

1. THE GAME

1.1 Game Description

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

1.2 Field Diagrams

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

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

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

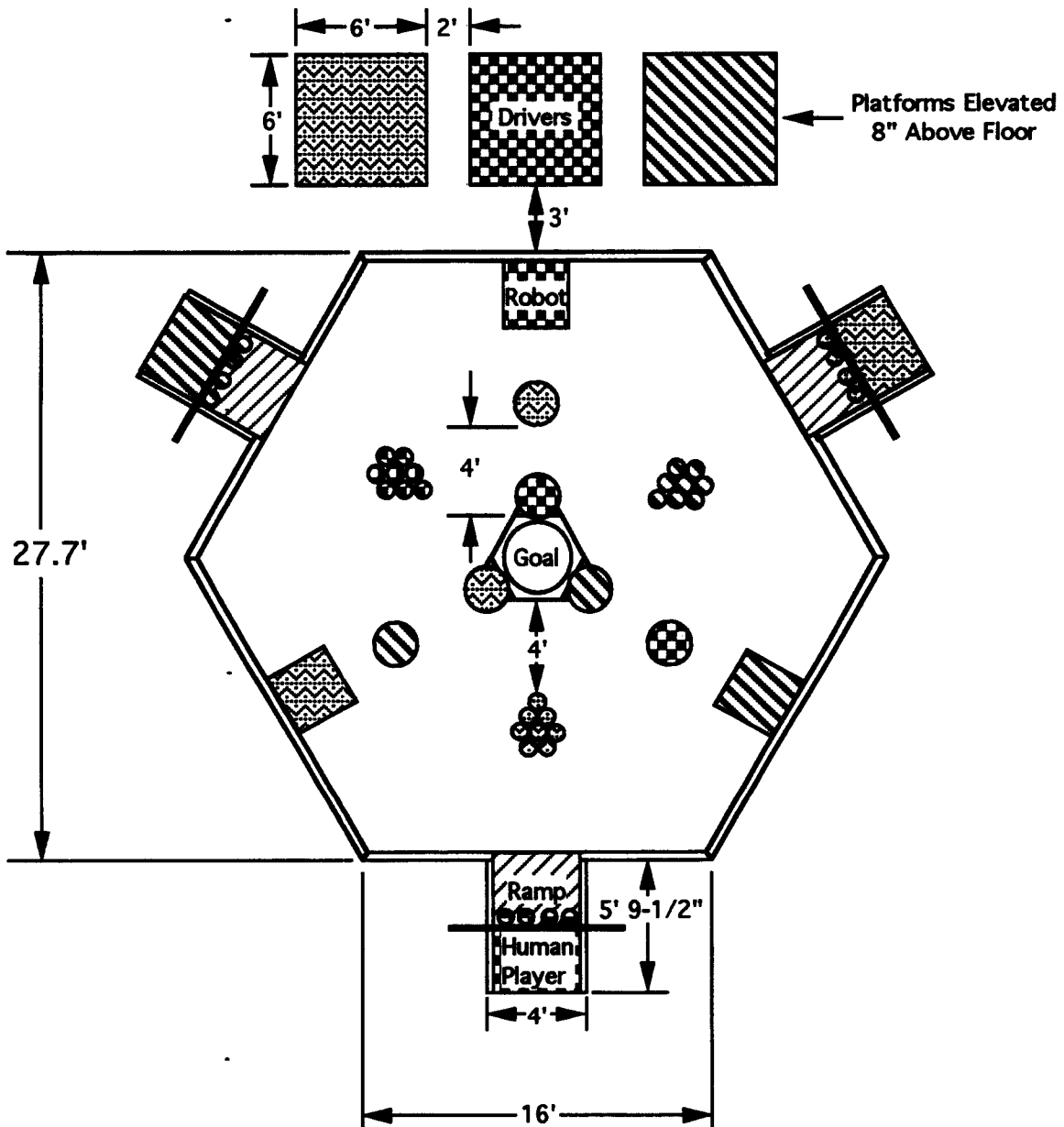
The base plate is a 3'-7" wide by 3' deep piece of 3/4" plywood connected to the lower edge of the ramp. It rests directly on the surface of the carpet. The base plate is used to secure the seat belt, the base of the posts, and indicate the area in which the human player may attempt to contain balls.

