the battery outputs.**
  - C11. The battery contacts inside the Skil drill shells must be used to draw power from the batteries. If the handle part of a drill shell is cut away from the main body, the wire side of the contacts must be insulated with heat shrink tubing or electrical tape to prevent short circuits.  
*It is strongly recommended that the contacts be used in conjunction with the handle of the drill shell and the battery clip at the end, as they are designed to hold the battery snugly yet allow for easy changeover of batteries.*
  - C12. The Skil drill motors may be powered only by the Tekin speed controllers.  
**Do not connect the drill motors to the relay outputs.**
  - C13. No more than one motor may be powered by each Tekin speed controller.
  - C14. The Delco seat motors and Delphi tape drives may be powered by the Tekin speed controllers or the relay outputs.
  - C15. Two 0.1 $\mu$ F capacitors, included with each speed controller, must be installed on each motor connected to a speed controller, as described in the Tekin REBEL Owner's Manual.



- C16. 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.
- C17. One 30A circuit breaker (provided in the Kit) must be installed in series with the positive terminal on each battery contact, such that all battery output flows through this breaker before being distributed to the Receiver, speed controllers, fan, or other battery. The circuit breaker must be accessible for inspection at each Competition event.
- C18. Only the 9 volt power supply included with the Kit should be used to power the Transmitter box. Use of an alternate power supply could damage the Transmitter box or RNet and is therefore prohibited.
- C19. Do not connect 12 volt power or ground wires to the relay outputs. Doing so will cause a short circuit and may damage the Receiver.
- C20. Do not connect power or other outputs to the sensor port on the Receiver. Power for sensors is available from the sensor port.
- C21. Any sensors used on the robot must be connected directly to the sensor port on the Receiver, and may not be wired in series with the motors, pumps, or valves.
- C22. R Nets may not be used in the Pit Area at any Competition event. A tether must be used for bench testing.
- C23. If the control system is damaged due to improper wiring or misuse, FIRST will charge for repair or replacement of the affected items. (*See Section 3.7 for details.*)
- C24. Robots must only be operated with both batteries present and wired in parallel.  
**Operating a robot with only one battery can permanently destroy the battery. Don't do it!**
- C25. All wires distributing power with a constant polarity (i.e. not a relay or speed controller output) must be color coded as follows:
- Use Red 12 AWG or White 16 AWG wire for +12Vdc.
  - Use Black 12 or 16 AWG wire for GND.
- C26. Teams are responsible for any software bugs introduced into the Receiver's control program when using a custom program. If a software bug negatively impacts the performance of a robot during a competition match, it will not be grounds for a rematch or even a pause in the match.

### 3.4 Materials Usage & Limitations

(see complete list of rules in Appendix A)

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

- 2' x 4' x 1" ROHACELL™ P170 structural foam shipped to each team from FIRST.
- Material available from outside sources, as explained below.
- Material satisfying the unlimited quantity criteria, as explained below.
- The Kit container, part packaging, and any documentation in the Kit container may not be used to build the device.
- Adhesive tape may not be used except as an electrical insulator.
- Lubricants may not be used except to reduce friction within your own robot.

#### **Outside Sources - 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 Appendix D for more details on accounting and ordering.

Up to \$425 worth of materials purchased from Small Parts, Inc. may appear on your final robot. Items which appear below in the unlimited quantity category do not count against the \$425 limit when used as described.

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 robot 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.

#### **Outside Sources - Additional Hardware List**

Materials on the Additional Hardware List may be obtained from any supplier, but in limited quantity. A specific list of materials and maximum quantities/dimensions is provided in Section 3.6. Cost is not considered.

If an item on the Additional Hardware List is available from Small Parts, Inc., then it may be purchased from SPI without being counted against the \$425 limit on materials purchased from SPI. However, any amount of the item purchased from SPI above and beyond the quantity allowed in the Additional Hardware List will count against the \$425 limit. Obviously, any item purchased from SPI will count against your credit limit, regardless of whether or not it is listed in the Additional Hardware List.

### Unlimited Quantity Items

The following items may be used in unlimited quantity subject to the following criteria. (See rule K9)

- Fasteners, washers and adhesives -- if used for joining and fastening purposes only.
  - Fasteners -- if used as pins in a linkage or as hinge pins.
  - Crimp-on spade connectors -- if used to conduct electricity, used with the proper gauge wire, crimped properly, and fully insulated, such as the Thomas & Betts units provided in the kits.
  - Adhesive tape -- if used as an electrical insulator.
  - Lubricants -- if used to reduce friction within your own device.
  - Teflon tape -- if used around the threads of pneumatic fittings to prevent leaks.
  - Shrink wrap tubing of any diameter -- if used for electrical insulation.
  - Pipe fittings (tees, reducers, elbows, and angles) -- if used to join sections of pipe
  - Endcaps -- if used to cap pipe.
- 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 robot.
- K3. There is no restriction on the total quantity of sprockets/pulleys and chain/belt that can appear on your robot. However, there is a restriction on the amount which can be obtained from outside sources other than SPI. (See the Additional Hardware List and Rule K4 .) Any quantity above the amount listed on the Additional Hardware List must therefore be purchased from SPI, or manufactured from raw materials available from either the Kit, the Additional Hardware List, or SPI.
- K4. As denoted in the Additional Hardware List, each team may purchase from an outside source sprockets (not gears) and/or pulleys and additional chain and/or belt, with the following conditions:
- On your final robot, you may use no more than a combined total of 4 sprockets and/or pulleys from outside sources other than SPI.
  - On your final robot, you may use no more than a combined total of 10' of chain and/or belt from outside sources other than SPI. 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 robot.
  - These components must be "commercially available," strictly *off-the-shelf* only. No custom or special orders.
  - A double-sprocket or double-pulley assembly counts as two sprockets or pulleys, respectively.

- K5. Gears (not sprockets) must be purchased from SPI, or manufactured from raw materials available from either the Kit, the Additional Hardware List, or SPI.
- K6. The dimensions for sheets and boards listed in the Additional Hardware List represent the maximum length and maximum width which may be purchased, not the total area. The thickness represents a fixed quantity, not a maximum.
- K7. The dimensions for rods and shafts listed in the Additional Hardware List represent the maximum length that may be purchased for a given diameter of rod/shaft.
- K8. You may purchase only one of the three types of 1/2" or thicker wood listed in the Additional Hardware List; Plywood, Chipboard, or Particleboard.
- K9. Items listed as unlimited quantity items, when used without satisfying the criteria for unlimited use, must be purchased from SPI against the \$425 limit or manufactured from raw materials available in the Kit, from the Additional Hardware List, or from SPI.
- K10. Net material is allowed; however, if it is used to entangle opponents' robots, the referees may disallow it.
- K11. For safety reasons, you may not fabricate your own springs. However, it is acceptable to elastically deform and relax materials not designated as springs as long as the rate at which the energy is released does not exceed the rate at which the energy was stored. This is intended to allow reasonable use of the elastic properties of materials without creating unsafe conditions caused by sudden the release of stored energy in materials not designed to act as springs. Materials which are designated as springs include: All items listed in the Springs section of the Kit List, and compression, tension, torsion, constant force, and washer springs available from Small Parts, Inc. Latex tubing from SPI is not considered a spring.
- K12. A limited number of replacement parts will be made available by 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.
- K13. 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.
  - metal may be heat treated in order to improve surface hardness
  - metal may be anodized to improve appearance

Completely melting and recasting a material is considered a chemical change. However, merely heating a material, such as a sheet of polycarbonate or ROHACELL™, in order to bend it into a new shape without cracking is not considered a chemical change.

- K14. The mailing tubes provided in the Kit are considered packaging material and may not be used during any Competition event.
- K15. All unused parts and materials must be returned to FIRST for proper recycling.
- K16. The control system is the property of 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 robots after this period, FIRST can provide basic instructions on how to refit the robots 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 FIRST staff member as you leave the Kickoff Workshop. Any materials you did not receive will be shipped to you as soon as possible.

updates and answers to rules questions in a special limited access area of the site. This area is located at: <http://www.usfirst.org/1997comp/teamonly/>

While this area is not open to the general public, it can be accessed by teams using the account name and password supplied in the Check-out materials at the Kickoff Workshop. The Rules are not for public access, and any team discovered giving out their password will have their access to this site revoked.

The web site also provides links to home pages setup by Teams involved in the FIRST Competition. If you have a school, company, or team-related web page that is not listed, please send email to [webmaster@usfirst.org](mailto:webmaster@usfirst.org).

### 5.3 Motorola Midwest Regional

#### Location

The Motorola Midwest Regional will be held at Harper College. The full address is:

Harper College  
Route 62, Algonquin Road  
Palatine, IL 60067

#### Hotels

Below are some suggestions on where to stay if you will need overnight accommodations

Embassy Suites Hotel  
1939 North Meacham Road  
Schaumburg, IL 60173  
800-654-8089  
\$109 single/double  
\$119 triple/quad/quintuplet/sextuplet  
Price includes full breakfast.  
Cut off 2/14/97

Holiday Inn, Schaumburg  
1550 North Roselle Road  
Schaumburg, IL 60195  
847-310-0500  
\$75 single/double/triple/quad  
Cut off 2/7/97

Wyndham Garden Hotel, Schaumburg  
800 National Parkway  
Schaumburg, IL 60173  
847-605-9222  
\$77 single/double/triple/quad  
Cut off 2/5/97

Hampton Inn, Schaumburg  
1300 East Higgins Road  
Schaumburg, IL 60173  
847-619-1000  
\$69 single/double  
\$74 triple/quad  
Price includes continental breakfast.  
Cut off 2/14/97

Hyatt Regency, Woodfield  
1800 East Golf Road  
Schaumburg, IL 60173  
847-605-1234  
\$89 single/double/triple/quad  
Cut off 2/12/97

Marriott, Arlington Heights North  
3700 North Wilke  
Arlington Heights, IL 60004  
847-394-9999  
\$73 single/double/triple/quad  
Cut off 2/12/97

Radisson Hotel, Schaumburg  
 1725 East Algonquin Road  
 Schaumburg, IL 60173  
 847-397-1500  
 \$74 single/double, \$84 triple/quad  
 Price includes airport shuttle. Please  
 give advance notice.  
 Cut off 2/14/97

*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 New England Regional

### Location

The New England Regional 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 Regional.