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

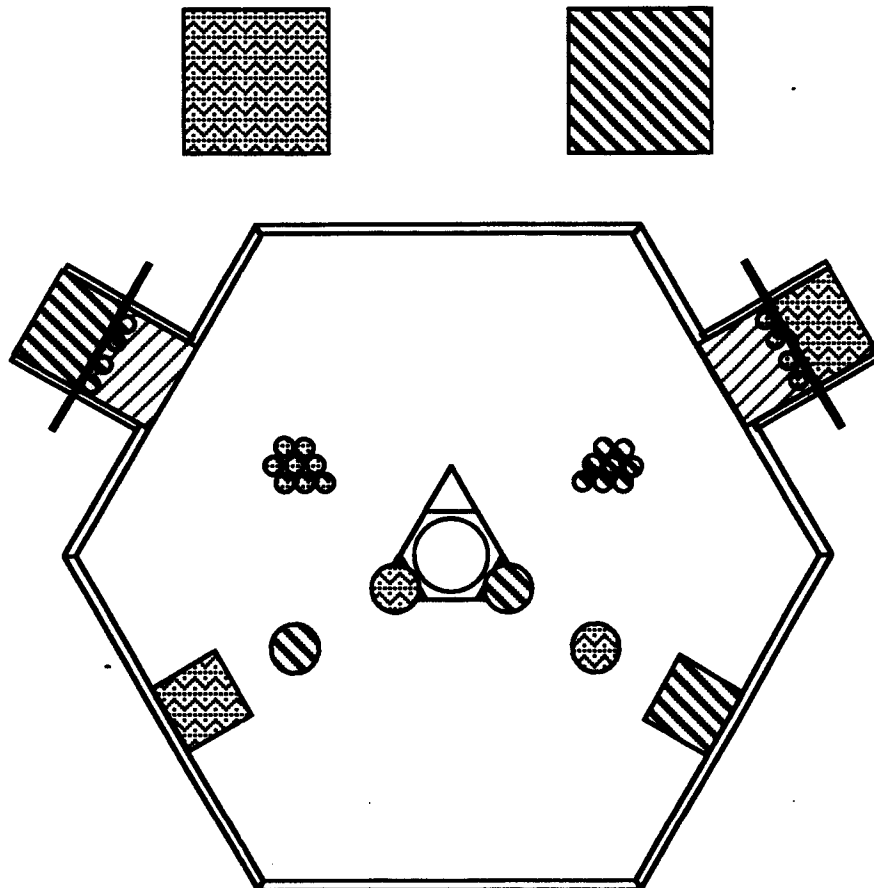
The seat belt is threaded through two slots in the rear center of the base plate.