Center of New Hampshire - Holiday  
 Inn  
 700 Elm Street  
 Manchester, NH 03101  
 603-625-1000  
 \$72 single/double, \$77 triple/quad  
 Cut off 2/20/97

Days Hotel  
 55 John E. Devine Drive  
 Manchester, NH 03103  
 603-668-6110  
 \$65 single/double + \$6 per person  
 Cut off 2/26/97

Comfort Inn  
 298 Queen City Avenue  
 Manchester, NH 03102  
 603-668-2600  
 \$59 single/double + \$6 per person  
 Cut off 2/26/97

Highlander Inn  
 2 Highlander Way  
 Manchester, NH 03101  
 603-625-6426  
 \$75 single/double + \$10 per person  
 Cut off 2/26/97

Susse Chalet  
 860 Porter Street  
 Manchester, NH 03103  
 603-625-2020  
 \$49.70 single/double/triple/quad  
 Price includes continental breakfast  
 Cut off 2/19/97

Wayfarer Inn  
 121 South River Road  
 Bedford, NH 03110  
 603-622-3766  
 \$70 single/double, \$80 triple/quad  
 Cut off 2/12/97

*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.*

## 5.5 Johnson & Johnson Mid-Atlantic Regional

### Location

The Johnson & Johnson Mid-Atlantic Regional will be held at Rutgers University. The full address is:  
 Rutgers University  
 College Avenue  
 New Brunswick, NJ 08903

### Hotels

Below are some suggestions on where to stay if you will need overnight accommodations for the Johnson & Johnson Mid-Atlantic Regional.

Clarion Hotel  
 2055 Lincoln Highway  
 Edison, NJ 08817  
 908-287-3500  
 \$85 single/double, \$90 triple/quad  
 Price includes buffet breakfast.  
 Cut off 2/26/97

Comfort Inn  
 I-287 & Stelton Road  
 South Plainfield, NJ 07080  
 908-561-4488  
 \$49 single/double + \$5 per person  
 Price includes continental breakfast.  
 Cut off 3/1/97

Somerset Marriott Hotel  
 110 Davidson Avenue  
 Somerset, NJ 08873  
 908-560-0500  
 \$75 single/double/triple/quad  
 Cut off 2/27/97

Quality Inn  
 1850 Easton Avenue  
 Somerset, NJ 08873  
 908-469-5050  
 \$52 single, \$56 double/triple/quad  
 Cut off 2/21/97



Wyndham Hotel  
 21 Kingsbridge Road  
 Piscataway, NJ 08854  
 908-980-0400  
 \$74 single/double, \$79 triple/quad  
 Cut off 2/26/97

Embassy Suites Hotel  
 121 Centennial Avenue  
 Piscataway, NJ 08854  
 908-980-0500  
 \$115 single/double/triple/quad  
 Price includes full breakfast.  
 Cut off 2/15/97

*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.*

### 5.6 National Championship

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

### 5.7 Schedule of Events

#### All Regionals

- |       |   |
|-------|---|
| Day 1 | • Team arrival, Registration and Practice, Official Weigh-in and Inspection |
| Day 2 | • Seeding Matches<br>• Celebration Party (following seeding matches)        |
| Day 3 | • Double Elimination Tournament & Finals<br>• Awards Ceremony               |

#### National Championship

- |       |   |
|-------|---|
| Day 1 | Team arrival, Registration and Practice, Official Weigh-in and Inspection                                   |
| Day 2 | Seeding Matches at Epcot Arena  |
| Day 3 | Double Elimination Tournament & Finals<br>Awards Ceremony at Epcot Arena<br>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 FIRST where the machine will be after The Competition.

See Section # 5, *Administrative Details*, for more information.

Once you have unpacked, a 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. Your robot should be clearly identified with your corporate/university/school names.

### **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 15 minute 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.

Practices are in the afternoon on the following days:

Motorola Midwest Regional.....	Thursday, March 6, 1997
New England Regional.....	Thursday, March 13, 1997
Johnson & Johnson Mid-Atlantic Regional.....	Thursday, March 20, 1997
National Championship.....	Thursday, April 10, 1997

### **Official Inspection**

Before competing in the Seeding Matches, every machine must pass an inspection for rules compliance. 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 all day on the following dates:

Motorola Midwest Regional.....	Friday, March 7, 1997
New England Regional.....	Friday, March 14, 1997
Johnson & Johnson Mid-Atlantic Regional.....	Friday, March 21, 1997
National Championship.....	Friday, April 11, 1997

#### 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. Double Elimination 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.

Double Elimination and Final matches are all day on the following dates:

Motorola Midwest Regional.....	Saturday, March 8, 1997
New England Regional.....	Saturday, March 15, 1997
Johnson & Johnson Mid-Atlantic Regional.....	Saturday, March 22, 1997
National Championship.....	Saturday, April 12, 1997

### **5.8 Shipping & Transportation of Machines**

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:

**Any team competing in the National Championship only**

1. Machines **MUST BE OUT OF TEAM HANDS** by 5:00 p.m. on Friday, February 28, 1997. This means you may ship the robot or drive the robot to the drayage/storage facility in Orlando by 5:00 p.m. on February 28.
2. Teams will be asked to provide FIRST with shipping documentation to prove shipment of machines.

**All teams competing in a Regional event**

1. Machines **MUST BE OUT OF TEAM HANDS** by 5:00 p.m. on Tuesday, February 25, 1997. This means you may ship the robot or drive the robot to the drayage/storage facility of your first event by 5:00 p.m. on February 25.
2. Teams will be asked to provide FIRST with shipping documentation to prove shipment of machines.

**Regional Competitors**

1. After competing in a Regional, any teams competing in another event will have two days to make repairs and/or changes to their machines, within all rules outlined in this document.
2. Machines **MUST ARRIVE** at the next site by the next Tuesday at 5:00 p.m. The exact dates are listed below.

For teams competing in more than one event...

If you are competing in this Regional... robot at 5:00 p.m.	then we must receive your the next site by this date at
---	--

Motorola Midwest Regional.....	Tuesday, March 11, 1997
New England Regional.....	Tuesday, March 18, 1997
Johnson & Johnson Mid-Atlantic Regional.....	Tuesday, March 25, 1997

**Shipping & transportation of machines**

- ST1. Teams are responsible for the shipment of their machines, including the costs involved in shipping. No COD shipments will be accepted.
- ST2. All machines must be shipped or brought to secured storage sites still to be determined. These addresses can be found in Appendix H. Refer to the deadlines listed above.

- ST3. 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.
- ST4. Cardboard is not acceptable packaging for your robot. Wooden crates must be used to avoid moisture problems. Remember, Florida is a humid state. Robots hand delivered to storage facilities must also be crated.
- ST5. All crates must be clearly marked with the team's complete name, as well as any other information requested by the drayage company for that site. A return address or the name of one team member is not enough information for identification. The team number must be on all shipping containers in a minimum of 6" numbers. The number must appear on all four sides and top of container.
- ST6. The machines may not leave The Competition event site until the conclusion of the that event. If repairs are required, they must be performed on site, unless accompanied by a FIRST staff member to an off-site designated machine shop.

## 5.9 Submission Deadlines

### Team Profiles

FIRST will publish short profiles on each team in the event programs. By **Friday, January 31, 1997** FIRST must receive by mail, email (dmt@usfirst.org) or fax, your typed 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) What is unique about your team?
- 2) Briefly tell "your story" - how has your team approached the project?
- 3) What makes your robot "a winner" (any information about your robot will remain confidential until the first day of The Competition).
- 4) How many students and engineers are involved in your effort? How is it organized?

This is your team's chance to tell the world who you are and what makes you great. Team profiles are also sent to judges prior to the events, so they can familiarize themselves with the teams. Profiles should be 200 words or less.

Please review pages 12-27 of the 1996 national event program for a look at team submissions for Hexagon Havoc.

#### Chairman's Award Materials

Must be received at the FIRST OFFICE NO LATER THAN 5:00 PM ON FRIDAY, FEBRUARY 28, 1997.

Please refer to Section #6 for details on this and other awards. FIRST must receive your number of attendees by mail, email (dmt@usfirst.org) or fax by the following dates:

#### Event Attendees

Two weeks before each event, we need to get an estimate from you of how many people will be attending from your team. The deadlines are as follows:

Motorola Midwest Regional.....	Friday, February 21, 1997
New England Regional.....	Friday, February 28, 1997
Johnson & Johnson Mid-Atlantic Regional.....	Friday, March 7, 1997
National Championship.....	Friday, March 28, 1997

### **5.10 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 will be delivered to your station.

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

FIRST reserves the right to limit the number of team members in the pit area. If the pit area becomes too crowded for machines and teams to safely and quickly move back and forth 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, please let FIRST know.

#### Warm Clothing

If your team attends a Regional, please be sure to bring warm clothing. The weather can be unpredictable in the North 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.

## 5.11 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

FIRST encourages teams to take their machines back home with them. 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 FIRST with a security 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 FIRST and the \$1,500 security deposit is to cover possible damage to the control system. Your security deposit will be returned once we receive the control system back. It can be a check or purchase order which will be held until the return of the system. At that time the security deposit will be canceled and returned to you. **The FIRST control system is not for sale.**

## 6. AWARDS

### 6.1 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 Competition - 1997 are eligible for this award. The recipient of this award is decided by an independent panel of judges at the National Championship.

While FIRST continues to leave this award without specific criteria, certain themes have developed which seem to best illustrate the partnerships efforts which stand out above others. In 1996, the team efforts continued to progress and develop beyond what we could have predicted so that the judges named finalists. The entries which were among that group consistently showed the impact that this program had on all team members, their families and communities.

Documentation may consist of any combination of the following:

- Video footage in VHS format, 10minute 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 12, 1997.

**ALL DOCUMENTATION MUST BE IN FIRST OFFICES NO LATER THAN 5:00 PM ON FRIDAY, FEBRUARY 28, 1997.**

The Chairman's Award will be presented at the Awards Celebration on Saturday evening, April 12, 1997. The team carries home a traveling trophy--a high-tech, custom crafted Dean Kamen Clock, which the *New York Times* called "Art That Ticks." Each finalist carries home one gear from The Clock, symbolizing their team's efforts to build an award winning team.



### 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.

## 6.2 Founder's Award

Each year 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, the City of Manchester, NH, will pass on the trophy clock to the '97 winner at the Awards Celebration in Orlando.

## 6.3 Judges' Awards

On Saturday evening, April 12, 1997, FIRST will hold an Awards Celebration at the Epcot Arena. At this event, a special judging panel will present the following awards:

- Chairman's Award
- Chairman's Award Finalists (5)
- 1997 National Champion
- Most Creative Design
- Best Offensive Round
- Outstanding Defense
- Best Play of the Day
- Best Team Spirit Display
- Best Sportsmanship
- Lightest Machine in Finals
- Number One Seed
- Most Photogenic
- The Procter & Gamble Creativity Award
- Motorola Quality Award
- Honeywell Leadership in Control Award
- Rookie All-Stars (3)
- Woodie Flowers Award for Teaching Innovation

presented by SMALL PARTS, Inc.

*A regional series of judges awards is also planned.*

**6.4 Autodesk Excellence in Engineering Creativity and Communications Award**

This award is determined by a special Autodesk judging panel prior to the event. Information about the Autodesk Animation Competition is located in Appendix E.

**6.5 WPI Design Innovation Scholarship**

Information about the WPI Design Innovation Scholarship is located in Appendix F.

**6.6 Daniel Webster College Scholarship**

Details on the Daniel Webster College Scholarship will be forthcoming.



## AUTODESK JUDGES AWARD

### ENTRY SPECIFICATIONS AND GUIDELINES

#### *For Excellence in Engineering Creativity and Communication*

##### **Competition Objective**

To clearly and creatively present design solutions for the Competition challenge through computer modeling and animation using industry standard software.

##### **Entry Requirements**

The Competition is open to all teams participating in FIRST—THE COMPETITION 1997. The Competition period for this award category is from January 11, 1997 to March 7, 1997 (contact FIRST for other Competition deadlines).

All Entries MUST include not more than 30 seconds (maximum) of animation created using Autodesk® software or Autodesk® Registered Developer products and a hard copy of the storyboard outline for the animation. Limit one (1) submitted Entry per team. Each Entry MUST include a properly completed Competition Entry Form representing each individual contributor (collectively, the "Entrant"). The Entry Form MUST be accompanied by a signed Autodesk® Archive Consent and Release Authorization (AC&R) agreement for the animation entered.

The AC&R form grants 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 AC&R form.

If Entrant's corporate or college/university sponsor or school has any rights or claims to the images or animation in an Entry, the Entry Form and the AC&R agreement MUST also be signed by an officer of such employer or parent company or school; otherwise, the Entry will be disqualified. Entrant and, where applicable, Entrant's sponsor and school represent and warrant that the image and animation in each Entry is owned by the Entrant and/or school and/or 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 imagery, animation, or sounds by the aforementioned violates any right of such third party.

Entry MUST NOT include any proprietary information, logos, or trademarks.

##### **Responsibility**

Autodesk is not responsible for Entries not delivered to Autodesk's San Rafael, CA, office by the DEADLINE of 5:00 PM on March 7, 1997 (See "Entry Deadline") nor for any lost, late, misdirected, illegible, incomplete, or damaged Entries.

## **Prizes and Prize Rules**

One (1) FIRST—THE COMPETITION 1997 Judges Award trophy will be presented to the team whose Entry best represents the objectives of this competition category. In addition to the trophy, a limited number of student contributors on the winning team *may* receive a choice of 3D Studio® Release 4 or 3D Studio™ MAX from Kinetix™, a division of Autodesk, Inc.

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 FIRST—THE COMPETITION 1997 National Championship Awards Ceremony being held at Epcot on April 12, 1997. Software awards will be shipped directly to individual student contributors following the Competition.

## **Judging**

Entries will be judged using preset criteria as defined below. Judging will be conducted by employees or consultants of Autodesk, its subsidiaries, or associated companies and organizations. The judges' decisions are final. Judges are not required to award prizes by default.

Entries may incorporate the robot design, the robot's functionality, how the Competition is run, or any other aspect of FIRST—THE COMPETITION. The approach taken will be determined by the Entrant.

Judges will evaluate and score each Entry based on the following:

### *Creativity/Innovation (50 pts)*

An overall measurement of the distinctiveness of the entire piece. The degree to which the use of the technology, storyboard, composition, realism, and aesthetics demonstrate a striving toward a standard of excellence, and the degree to which the final animation is different from other Entries. Quality measured in terms of that "edge" that separates the winning Entry from all others submitted.

### *Storyboard (15 pts)*

A quality measured in terms of effective planning, organization of content, and in terms of what the audience understands from the final animation.

### *Composition (15 pts)*

A quality measured in relation to the storyboard in terms of how well the objectives are implemented and of how the final animation is brought together from storyboard to design, revision through thoughtful editing, and final presentation (see Entry Specifications).

### *Realism (10 pts)*

The degree to which the animation realistically and accurately portrays something about the robot design and functionality, how the Competition is run, or any other aspect of FIRST—The Competition.

### *Aesthetics (10 pts)*

A quality measured in more subjective terms and in relationship to effective use of color, lighting, cameras, motion, sound effects, humor, etc.

**Entry Deadline: 5:00 PM, March 7, 1997**

All Entries (regardless of preferred shipping method) MUST be received at Autodesk, Inc. not later than 5:00 PM on March 7, 1997. Entries will not be accepted for judging after the deadline.

Ship Entries to Autodesk, Inc., Marketing Support Team—Image Archives, 111 McInnis Parkway, San Rafael, CA 94903, Attn.: Autodesk Judges Award.

**Entry Specifications**

- MUST submit a hard copy of the storyboard in 8½ -by- 11-inch format and not more than three (3) pictures per page and a total of six (6) pages.
- MUST include not more than 30-seconds (maximum) of animation. Credits are acceptable but will not be included in judging Entries or in the 30-seconds of animation.
- Animation MUST be submitted as videotape in one of the following tape formats: BETACAM SP; ¼ inch; SVHS, Hi-8; or VHS tape in NTSC format.
- Animation MUST NOT include the use of any proprietary information, soundtracks, logos, or trademarks including the official FIRST and/or Autodesk logos.
- Animation MUST be created using Autodesk or Autodesk Registered Developer software products.
- Entry MUST be clearly labeled with the title of the animation submitted, the corporate sponsor, the school, and the name, daytime phone, fax number, and e-mail address of your team's primary contact.
- Entry MUST be accompanied by a completed Competition Entry Form including an appropriately signed Autodesk Archive Consent and Release Authorization (AC&R) Form.

*Note: Entries will remain the property of Autodesk, Inc. No hard copies, digital files, videocassettes, or computer disks will be returned.*

Direct all Entries to the following address: Autodesk, Inc.  
Marketing Support Team—Image Archives  
111 McInnis Parkway  
San Rafael, CA 94903  
Attn.: FIRST Judges Award

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 should be omitted from the Entry if 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.

## APPENDIX F - WPI DESIGN INNOVATION

**SPECIAL ANNOUNCEMENT**

January 11, 1997

**The Competition-1997  
WPI Design Innovation Scholarship**

FIRST and Worcester Polytechnic Institute (WPI) are proud to once again announce a bold step for the The Competition-1997. This year, WPI and FIRST will award a full four-year undergraduate scholarship to one of the FIRST student participants to attend WPI.

With this WPI Design Innovation Scholarship, FIRST continues on with an academic strategic alliance to provide FIRST participants with not only an introduction to math, science, technology, and engineering, but an opportunity to pursue studies, gain experience, and choose a career in these exciting fields.

One of FIRST's main goals is to show today's kids that it is important to be smart and profitable to use your brain. The addition of this \$75,000 scholarship to WPI is one more way in which WPI and FIRST will show today's students that science and technology can be fun and rewarding.

All teams participating in The Competition-1997 will qualify for the WPI Design Innovation Scholarship. The winning team will be selected through a vote conducted by all of the teams. Each team will receive one ballot containing five criteria with which they must select a first (50 points), second (25 points), and third (10 points) place candidate other than their own team. The criteria includes: (1) the robot with the most innovative design, (2) the team that thrives in a partnership or teamwork atmosphere, (3) the team whose student participants demonstrate enthusiasm for engineering and science, (4) the team displaying the best sportsmanship, and, (5) the best team spirit. All votes must be submitted to FIRST in time for the final awards ceremony to take place at the National Championship at Epcot on April 10-12, 1997. The scholarship award will be presented to the team who receives the most points.

Once the winning team has been selected, the scholarship award will be made to an individual student designated by the corporate member and school of the winning team.

The student selected for the scholarship may be from any grade level and must have demonstrated enthusiasm for engineering and science and possess the ability and innovation necessary to excel as an engineer or scientist. WPI's project-based curriculum is well suited to students with demonstrated ability to take responsibility to thrive in the team environment, to solve problems and to assume leadership; in short, the same characteristics for success in FIRST. The winning student must also meet WPI's admission requirements and must maintain satisfactory academic progress at WPI to maintain the award. Ultimately, the student selected for the WPI Design Innovation Scholarship should exemplify the spirit of the FIRST program.

FIRST would like to congratulate WPI for blazing a trail for other academic institutions to follow. FIRST and WPI remain committed to introducing today's students to the many rewards that science and technology offer. This scholarship will provide a student with the opportunity to obtain an undergraduate degree as a result of their participation and effort in the FIRST program. More importantly, it highlights a key role academic institutions can play in continuing the demand for excellence in science and technology created through the student, teacher, academic institution and corporation partnership.

## APPENDIX A - COMPLETE LIST OF RULES

- T1. Referees have ultimate authority during The Competition--their rulings are final.
- T2. If a team is disqualified by a referee, their robot is turned off for the remainder of the match, the human player must cease interacting with tubes at the player station, and any points scored during that match will be forfeited.
- T3. If a robot is disabled by a referee, the robot is turned off for the remainder of the match, and any points scored during that match will count. The human player may continue to interact with tubes at the player station.
- T4. A team 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' robots are not in the spirit of The Competition and will not be allowed. Turning over an opponent's robot 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. Robot shoving will be allowed and is expected to be quite common; however, if you damage opponents' robots, referees may take action against your team. Possible actions include, but are not limited to: stopping the match to allow the damaged robot to be repaired before resuming play, a complete rematch after repairs have been made, or disqualification of your team and forfeiture of any points scored.
- T7. If a team's robot 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 robot, it may result in disqualification. However, if the damaged team's robot is considered too flimsy to begin with, the other team may not be disqualified. The ultimate determination will be with the referees.
- T9. Deliberately damaging the playing field, controls, or tubes (using spiked wheels, for example) is strictly illegal and may result in disqualification.
- T10. If a robot damages the playing field, barriers, tubes, or another robot, even inadvertently, and the referees feel that further damage is likely to occur, the referees may decide that corrective measures (such as eliminating a sharp edge) are required to allow the robot to continue competing.
- T11. A robot may not intentionally contaminate the playing field, tubes, goal, or another robot with lubricants.
- T12. After a match, team members are not allowed on the playing field until referees have completed the scoring procedure.