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

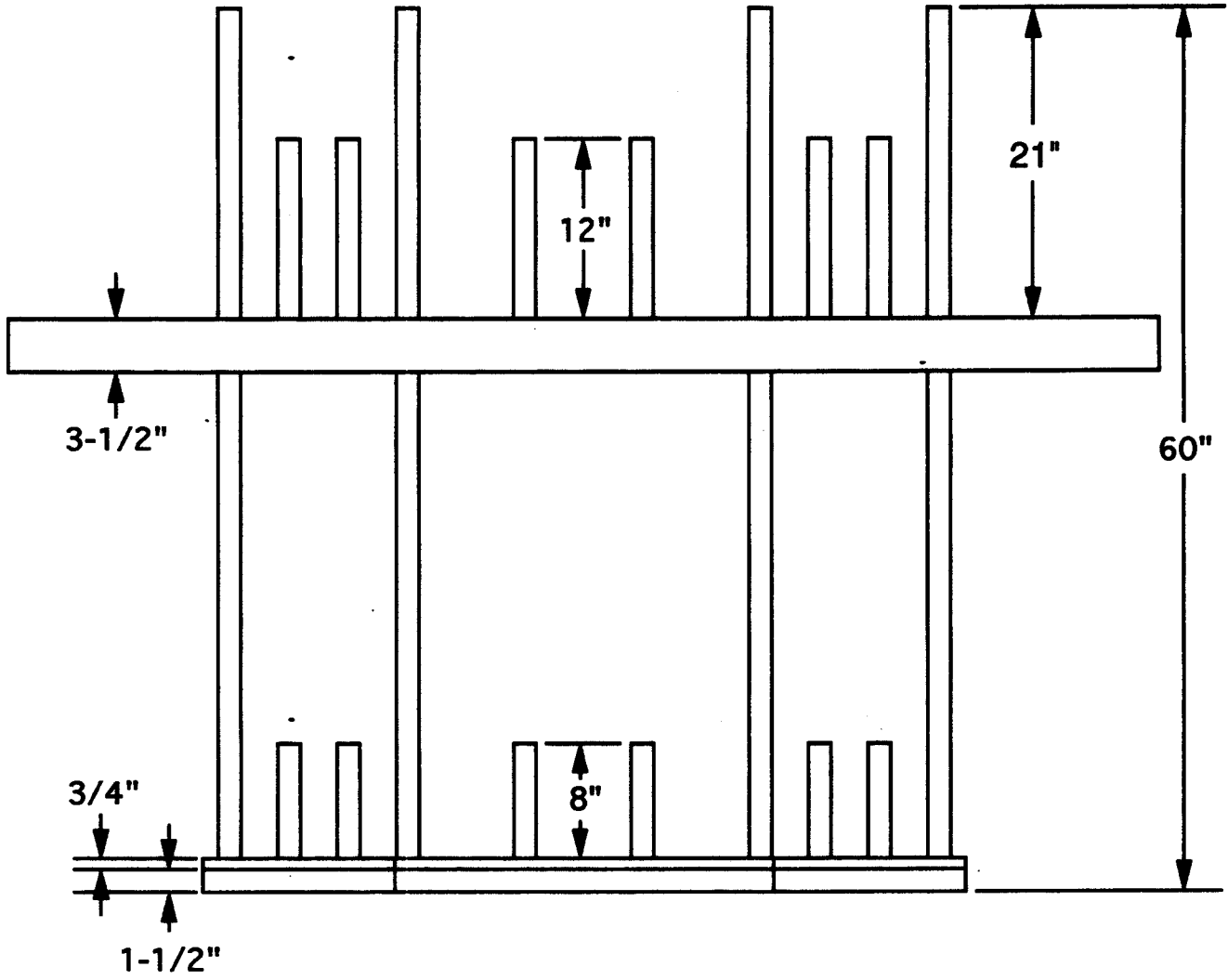
Playing Field - Top View
 Seeding/Double Elimination Rounds
 Figure 1