- T13. The barriers in front of the player stations are safety features, not part of the playing field. Robots should not be designed to react against them. Incidental contact with the barriers is acceptable. Pushing a tube against a barrier to allow pickup of the tube is acceptable if the forces applied are not sufficient to damage the barrier or otherwise deform the playing field.
- T14. Robots which become entangled in the barriers or goal will not be freed until after the match has finished, unless the entanglement represents a safety hazard.
- T15. If a robot goes out-of-bounds to the point that it has to apply force to any out-of-bounds surface to rejoin play, its control system will be disabled.
- T16. If one team intentionally moves another robot out-of-bounds, the robot out-of-bounds will be disabled for the remainder of the match.
- T17. Tubes which are knocked out-of-bounds will be placed back into play next to the field border near the exit point without undue delay. Tubes returned to play will not be fed directly to a robot or human player.
- T18. Tubes which are popped will be replaced without undue delay. If a tube pops while being held by a robot, the referees may opt to pause the match and place the replacement tube in the hold of the robot.
- T19. It is not the responsibility of the referees if they damage trapping devices while attempting to retrieve tubes. Please design your robot so that tubes may be retrieved quickly and easily after a match is over.
- T20. No remote communication devices, such as air phones, walkie-talkies, cellular phones, etc., may be used by teams during a match. The wireless communications systems used by FIRST staff have been carefully checked to insure that they do not interfere with the robot control systems.
- T21. During The Competition, 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 robots on the field and a maximum of one minute to remove all robot parts from the playing field following a match. You will have at least 4 minutes before your next scheduled match.
- T22. If a team is not ready to setup their robot 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 inform the field coordinator that they are invoking 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 robot is still not ready at the end of the time-out period, the team will forfeit the match.
- T23. During the finals matches (quarter-finals on), each team may take up to 10 minutes (cumulative) of time-outs which can be used to delay the start of a match if their robot 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.

- 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 robot.**
- P1. Prior to the start of each match, teams will be assigned a color: Red, White, or Blue. This color will be used to determine the placement of the robot, human player, and drivers & coaches around the playing field. Figures 1.1 & 1.2 show the color-based layout of the playing field.
- P2. During setup for each match, robots may be placed in any orientation within the designated starting area, but may not touch the 4x4 boundary.
- P3. 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 FIRST at each event and must be worn by these team members for field access.
- P4. The two drivers and human player must be students from a pre-college team partner school.
- P5. During a match, the robots may only be operated the drivers and/or by software running in the on-board control system.
- P6. The drivers and coaches must remain at the driver stations during the match, and may not reach over the playing field or player stations.
- P7. Human players must remain at the player stations during a match, and may not reach over the playing field or team operator areas.
- P8. Inside the player station, adjacent to the playing field, is a three foot interaction zone. Although this is part of the player station, players may not apply weight (stand, sit, kneel, etc.) to this portion of the player station during a match. Reaching and/or leaning over the interaction zone, such as to grab or throw tubes, is ok.
- The interaction zone is intended as a safety feature to help prevent potentially dangerous contact between robots and humans. Please exercise caution when reaching into the interaction zone.**
- P9. The player stations are not considered part of the playing field, and are thus off limits to the robots. (*See rule T15.*)
- P10. For safety reasons, no part of a robot may touch the human players. If this occurs due to an intentional act, the team causing the safety hazard will be disqualified. If this occurs by accident, the robot causing the safety hazard will be disabled. The referees will decide whether the violation was intentional or an accident.
- P11. For safety reasons, no robot may launch a projectile of any sort, including tubes, toward the player stations or driver stations, with the one exception

noted below. If this occurs due to an intentional act, the team causing the safety hazard will be disqualified. If this occurs by accident, the robot causing the safety hazard will be disabled. The referees will decide whether the violation was intentional or an accident.

- It is acceptable for a robot to launch tubes, but no other types of projectiles, toward the player station assigned to the same team as the robot.
- P12. During a match, no team member may intentionally touch any robot, except for reasons of personal safety. If this happens, the team will be disqualified.
- P13. During a match, no driver or coach may intentionally touch a tube, except for reasons of personal safety. If this happens, the team will be disqualified.
- P14. A human player may choose not to return tubes to the playing field. However, any tubes which leave the player's station, such as by rolling or being pushed out of the boundaries, will be returned to the playing field near the player's station without undue delay.
- P15. Human players may use only their bodies to interact with the tubes. Special clothing and/or equipment will only be allowed for those who demonstrate a need based on a physical disability.
- P16. Each team will start with 3 tubes in the interaction zone at their player station, and 6 tubes on the playing field. The tubes on the playing field will be arranged in stacks as shown in Figures 1.1 & 1.2.
- P17. 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.
- P18. Final scoring will begin when all tubes come to rest or upon a referees' decision. Team members will not be allowed onto the field until all scoring is complete.
- P19. Final Scoring - Phase I
- Each tube on any peg is worth 1 point. A tube will count as "on a peg" if any part of the peg, including the end flange, passes through the hole at the center of the peg. See Figure 1.3 for an example.
  - Each tube on or above the center of the top of the goal is worth 1 point. A tube will be considered "on or above the center of the top of the goal" if the rotational axis of the goal passes through the open middle of the tube, and the tube is above the bottom of the apex bracket.
- P20. Final Scoring - Phase II
- Each tube on or above the center of the top of the goal doubles the score.

- Each vertical row of tubes doubles the score. A "vertical row" occurs when a team has at least one tube on every peg on one corner of the goal. Separate vertical rows may be achieved on separate corners. Alternately, if a team has at least two or three tubes on every peg on one corner of the goal, they will achieve two or three vertical rows, respectively.
- P21. All decisions regarding scoring will be made by the referees.
- P22. The winner of a match is the team with the highest score.
- P23. In the event of a tied score the following tie breaking conditions will be applied in the order below until the tie is won:
- The team with the highest tube in a scoring position wins the tie. To be considered highest, it must be the highest tube on or above the center of the top of the goal. If no tubes are in that position, it is the tube on the highest level of pegs. Subtle variations in height for a given level of pegs will not be considered.
  - The team with the most tubes in scoring position in the highest level of the goal. This starts at the top level of pegs and progresses to the lowest level of pegs until the tie is broken.
  - The team with the most tubes (of any color) in their player station.
  - The team with the highest tube not contacting the floor.
  - The team with the tube closest to the center of the base of the goal.
- P24. Robots may not intentionally move or prevent the free rotation of the goal by placing objects underneath the triangular base of the goal. However, it is acceptable for a robot to move or block the goal via other means.
- F1. All field dimensions listed in Section 2 are  $\pm 1$ " non-cumulative.
- F2. Tubes will be inflated to size, not pressure. All tube dimensions listed in Section 2 are  $\pm 1$ ".
- F3. The playing field carpet will rest directly on the floor except where otherwise noted.
- F4. The central goal will rest directly on the floor. The carpet will overlap the circular disk by three inches, and will be attached to the disk via heavy duty staples.
- 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. Safety glasses must be worn by all team members in the driver stations and player stations during matches, and in the pit area when working on robots. They are also highly recommended if your neighbor(s) in the pit are working on their robot.
- S3. Any robot which causes a safety hazard during a match will be disabled.

- S4. If at any time the referees determine that a robot is likely to cause safety hazards in future matches, the robot must be modified to the referees' satisfaction or it will not be allowed to compete.
- S5. 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, the inner tubes are the only projectiles the latex tubing may be used to launch.
- S6. Projectiles must have a frontal area greater than or equal to 10 square inches and be shaped to avoid eye injury.
- S7. **Do not tamper with the power supply, batteries, chargers, speed controllers, 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, and lead to a safety hazard or damage to the robot.
- S8. Remove batteries from the robot while making adjustments to your robot. Due to the strength of the motors in the Kit, it is important to keep fingers away from the gears while your robot is connected to a power supply.
- S9. 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, fire, and/or permanent destruction of the batteries.
- M1. The energy used by the robots 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.
  - storage achieved by deformation of springs purchased from Small Parts, Inc. (SPI) Latex tubing from SPI may not be used as a spring.
- M2. Robots must sit, unconstrained, inside a 36" square footprint and be no more than 48" high at the start of a match. The weight of the robot, including batteries and control system, may not exceed 120.0 pounds.

**Size  $\leq$  36" long x 36" wide x 48" high; Weight  $\leq$  120.0 pounds**

*Keep in mind that these are maximum dimensions. It is recommended that robots be designed for slightly smaller dimensions and weights in order to allow a degree of tolerance for oversized/overweight mechanisms and differences in measurement between the team and the official inspection. Many teams have discovered the hard way that reducing size and weight while preserving functionality is no easy task after the robot has been constructed.*

*Also, many shippers such as UPS will not ship packages as large as a full robot. Many teams have found it helpful to make ease of disassembly and reassembly one of the design goals.*

- M3. All robots 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 robot are necessary to meet the above requirements, they must be completed before seeding matches begin.
- M4. **Teams are expected to design and build robots to withstand vigorous amounts of interaction with other robots.** (See also rules T6-8.)
- M5. Until the controls are enabled at the beginning of each match, robots and any appendages, extensions or projectiles must remain unconstrained within the 36"x36"x48" starting size. Once a match begins, robots may extend beyond that limit under their own power.
- M6. Robots must be designed to operate by reacting against the surface of the playing field, the innermost face of the 4x4 field border, the goal, the tubes, the other robots, and the air. (See Section 2.2 for Field Diagrams.)
- M7. **Robots must display their team company and school names and/or logos. The judges, referees, and announcers must be able to easily identify them by name. In addition, team numbers must be displayed on at least two opposite sides (180 degrees apart) of the robot. Numbers should be at least 3 inches high and clearly visible from a distance of not less than 50 feet.**
- M8. During a match, robots may be manipulated only by the normal operation of the wireless programmable control system.
- M9. Gaining traction by using adhesives or by damaging the surface of the playing field or the tubes is not allowed. (See also Rules T9-10.)
- M10. During any Competition event, any mechanism which will alter the operation of the robot may not be added or removed after the first match of the seeding rounds unless mandated by the judges for rule compliance reasons. However, mechanisms existing on the robot may be reconfigured between matches. Also, the control system may be reprogrammed as described in the control system rules between matches.
- M11. No substitute robots are permitted; however, functionally identical replacement parts are allowed.
- 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 defined 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 robots. The Transmitter box, Receiver box, servos, speed controllers, RNETs, antennas, batteries, battery chargers, 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 and Receiver may be set for custom operation.
- the user programmable code in the Receiver may be customized.
- the speed controllers may be calibrated as described in the Tekin REBEL Owner's Manual.
- The connectors on the ends of the 12 AWG wires on the Tekin REBEL Speed Controllers must be removed. Do not remove the connector on the 24 AWG, 3 wire PWM cable.

**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 only exceptions to this rule are:

- Tape may be used to secure the position of the trimmers on the Joysticks in order to prevent accidental changes in calibration.
- Stick-on hook & loop fasteners may be used to attach the speed controllers.

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

C4. **Only the wire supplied in the Kit may be used to conduct electricity.** Additional wire is not permitted.

C5. Electrical devices may only be wired as described in Section 4. Some important facts are listed here in Section 3.3.

C6. The 12 gauge wire must be used for connections from the batteries to the speed controllers, from the speed controllers to any motors, and from the batteries to the Receiver box.

C7. The 16 gauge jacketed cable must be used for any device connected to a relay output.

- C8. The 22 and 24 gauge wire may only be used for connecting sensors (limit switches, reed switches, rocker switches, air pressure switches, potentiometers) to inputs or for extending the PWM cables.
- C9. **Relay outputs may not power more than one device per output.** (The double-solenoid valve is considered one device, because the diodes may be used to route power to only one solenoid at a time.)
- C10. **Only the Receiver, speed controllers, and muffin fan may be connected directly to the battery outputs.**
- C11. The battery contacts inside the Skil drill shells must be used to draw power from the batteries. If the handle part of a drill shell is cut away from the main body, the wire side of the contacts must be insulated with heat shrink tubing or electrical tape to prevent short circuits.

*It is strongly recommended that the contacts be used in conjunction with the handle of the drill shell and the battery clip at the end, as they are designed to hold the battery snugly yet allow for easy changeover of batteries.*

- C12. The Skil drill motors may be powered only by the Tekin speed controllers.  
**Do not connect the drill motors to the relay outputs.**
- C13. No more than one motor may be powered by each Tekin speed controller.
- C14. The Delco seat motors and Delphi tape drives may be powered by the Tekin speed controllers or the relay outputs.
- C15. Two 0.1 $\mu$ F capacitors, included with each speed controller, must be installed on each motor connected to a speed controller, as described in the Tekin REBEL Owner's Manual.
- C16. 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.
- C17. One 30A circuit breaker (provided in the Kit) must be installed in series with the positive terminal on each battery contact, such that all battery output flows through this breaker before being distributed to the Receiver, speed controllers, fan, or other battery. The circuit breaker must be accessible for inspection at each Competition event.
- C18. Only the 9 volt power supply included with the Kit should be used to power the Transmitter box. Use of an alternate power supply could damage the Transmitter box or RNet and is therefore prohibited.
- C19. Do not connect 12 volt power or ground wires to the relay outputs. Doing so will cause a short circuit and may damage the Receiver.
- C20. Do not connect power or other outputs to the sensor port on the Receiver. Power for sensors is available from the sensor port.
- C21. Any sensors used on the robot must be connected directly to the sensor port on the Receiver, and may not be wired in series with the motors, pumps, or valves.

- C22. RNETs may not be used in the Pit Area at any Competition event. A tether must be used for bench testing.
- C23. If the control system is damaged due to improper wiring or misuse, FIRST will charge for repair or replacement of the affected items. (*See Section 3.7 for details.*)
- C24. Robots must only be operated with both batteries present and wired in parallel.

**Operating a robot with only one battery can permanently destroy the battery. Don't do it!**

- C25. All wires distributing power with a constant polarity (i.e. not a relay or speed controller output) must be color coded as follows:
- Use Red 12 AWG or White 16 AWG wire for +12Vdc.
  - Use Black 12 or 16 AWG wire for GND.
- C26. **Teams are responsible for any software bugs introduced into the Receiver's control program when using a custom program. If a software bug negatively impacts the performance of a robot during a competition match, it will not be grounds for a rematch or even a pause in the match.**
- K1. Each robot must be constructed exclusively from materials provided in the Kit of Parts ("the Kit") supplied by FIRST, with the following additions and exceptions:
- 2' x 4' x 1" ROHACELL™ P170 structural foam shipped to each team from FIRST.
  - Material available from outside sources, as explained below.
  - Material satisfying the unlimited quantity criteria, as explained below.
  - The Kit container, part packaging, and any documentation in the Kit container may not be used to build the device.
  - Adhesive tape may not be used except as an electrical insulator.
  - Lubricants may not be used except to reduce friction within your own robot.

### **Outside Sources - 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 Appendix D for more details on accounting and ordering.

Up to \$425 worth of materials purchased from Small Parts, Inc. may appear on your final robot. Items which appear below in the unlimited quantity category do not count against the \$425 limit when used as described.



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 robot 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.

### **Outside Sources - Additional Hardware List**

Materials on the Additional Hardware List may be obtained from any supplier, but in limited quantity. A specific list of materials and maximum quantities/dimensions is provided in Section 3.6. Cost is not considered.

If an item on the Additional Hardware List is available from Small Parts, Inc., then it may be purchased from SPI without being counted against the \$425 limit on materials purchased from SPI. However, any amount of the item purchased from SPI above and beyond the quantity allowed in the Additional Hardware List will count against the \$425 limit. Obviously, any item purchased from SPI will count against your credit limit, regardless of whether or not it is listed in the Additional Hardware List.

### **Unlimited Quantity Items**

The following items may be used in unlimited quantity subject to the following criteria. (*See rule K9*)

- Fasteners, washers and adhesives -- if used for joining and fastening purposes only.
- Fasteners -- if used as pins in a linkage or as hinge pins.
- Crimp-on spade connectors -- if used to conduct electricity, used with the proper gauge wire, crimped properly, and fully insulated, such as the Thomas & Betts units provided in the kits.
- Adhesive tape -- if used as an electrical insulator.
- Lubricants -- if used to reduce friction within your own device.
- Teflon tape -- if used around the threads of pneumatic fittings to prevent leaks.
- Shrink wrap tubing of any diameter -- if used for electrical insulation.
- Pipe fittings (tees, reducers, elbows, and angles) -- if used to join sections of pipe
- Endcaps -- if used to cap pipe.

- 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 robot.
- K3. There is no restriction on the total quantity of sprockets/pulleys and chain/belt that can appear on your robot. However, there is a restriction on the amount which can be obtained from outside sources other than SPI. (*See the Additional Hardware List and Rule K4 .*) Any quantity above the amount listed on the Additional Hardware List must therefore be purchased from SPI, or manufactured from raw materials available from either the Kit, the Additional Hardware List, or SPI.
- K4. As denoted in the Additional Hardware List, each team may purchase from an outside source sprockets (not gears) and/or pulleys and additional chain and/or belt, with the following conditions:
- On your final robot, you may use no more than a combined total of 4 sprockets and/or pulleys from outside sources other than SPI.
  - On your final robot, you may use no more than a combined total of 10' of chain and/or belt from outside sources other than SPI. 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 robot.
  - These components must be "commercially available," strictly *off-the-shelf* only. No custom or special orders.
  - A double-sprocket or double-pulley assembly counts as two sprockets or pulleys, respectively.
- K5. Gears (not sprockets) must be purchased from SPI, or manufactured from raw materials available from either the Kit, the Additional Hardware List, or SPI.
- K6. The dimensions for sheets and boards listed in the Additional Hardware List represent the maximum length and maximum width which may be purchased, not the total area. The thickness represents a fixed quantity, not a maximum.
- K7. The dimensions for rods and shafts listed in the Additional Hardware List represent the maximum length that may be purchased for a given diameter of rod/shaft.
- K8. You may purchase only one of the three types of 1/2" or thicker wood listed in the Additional Hardware List; Plywood, Chipboard, or Particleboard.
- K9. Items listed as unlimited quantity items, when used without satisfying the criteria for unlimited use, must be purchased from SPI against the \$425 limit or manufactured from raw materials available in the Kit, from the Additional Hardware List, or from SPI.
- K10. Net material is allowed; however, if it is used to entangle opponents' robots, the referees may disallow it.

- K11. For safety reasons, you may not fabricate your own springs. However, it is acceptable to elastically deform and relax materials not designated as springs as long as the rate at which the energy is released does not exceed the rate at which the energy was stored. This is intended to allow reasonable use of the elastic properties of materials without creating unsafe conditions caused by sudden the release of stored energy in materials not designed to act as springs. Materials which are designated as springs include: All items listed in the Springs section of the Kit List, and compression, tension, torsion, constant force, and washer springs available from Small Parts, Inc. Latex tubing from SPI is not considered a spring.
- K12. A limited number of replacement parts will be made available by 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.
- K13. 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.
  - metal may be heat treated in order to improve surface hardness
  - metal may be anodized to improve appearance
- Completely melting and recasting a material is considered a chemical change. However, merely heating a material, such as a sheet of polycarbonate or ROHACELL™, in order to bend it into a new shape without cracking is not considered a chemical change.
- K14. The mailing tubes provided in the Kit are considered packaging material and may not be used during any Competition event.
- K15. All unused parts and materials must be returned to FIRST for proper recycling.
- K16. The control system is the property of 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 robots after this period, FIRST can provide basic instructions on how to refit the robots to use off-the-shelf remote control systems.

## 2. THE PLAYING FIELD

### 2.1 Playing Field Description

The playing field is a carpeted, hexagon-shaped area with a freely rotating central goal. Around the perimeter of the field are three stations for human players, and three stations for drivers and coaches. At the start of each match, inner tubes are placed in various starting locations around the playing field and at the player stations, as shown in Figures 1.1 and 1.2.

### 2.2 Playing Field Construction

Section 2.2 presents the information necessary to replicate the playing field and tubes.

#### Border

The perimeter of the field is defined by three sections of a curb of 4x4 lumber, resting directly on the carpet, and three barriers which join these sections.

#### Player Stations

There are three player stations located outside the perimeter of the playing field. The stations are centered on three adjacent sides of the hexagonal field border. There are breaks in the usual 4x4 border of the playing field at the interfaces between the field and the player stations. A special barrier, designed to allow tubes to be pushed into the player station without allowing robots in, is used at these interfaces. Aside from these barriers, the player stations have no physical structure. Player station borders are represented by tape on the floor.