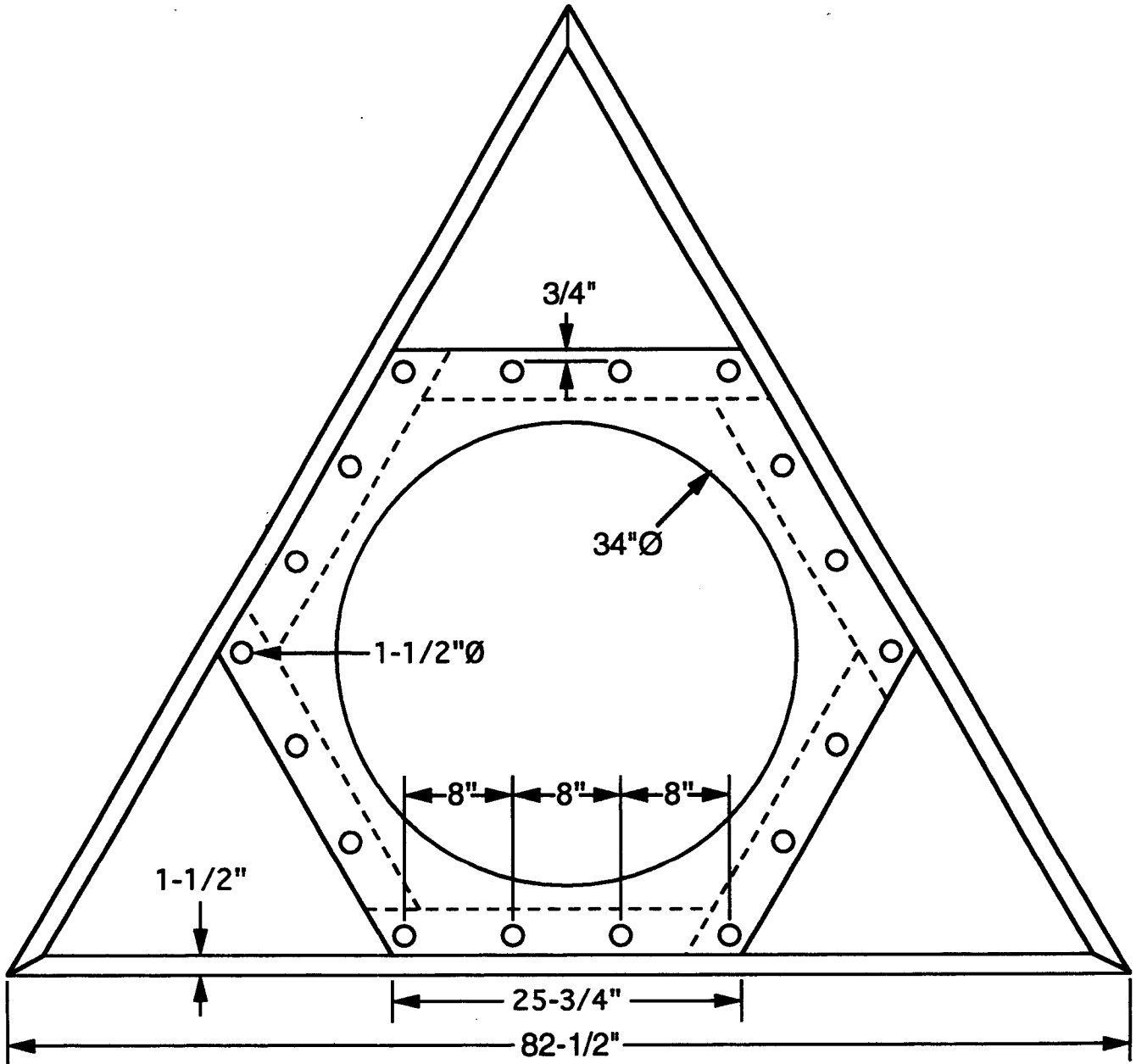
Playing Field - Top View
Finals Rounds
Figure 2