Each player station is 5 feet wide (parallel to the field border), and 6 feet long (extending out perpendicular to the field border). Each station is divided into two areas, an area where the player can sit/stand/kneel/etc., and the interaction zone. The interaction zone extends outward from the playing field border for a distance of 3 feet. The remaining area extends a further 3 feet from the interaction zone. The exact dimensions and locations of the player stations are indicated on the Playing Field blueprint provided by FIRST.

The special barrier is constructed from 2"Ø metal pipe and fittings, and is mounted to the tops of the 4x4 border by pipe flanges. Small sections of 2x4 are mounted to the outside of the 4x4 border to provide sufficient width to mount the pipe flanges. In addition, an oak 1x4, which rests on top of the playing field rug, is used to provide a rigid connection for the sections of 4x4 that make up the field border. This board is attached to recesses in the bottom of the 4x4 border such that it does not raise the 4x4s off the rug. The exact dimensions of the barrier are indicated on the blueprint.

#### Driver Stations

The driver stations are located outside the playing field to the right of the player stations. Driver stations have no physical structure other than a shelf on which the Transmitter and associated control system equipment can be placed. The

borders of the driver stations are represented by tape on the floor. The exact dimensions and locations of the driver stations are indicated on the blueprint.

### **Goal Assembly Procedure:**

The goal consists of a triangular wooden base upon which is bolted a pyramid shaped vertical structure fabricated from steel pipe, metal castings, and a connecting bracket at its top called an apex bracket. The entire unit is mounted on three, fixed caster wheels which allow the goal to rotate as a unit about its vertical centroidal axis. A short vertical, central steel stub shaft and ball bearing assembly, bolted to a large plywood disk that rests on the playing field floor (floor disk mount) keeps the goal located in the center of the playing field while allowing it to rotate due to moments it may be subject to by robots and inner tubes touching it during a competition round.

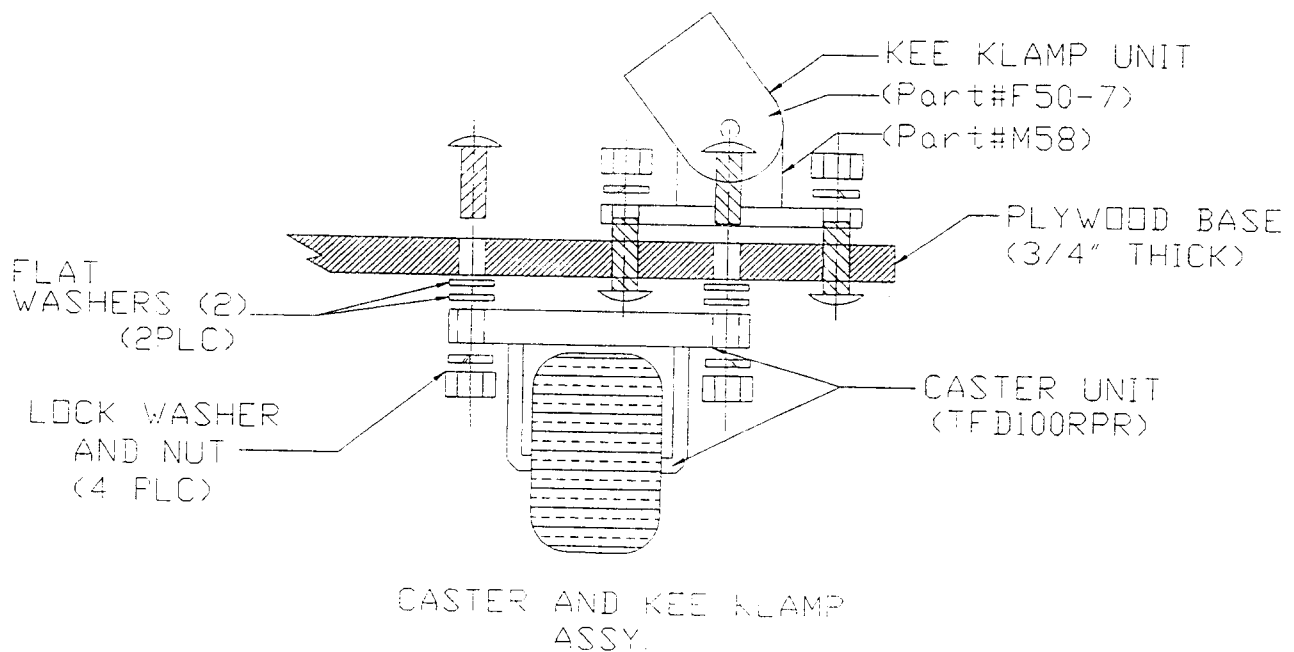
It is important that this procedure be carefully followed when fabricating the goal base and assembling the metal parts to it. **Read through this procedure in its entirety and plan it out before starting the assembly process.** Carry out the steps in numerical order, and carefully measure and lay out all dimensions as indicated. The various metal fittings used in this year's game design have been sourced from the Kee Industrial Products Co. Refer to the Playing Field blueprint provided by FIRST and the drawings herein, and review to the KEE KLAMP fittings catalog provided in the kit of parts.

- 1) Begin fabricating the triangular base by cutting out an equilateral triangle from a sheet of 3/4" thick plywood, the triangle being exactly 48" on each side.
- 2) Locate the exact center of the triangle as follows: bisect each side of the triangle, and pencil in a line from each side's center point to its opposite apex. All three lines should cross exactly at the geometric center point of the plywood base. Drill a small hole (1/16" diameter bit) through this center point. Be sure that the drill is perfectly normal (perpendicular) to the surface of the plywood. Flip the base over, and pencil in reference lines on the bottom surface from each triangle vertex to the drilled center hole. You now have established the important references from which all other measurements will be made when assembling the goal.
- 3) Fabricate a protective skirt for the base by measuring and cutting three appropriate lengths of standard stock 2"x4" lumber (actual dimensions are 1-1/2" x 3-1/2"), and attach the narrow (2") edges of the 2x4s to the plywood base thus forming a protective skirt around it. Use both wood glue and screws, driving 4 evenly spaced 2" long wood screws down through the top of the plywood into the narrow edge of each of the 2x4s, keeping the outer edges of the 2x4s aligned with the vertical edges of the triangular base. Also screw the butt ends of the 2x4s together, while keeping the screws away from the tip areas that will be removed when the triangle's points are cut off. Once the glue has set, saw off the three sharp points of the triangle thus creating a 1" flat on each one. Sandpaper the resulting base to remove any splinters and sharp edges.

- 4) On the top surface of the wooden base, carefully measure and mark the positions of the cast base plate fittings (KEE P.N. M58) at each vertex of the triangle. Mark the locations of the two bolt drill holes of each fitting on the lines previously penciled in step 2) above.
- 5) Flip the base over and carefully measure and lightly mark the four mounting hole locations for each of the three supporting fixed casters. Temporarily position the fixed casters on the bottom surface of the wood base over the mounting hole marks such that the wheel axles are directly over and parallel to the radial reference lines previously marked between the triangle apexes and base's geometric center. Carefully measure and verify the specified distance from the center of the plywood base to the center of each wheel's footprint. Check that there is no interference between the inner edges of the 2x4 skirts and the casters' mounting flanges. Check the positioning of the casters relative to the KEE cast base plate fittings on the top surface of the base. With the **exception of the inner bolt holes** of the KEE base plates fittings, there should be no overlap between bolt holes and mounting brackets of the casters and those of the base plates. Mark the final locations of the center of each of the mounting bolt holes, and using the caster mounting brackets as templates, pencil the outline of the bracket on the plywood at each apex
- 6) With the base still inverted, mark the locations of the two attachment bolt holes for the self-aligning 1" I.D. bearing at the center of the wood base. These are for the bolts that anchor the flange units (between which the bearing is clamped) that forms the central, vertical pivot of the goal proper.
- 7) Drill all mounting bolt holes in the base. Be sure the drill bits are precisely placed on the hole center marks. Use a 3/8" Ø drill bit for all the casters and center bearing bolt holes, and a 13/32" Ø bit for the KEE base plate bolts. Complete the goal base drilling procedure by cutting out the 2 1/2" diameter hole to accept the center bearing.
- 8) Assemble the goal's hardware to the plywood base as follows (see Figure 2.1):
  - a) Starting at one of the triangle apexes, insert the mounting bolts for the KEE base plate through the plywood base from **below** using two 3/8" dia x 2" carriage bolts.
  - b) Insert four 5/16" dia. x 1-1/2" carriage bolts through the plywood from **above** at the caster's position.
  - c) Place the KEE base plate on the top surface of the plywood base over the upward protruding bolt ends. Add a locking washer to each bolt, then screw on the nuts and tighten the bracket down onto the plywood. Check to be sure that the heads of the bolts have been

drawn up tightly against the underside surface of the plywood base. Repeat this procedure for the other two KEE base plates.

- d) Invert the base and place **two flat washers** over each of the four protruding wheel mounting bolts. Next, slip the three casters down over the protruding bolts (the flat washers are located **between** the plywood and the mounting brackets of the casters). Place locking washers over the bolt ends and screw a nut onto each one. Carefully adjust the casters such that their wheel axles are aligned directly over and parallel to the radial lines penciled in step 2) above. This will ensure that the wheels will be exactly tangent to the radius line from the vertical centroidal axis of the goal.
- e) Mount the central bearing onto the **bottom surface** of the plywood base by clamping the bearing between its two holding flanges, and bolt it into position from underneath using two 5/16" x 1-1/2" carriage bolts. Place a flat washer and a lock washer over the protruding bolt ends, screw on nuts and tighten the assembly.
- f) Mount the three Female Single Sockets (KEE P.N. F50-7) onto the KEE Base Plates as follows: Insert one or more washers as needed in the clearance space between the sides of the Single Sockets and the vertical tab of the Base Plates to achieve a snug fit between them. Bolt each joint together with a 5/16" dia. bolt and nut, and lightly tighten the bolts. We will hereafter refer to this Single Socket / Base Plate assembly as a swivel mount.



- 9) Prepare the pipe segments and assemble the vertical structure of the goal as follows:
  - a) The pipe used for the upper structure is standard iron pipe schedule 40 with an I.D. of 1-1/4", obtainable from most plumbing supply houses. Cut three pieces each 7' 6" long for the canted vertical posts, and nine pieces exactly 2' long for the canted horizontal arms.
  - b) Slip three of the cast iron Tees over each of the 7' 6" lengths, and carefully determine the positions of the Tees by measuring the specified distances from the top end of the vertical posts. Clearly mark their positions on the pipes for future reference. Place the Tees in their approximate positions on the pipes, and lightly tighten their set screws to temporarily hold them.
  - c) Place the goal base on a level floor and support it so that its wheels are slightly off of the floor. Place wooden blocks or their equivalent under the 2x4 skirt so that the base will not move. Using a carpenter's level and some wedges as necessary, accurately level the base in both the E-W and N-S directions.
  - d) Place a stepladder next to the base, and with someone on the ladder to hold the pipes, carefully insert the three long pipe sections into the pipe swivel mounts on the base. Be sure that the pipes are fully seated into the mounts, then tighten the set screws on the Single Sockets to securely anchor the bottom ends of the pipe sections.
  - e) Move the top ends of the pipes so that they come together approximately over the vertical center of the base forming a pyramid. Sufficiently tighten the bolt and nut fasteners at the base on the pipe swivel mounts (paragraph. 8f above) so that the pipes will remain in their canted positions without being supported at the top.
  - f) Attach the goal's top triangular shaped Apex Bracket supplied by FIRST. The Bracket consists of three aluminum plates welded into a triangular, Y shaped structure. Each plate has two bolt holes drilled near its outer end, with the holes near the top edge slightly closer to the triangular center than the holes near the bottom edge.
  - g) Position the Bracket at the top of the vertical pipes such that the top ends of the pipes are approximately aligned with the top edges of the Bracket. The pipes should be positioned such that they lie against the vertical faces of the Bracket **on the same sides as the weld beads**, with the two drilled holes in each plate falling approximately in the center of the side wall of each pipe. Using three, 6" C-clamps, temporarily clamp each pipe to the Apex Bracket. Place the clamps at the very top of the Bracket so that they are not close to the lower of the two bolt holes in the Bracket's plates.
  - h) Using a plumb bob on a length of string, drop a plumb line from the exact center of the Bracket down to the center of the vertical bearing



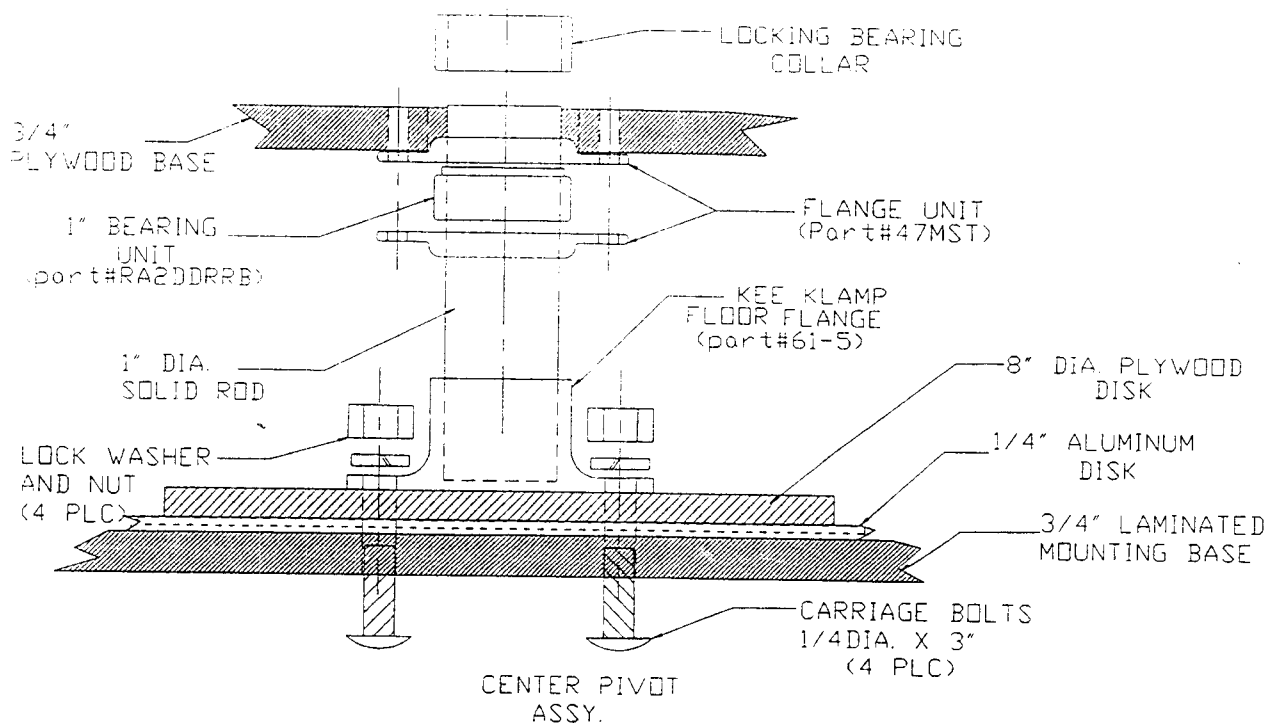
in the goal's base. Working with the Bracket and clamps at the top while observing the plumb bob, carefully adjust the Bracket until it is centered over the bearing, and its top surface is horizontal (not cocked - check it with a small level). This procedure requires a little trial and error, don't rush it!

- i) Once the Bracket is properly positioned, securely tighten the bolt and nut fasteners on the pipe swivel mounts at the goal's base.
  - j) Drill a 17/64"  $\varnothing$  hole through one of the three vertical pipes using the lower hole in the apex bracket-bracket plate as your guide. Run the drill through the hole and penetrate the adjacent pipe wall. **Note**, it is not necessary to drill into the opposite wall of the pipe. Carefully remove the C-clamp from the just drilled pipe, and holding a matching 1/4" nut with your fingers, slide the nut down into the pipe until it aligns with the just drilled hole. Now thread a 1" long x 1/4"  $\varnothing$  hex headed bolt through the plate and drilled hole, into the nut held inside the pipe. While now holding the nut inside the pipe with a small wrench, tighten the bolt securely. This will anchor the top end of the first pipe.
  - k) Repeat the above procedure at each of the other two pipe / Bracket lower hole connections.
  - l) Finally, using the same procedure as above, drill through each top Bracket bolt hole through the pipe inner wall, and place and tighten the second bolt and nut fastener on each pipe. At this point, the basic structure of the goal should form a rigid, strong pyramid structure.
- 10) Assemble the canted horizontal members to the vertical posts:
- a) Rotate the three Tees on each vertical pipe until they are roughly pointing radially outward from the center line of the goal. Lightly tighten the dual set screws to temporarily hold the Tees in place. Insert the 2' long horizontal pipe segments into each of the nine Tees, then securely tighten the single set screws that hold the short pipe segments in the Tees.
  - b) Working with each horizontal member individually, loosen the two vertical pipe set screws on the Tee, and make final adjustments to the members until each is at its specified vertical position and pointed exactly radially outward from the center of the goal. This can be done by having someone stand behind the goal, and using the vertical plumb bob line as a reference, sight back through the plumb line to the Tee and instruct another team member to rotate the Tee until the horizontal pipe is properly aligned. Give a final alignment check of all parts of the goal and securely tighten all set screws.
- 11) Assemble the flanges to the horizontal pipe segments:
- a) From a sheet of 1/4" plywood, cut out nine disks that are exactly 3 15/16" in diameter. Using one of the round Kee Klamp cast iron

flanges as a template, center it over each disk and mark the centers of two (opposite each other) flange mounting holes onto the disks. Using a 3/16" Ø bit, drill the two screw holes where marked through each disk. Chamfer (one surface only) each hole to accept a flat headed screw such that the surface of the heads will lie even with the surface of the disk. Attach one disk to the flat mounting surface of each flange using two 1/2" x 10/32" Ø flat headed screws and nuts, placing the screws through the chamfered side of the disks, then the flanges, and thread on the nuts from behind the flange.

- b) Mount the flanges on their respective horizontal posts. This completes the fabrication of the rotatable upper portion of the goal.
- 12). Fabricate the circular, laminated floor disk mount assembly (see Figure 2.2):
- a) From 3/8" thick sheets of plywood, cut four semicircular segments each having a radius of 2 1/2'. Identify the smoothest two segments (which will be used for the top surface), and set them aside. Place the remaining two segments on a flat horizontal surface with their diameters butted together so as to form a 5' diameter disk. Place and glue the other two semicircle segments on top of the bottom disk (smooth surface up), aligning the top butted diameters at 90 degrees to the seam of the bottom pair. This forms a 3/4" thick laminated floor base upon which the goal proper will ride.. Be sure that this laminated structure is perfectly flat and not warped. It will help to place weights (such as bricks) on the base until the glue has set.
  - b) Fabricate the track that the caster wheels will ride on: **Note:** for the official competition, FIRST will use a 1/4" thick disk of aluminum as the surface upon which the wheels will ride. The full weight of the goal will be carried by the three caster wheels riding on this disk which will be subject to wear with repeated use over the many competition rounds. (For their test purposes, teams fabricating goals may wish to use some other less expensive material such as 1/4" hard board (Masonite)). Cut out a 42" Ø disk from a sheet of 1/4" thick aluminum
  - c) Center and glue the disk to the top surface of the laminated floor disk mount
  - d) Cut an 8" diameter disk from a scrap of the plywood and glue it to the center of the top surface of the laminated floor disk mount. (This smaller disk functions both as a support base for the stub shaft and a reinforcement to the floor mount).
  - e) Position the small Kee Flange (P.N. 61-5, 3/4"Round Flange) at the center of the 8" plywood disk and mark the position of the four mounting holes of the flange. Using a 17/64" drill bit, drill each of the holes all the way through the entire base assembly.