Central Goal - Side View
Figure 3

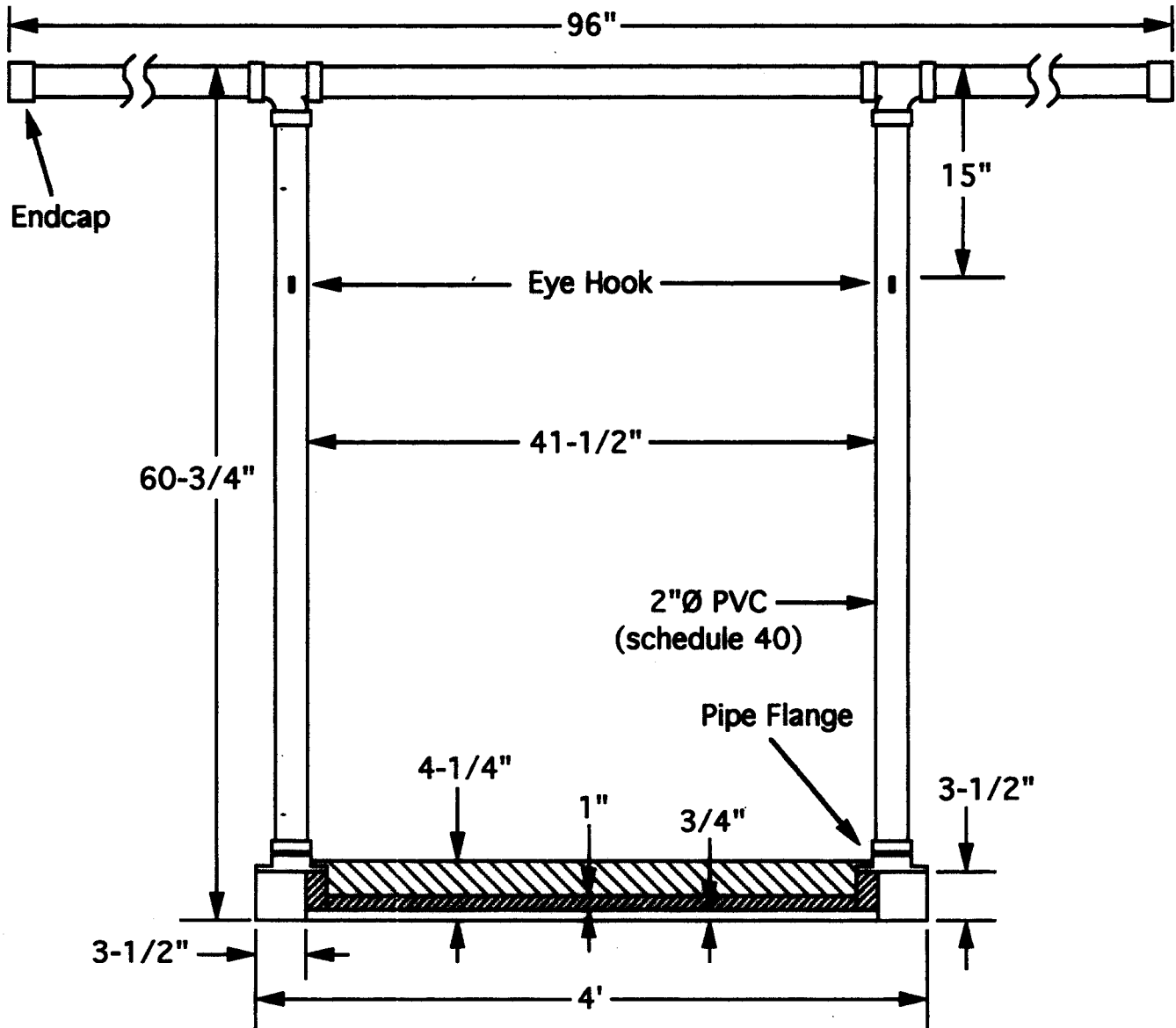


Central Goal - Top View
Figure 4




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

Player Station - Back View
Figure 5

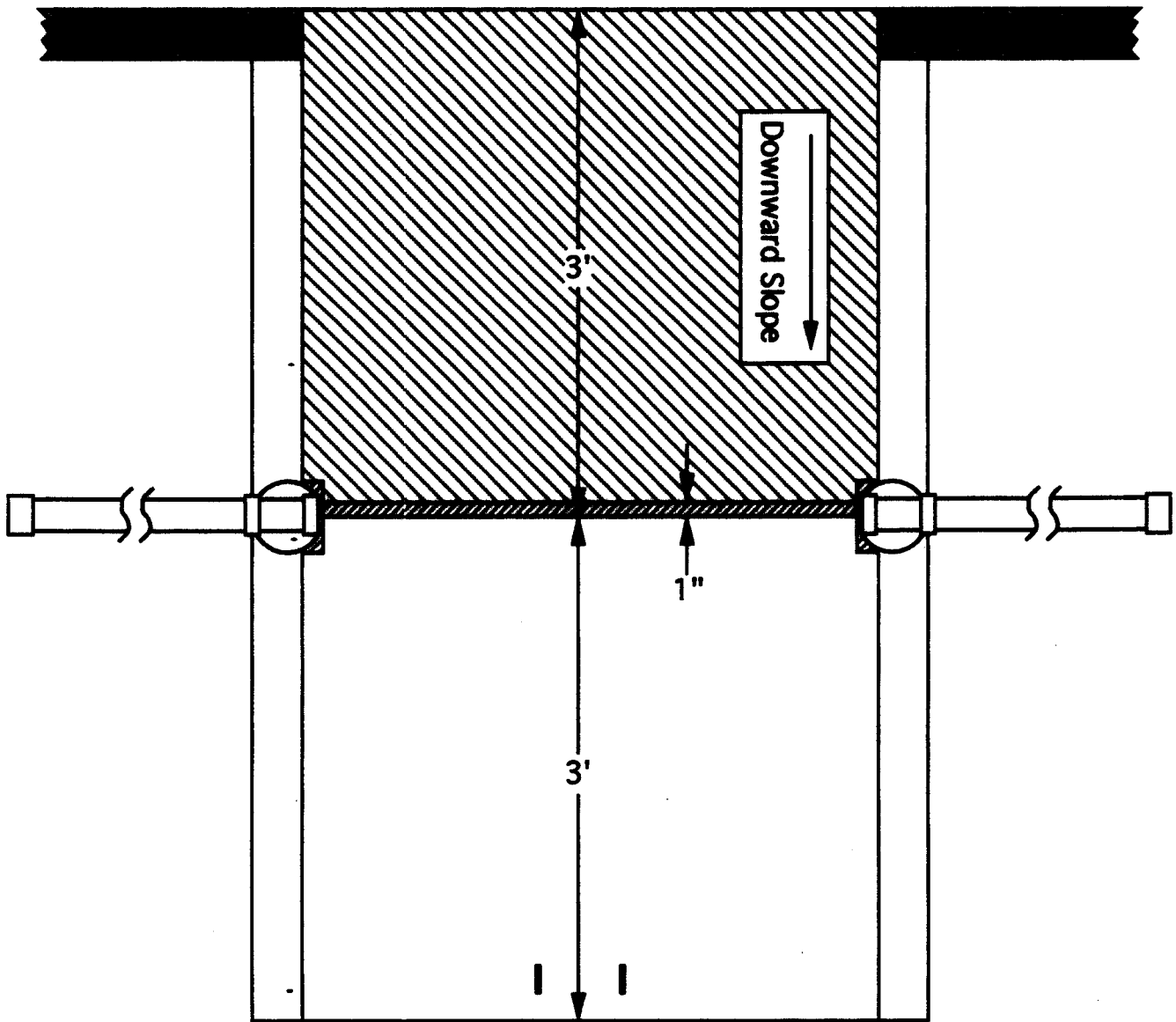


Notes: Nylon rope and lower eye hooks and omitted for clarity.




 Ramp (3/4" plywood on slope)

 Pipe flange supports and ball stop

Player Station - Top View
Figure 6



Notes: Center PVC bar omitted for clarity.