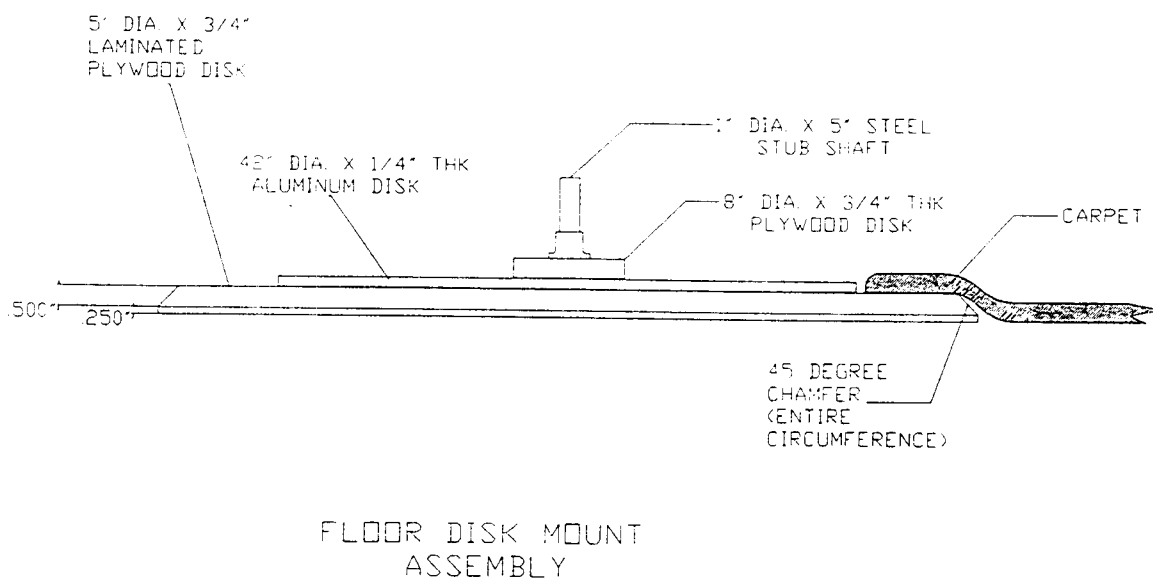
- f) Take the 1" dia. x 5" long steel stub shaft provided in the kit and check its fit with the 1" Ø goal center bearing. The stub shaft should easily slip into the inner bore of the bearing. If it is tight, use some fine emery cloth and light oil, and polish the surface of the shaft until it easily slides in and out of the bearing.
- g) Insert the 1" Ø stub shaft into the small Kee Klamp flange. Securely tighten the set screw on the flange to hold the stub shaft in place. Next place the flange on the center of the 8" plywood disk and floor mount. Check to see that the upward pointing stub shaft is perfectly perpendicular to the surface of the aluminum disk. Place flat washers as shims under the flange if needed to achieve an accurate alignment. Using four, 1/4" x 3" Ø carriage bolts, lock washers and nuts, fasten the flange and 8" disk securely down onto the mount by inserting the bolts from underneath the floor mount and drawing their heads up tightly into the laminated base.



13). Complete the goal assembly and mating with the playing field carpet (see Figure 2.3):

- Cut a 44" diameter hole in the center of the playing field carpet, and position the carpet on the competition playing field.
- Lift up one edge of the carpet, slide the laminated base assembly under it and center the base in the carpet opening. Check the level of the base and place thin shims under it if needed.

- c) Lift the upper portion of the goal, align it over the center of the floor mount, and lower it over the stub shaft to engage the shaft into the bearing on the base. Spin the upper portion to check for any binding of the wheels and vertical shaft bearing. The structure should rotate easily.
- d) Slip the locking collar down the protruding end of the stub shaft until it contacts the bearing, then raise it up 1/16" and securely lock it in place. Check to see that there is no binding against the collar when the goal is rotated.
- e) Finally, give the entire structure a quality assurance check for alignment, and recheck the tightening of all accessible fasteners.
- f) Using a staple gun, staple the edge of the circular opening in the carpet to the laminated base. (If the carpet has been rolled up, let it lay flat for a day or two before stapling it to the base).



### **Inner tube preparation:**

Each team will use nine, type KR 14 /15 rubber automobile inner tubes painted the color of the assigned team position. These are standard inner tubes, and are available at most automotive supply stores. For practice purposes, teams should procure only the above type inner tubes designed for use in radial tires. The inner tubes must be prepared for use as indicated below.

- 1) Before painting, the inner tubes must be cleaned to ensure good paint adhesion. The following cleaning procedure is recommended:  

Bring four gallons of water to a boil, remove it from the heat and pour it into a five gallon plastic bucket. Dissolve one cup of TSP cleaner (available at most paint and hardware stores) in the hot water and place three uninflated inner tubes into the solution. Using a long handled brush, agitate the tubes, turning and scrubbing them for several minutes. Repeat this process several times until the tubes have been in the solution for a total of 15 minutes. Remove them from the solution, thoroughly rinse in cool water and let dry. Repeat this procedure with the rest of the tubes. It will be necessary to use a fresh TSP solution for each batch of tubes as the cleaner will quickly darken with material dissolved from the rubber.
- 2) Inflate the tubes before painting them. Fill them with air until they reach 25 3/4" in (outer) diameter measured as follows: Lay the tube to be measured on a horizontal surface. Locate the diameter line that runs across the tube and passes directly over the tube's air filler stem. Locate the two vertical lines that just touch the outer edges of the tube where the diameter line intersects them. The distance between these points is the officially recognized inner tube diameter. A simple jig can be built that will easily indicate this measurement while the tube is being inflated.
- 3) Paint the inner tubes. Because of the flexing of the tubes, we are employing latex paints. The official paints that will be used during the competition will be Satin Breakthrough Paint manufactured by Vanex Coatings, 1700 South Shawnee Street, Mount Vernon, IL. Their phone numbers are: (618)-244-1414 and (800)-851-7390. Vanex will advise teams of the name and address of their nearest distributor. Apply a prime coat of latex primer followed by two coats of the color.

**Notes on Playing Field Construction**

- F1. All field dimensions listed in Section 2 are  $\pm 1$ " non-cumulative.
- F2. Tubes will be inflated to size, not pressure. All tube dimensions listed in Section 2 are  $\pm 1$ ".
- F3. The playing field carpet will rest directly on the floor except where otherwise noted.
- F4. The central goal will rest directly on the floor. The carpet will overlap the circular disk by three inches, and will be attached to the disk via heavy duty staples.

## 6. AWARDS

### 6.1 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 Competition - 1997 are eligible for this award. The recipient of this award is decided by an independent panel of judges at the National Championship.

While FIRST continues to leave this award without specific criteria, certain themes have developed which seem to best illustrate the partnerships efforts which stand out above others. In 1996, the team efforts continued to progress and develop beyond what we could have predicted so that the judges named finalists. The entries which were among that group consistently showed the impact that this program had on all team members, their families and communities.

Documentation may consist of any combination of the following:

- Video footage in VHS format, 10minute 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 12, 1997.

**ALL DOCUMENTATION MUST BE IN FIRST OFFICES NO LATER THAN 5:00 PM ON FRIDAY, FEBRUARY 28, 1997.**

The Chairman's Award will be presented at the Awards Celebration on Saturday evening, April 12, 1997. The team carries home a traveling trophy--a high-tech, custom crafted Dean Kamen Clock, which the *New York Times* called "Art That Ticks." Each finalist carries home one gear from The Clock, symbolizing their team's efforts to build an award winning team.

**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.

**6.2 Founder's Award**

Each year 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, the City of Manchester, NH, will pass on the trophy clock to the '97 winner at the Awards Celebration in Orlando.

**6.3 Judges' Awards**

On Saturday evening, April 12, 1997, FIRST will hold an Awards Celebration at the Epcot Arena. At this event, a special judging panel will present the following awards:

- Chairman's Award
- Chairman's Award Finalists (5)
- 1997 National Champion
- Most Creative Design
- Best Offensive Round
- Outstanding Defense
- Best Play of the Day
- Best Team Spirit Display
- Best Sportsmanship
- Lightest Machine in Finals
- Number One Seed
- Most Photogenic
- The Procter & Gamble Creativity Award
- Motorola Quality Award
- Honeywell Leadership in Control Award
- Rookie All-Stars (3)
- Woodie Flowers Award for Teaching Innovation  
presented by SMALL PARTS, Inc.

*A regional series of judges awards is also planned.*

#### **6.4 Autodesk Excellence in Engineering Creativity and Communications Award**

This award is determined by a special Autodesk judging panel prior to the event. Information about the Autodesk Animation Competition is located in Appendix E.

#### **6.5 WPI Design Innovation Scholarship**

Information about the WPI Design Innovation Scholarship is located in Appendix F.

#### **6.6 Daniel Webster College Scholarship**

Details on the Daniel Webster College Scholarship will be forthcoming.



**APPENDIX G - CALENDAR OF EVENTS AND DEADLINES**

**Hotel Cut Offs:**

**Motorola Midwest Regional:**

Embassy Suites Hotel	2/14/97
Hampton Inn	2/14/97
Holiday Inn	2/7/97
Hyatt Regency	2/12/97
Wyndham Garden	2/5/97
Marriott	2/12/97
Radisson Hotel	2/14/97

**New England Regional:**

Center of New Hampshire	2/20/97
Comfort Inn	2/26/97
Days Hotel	2/26/97
Highlander Inn	2/26/97
Susse Chalet	2/19/97
Wayfarer Inn	2/12/97

**Johnson & Johnson Mid-Atlantic Reg.:**

Clarion Hotel	2/26/97
Comfort Inn	3/1/97
Somerset Marriott	2/27/97
Quality Inn	2/21/97
Wyndham Hotel	2/26/97
Embassy Suites	2/15/97

**National Championship:**

All Star Resort	3/2/97
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Team logos .....	5:00 pm, Friday 1/31/97 at FIRST
Team Profiles.....	5:00 pm, Friday 1/31/97 at FIRST
Autodesk Award Submission.....	5:00 pm, Wednesday 3/7/97 at Autodesk
Chairman's Award Submission .....	5:00 pm, Wednesday 2/28/97 at FIRST

**Ship Robots**

Teams competing in the National Championship only must ship by 5:00pm, Friday, 2/28/97.

Teams competing in a Regional must ship to the drayage/storage facility of their first competition by 5:00 pm, Tuesday, 2/25/97.

For teams competing in more than one event...

If you are competing in this Regional... then we must receive your  
robot at the next site by this date at  
5:00 p.m.

- Motorola Midwest Regional, IL.....Tuesday, March 11, 1997
- New England Regional, Manchester, NH.....Tuesday, March 18, 1997
- Johnson & Johnson Mid-Atlantic Regional, NJ ..... Tuesday, March 25, 1997

Complete details on drayage for robots can be found in Appendix H.

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

FIRST  
200 Bedford Street  
Manchester, NH 03101

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

**Event Attendees**

Two weeks before each event, we need to get an estimate from you of how many people will be attending from your team. The deadlines are as follows:

- Motorola Midwest Regional.....Friday, February 21, 1997
- New England Regional.....Friday, February 28, 1997
- Johnson & Johnson Mid-Atlantic Regional.....Friday, March 7, 1997
- National Championship.....Friday, March 28, 1997