-  Ramp (3/4" plywood on slope)
-  Pipe flange supports and ball stop
-  Field border

1.3 General Tournament Rules

(see complete list of rules in Appendix B)

- T1. Referees have ultimate authority during the competition—their rulings are final.
- T2. If a machine is disqualified by a referee, that machine is turned off for the remainder of the match, and any points scored during that match will be forfeited.
- T3. If a machine is disabled by a referee, that machine is turned off for the remainder of the match, and any points scored during that match will count.
- T4. A machine may not win a match through an advantage gained by breaking a rule, even accidentally. The effect of the infraction on the outcome will be decided by the referees.
- T5. Strategies aimed solely at the destruction, damage, or entanglement of opponents' machines are not in the spirit of the tournament and will not be allowed. Turning over an opponent's machine is not considered damaging and will be allowed, but stabbing, cutting, etc., is illegal. If a breach of this rule occurs the contestant's control system may be disabled by the referees.
- T6. Limited amounts of machine shoving will be allowed; however, if you damage opponents' machines, referees may take action against your team. Possible actions include, but are not limited to; stopping the match to allow the damaged machine to be repaired before resuming play, a complete rematch after repairs have been made, or disqualification of your machine and forfeiture of any points scored.
- T7. If a team's machine is damaged to the point that it cannot complete a round on a fair basis, that team may be eligible for a rematch. This decision will be up to the referees.
- T8. If one team intentionally damages another team's machine, it may result in disqualification. However, if the damaged team's machine is considered too flimsy to begin with, the other team may not be disqualified. The ultimate determination will be with the referees.
- T9. The playing field carpet will be directly on the floor.
- T10. Deliberately damaging the playing field, controls, or balls (using spiked wheels, for example) is strictly illegal and may result in disqualification.
- T11. A machine may not intentionally contaminate the playing field, balls, goal, or another machine with lubricants.
- T12. After a match, team member are not allowed on the playing field until referees have completed the scoring procedure.
- T13. The fence is a safety feature, not part of the playing field. Therefore, no part of any machine may react against it.
- T14. No remote communication devices, such as air phones, walkie-talkies, cellular phones, etc., may be used by teams during a match.
- T15. During the tournament, teams will be notified of their field positions at least two minutes prior to the start of their match in the staging area. Teams will be allowed a maximum of one minute to set up their machines on the field and a maximum of one minute to remove all machine parts from the playing field following a match. You will have at least 4 minutes before your next scheduled match.
- T16. If a team is not ready to setup their machine on the field, and the two minute notification period is about to expire, and they do not wish to forfeit the match, then

- they must call a time-out. Each team may take up to 10 minutes (cumulative) of time-outs during the double-elimination rounds. The duration of a single time-out may not exceed 5 minutes. If a machine is still not ready at the end of the time-out period, the team will forfeit the match.
- T17. During the finals matches (quarter-finals on), each team may take up to 10 minute (cumulative) of time-outs which can be used to delay the start of a match if their machine is not ready. The duration of a single time-out may not exceed 5 minutes. Unused time-out time from the double elimination matches is lost.
- T18. At the start of each match, machines may be placed in any orientation within the designated starting area, without touching other machines, the 4x4 boundary, or the fence
- T19. If, in an attempt to remove an opponent's balls from the field, a part of your machine drops out-of-bounds, your machine will be disabled. Any points scored will count.
- T20. If a machines goes out-of-bounds to the point that it has to apply power to any out-of-bounds surface to rejoin play, its control system will be disabled. Any points scored will count.
- T21. If one team intentionally moves another machine out-of-bounds, the machine out-of-bounds will be disabled for the remainder of the match. Points scored will count.
- T22. Balls which are knocked out-of-bounds or popped will be placed back in play next to the fence near the exit point without undue delay. Additional balls will be available for substitution.
- T23. It is not the responsibility of the referees if they damage trapping devices while attempting to retrieve balls. Please design your machine so that balls may be retrieved quickly and easily after a match is over.
- T24. **We strongly encourage you to develop and wear team uniforms, including identifying hats and t-shirts that display company and high school team names and/or logos. This will help the audience, announcers, judges and spectators identify you and your machine.**

1.4 Game Specific Rules

(see complete list of rules in Appendix B)

- P1. Machines will start at equidistant locations, midway along the length of the playing field borders, as shown in Figures 1 & 2.
- P2. Each team will start with 8 small balls on the playing field and 4 small balls on the ramp of the player station. The small balls on the field will be arranged in clusters as shown in Figures 1 & 2. The clusters will be distributed at equidistant locations around the central goal at a distance of 4 feet from the flat side of the base of the goal.
- P3. Each team will start with 1 large ball on the side of the goal and 1 large ball on the playing field. The large balls on the goal will start atop the three triangular frames on the upper portion of the central goal. The large balls on the surface of the playing field will be distributed at equidistant locations around the central goal at a distance of 4 feet from the flat side of the base of the goal, as shown in Figures 1 & 2.
- P4. Each match will last for two minutes. It will begin when the control system is enabled and end when it is disabled, unless whistled dead by the referees.
- P5. Final scoring will begin when all balls come to rest or upon a referees' decision. Students and coaches will not be allowed onto the field until all scoring is complete.

- P6. Upon reaching the scoring stage, each small ball in or above the central hexagonal area of the goal is worth 3 points for the owner. Each large ball in or above the central hexagonal area of the goal is worth 10 points for the owner. Each large ball on or above the triangular frames at the three corners of the goal is worth 5 points for the owner. Ball position will be determined by the geometric center of the ball as estimated by the referees.
- P7. The winner of each match is the team with the highest score. Ties will be won by the team owning the higher large ball in or above the hexagonal portion of the goal. If all teams that are tied have no large ball in or above the hexagonal portion of the goal, the tie will be won by the team with the large ball closer to the center of the field.
- P8. During a match, five members per team (two "drivers", two "coaches", and one "player") are allowed in the designated areas next to the field. Operator badges will be supplied by U.S. FIRST at each event and must be worn by these team members for field access. Of these five team members, at least three must be students from team partner pre-college school(s).
- P9. During a match, machines must be operated from the team operator area next to the field by two students from the pre-college team partner school(s). The coaches must also remain within the team operator area during the match.
- P10. Each team will be allowed to use one human player. Human players will be stationed at equidistant locations just outside the perimeter of the playing field, as shown in Figure 1 & 2.
- P11. The player must be a student from a pre-college team partner school, and must sit at the player station during the match.
- P12. Human players will be secured at each station by a seat-belt-like strap.
- P13. A human player may remove balls from the playing field by passing them over or under the horizontal bar at the player station, or around the outside of the vertical posts. A human player may also catch flying or bouncing balls.
- P14. If a human player returns a ball to the playing field by passing it under the horizontal bar, or after the end of the match, it will result in disqualification for the match, and any points scored by the team will be forfeited.
- P15. A human player may choose not to return balls to the playing field. However, any balls which leave the player's station, such as by rolling off the side, will be returned to the playing field near the player's station without undue delay.
- P16. For safety reasons, the player stations are not considered part of the playing field for the machines. Machines may not drive onto the ramps at the front of any player station, nor may they attempt to retrieve balls from any player station. Any machine which does so will be disabled. Any points scored will count.
- P17. For safety reasons, no part of a machine may pass through, around, or over the PVC posts at each player station or in any way touch the human players. If this occurs due to an intentional act, the machine causing the safety hazard will be disqualified and any points scored will be forfeited. If this occurs by accident, the machine causing the safety hazard will be disabled, and any points scored will count. The referees will decide whether the violation was intentional or an accident.
- P18. For safety reasons, no machine may launch a projectile of any sort, including balls, toward the player station or team drivers and coaches, with the one exception noted below. If this occurs due to an intentional act, the team causing the safety hazard will be disqualified and any points scored will be forfeited. If this occurs by accident, the machine causing the safety hazard will be disabled, and any points

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

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

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

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

1.5 Competition Structure

Seeding Rounds

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

Seeding order will be determined as follows:

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

Double-Elimination Rounds

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

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

Finals Rounds

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