

ECE 160
Product Design Specification (PDS)
Fall 2012- 2013



Version 2.0*

***changes from version 1.0 are in red**

Design Project Overview:

Berry, Ltd., a division of Rose Enterprises, has oversight of the ROBOWL-A-RAMA Tournament. Berry, Ltd., would like to solicit your team's professional expertise to design and construct a *system* for entry into the Tournament.

Your team is required to design and construct a *system*, also referred to as *robot*, that will execute the requirements for the **ROBOWL-A-RAMA Tournament** in a superior manner. The tournament playing field consists of a planar surface with 4 miniature bowling balls and 20 miniature bowling pins. Your *system* must be designed to collect the balls and use them to knock down the pins.

The product design specifications and contest rules have been sent out to many well-qualified and motivated teams. Therefore, your team must be deliberative and diligent in order to work hard to come up with the most creative and effective solution.

Project Competition:

A project competition, **ROBOWL-A-RAMA Tournament**, will be held at 17:30 on Thursday, November 1, 2012 in the Kahn Arena (aka, the Kahn Rooms of the Hulman Memorial Union). Each team will show off their design to the amazement of their peers. Competition results do not impact your course grade; however attendance at the competition is mandatory. Any conflicts must be discussed with, and approved by, your instructor before the dry run. Due to the competition, the 18th day of class (9-2), **11/1-11/2/12**, will be cancelled.

Project Award Categories:

- “**Gutter Ball** Supreme” - Overall Tournament Winner;
- “**Frame King** Extraordinaire” - Overall Tournament Runner Up;
- “Top Alley Designer” - Most creative, unique and elegant solution;
- “Team Spirit” – Most “spirited” team with an identifiable non-offensive theme;

Product Design Specification

The requirements placed upon the *system* are as follows:

General Requirements:

1. The *system* shall be designed to perform on the competition surface shown in Figure 1. The lane (or alley) is 34” from the foul line to the head pin and it is 14.45” wide. The approach lane is 24” long and ends at the foul line. There are two alleys on the competition surface and they are separated by approximately **0.25** inches.
2. Each frame is made of ten pins. The ten pins are arranged in four rows with one pin, the head pin, in the first row, two in the second row, three in the third row and four in the fourth row. There are two balls available for each frame and they are placed in



the two pits at the end of the approach lane. The pins are 1-1/2" in diameter and 3-15/16" tall. The painted red ball has a diameter of 1-3/4". The bowling ball and pins are shown in Figure 2.

3. The *system* shall be constructed only from LEGO® pieces included in the provided kit as listed in the kit inventory; one additional light sensor may be requested by each team; two (2) meters of orange string may be requested at the ECE stockroom by each team. A laptop of one team member will be allowed to be used as control devices for the *system* but are not considered a part of the *system*.
4. The *system* shall operate without damaging the competition surface or any of the game pieces.
5. The *system* shall be designed to operate for the entire match without any reconstruction or reconfiguration.
6. The *system* shall be designed to operate without any physical contact (this includes wired connections) during each match of the tournament. During the remote control period, the laptop of one team member may be used to control the *system* as long as there is no physical contact during the match. All controlling devices must be operated by the same team member during the entire match; **teams can only change drivers between rounds.**

Materials:

1. Student teams shall use only the parts provided in their LEGO® kit as listed on their kit inventory, parts provided by the ECE Parts Room to complete their kit inventory or as listed in this document including string and one additional light sensor, if required. One team member laptop will be allowed to be used as control device for the *system* but it is not considered a part of the *system*.
2. No additional parts shall be added to the inventory received from the ECE Stockroom without prior written approval by the ECE160 faculty.
3. Parts shall not be traded between teams.
4. Students shall not modify the kit or parts provided.

Students shall return the LEGO® NXT kit as listed in the kit inventory and all additional parts supplied with all items accounted for one day before the final presentation session held during Finals Week.

Communication/Programming requirements:

1. The *system* shall be programmed in NXT-G (the drag and drop language supplied by LEGO®) or other appropriate programming language selected by each team. Any programming language/operating system software used must be available to all students at no cost, freeware, or available through existing Rose-Hulman licenses. All teams using any software other than NXT-G must provide information for acquiring the software to the instructor (who will publicize this to all teams).

2. During the autonomous period, the system must acquire balls, move to the foul line and release balls with no human intervention or communication with the laptop.
3. During the teleoperation (remote control) period, the laptop may be used to communicate with/control only your team's NXT within the wireless capabilities of the control devices. The control devices may not be positioned within, over, or under the competition surface during the match. The laptop may be placed on the surface adjacent to the competition surface during the team's competition.
4. The *system* may communicate with the control devices via wireless or wired connection during the set up period before each match, but only via wireless communication channels during the match.

Competition Surface:

The competition will be held on a fixed operating surface. The competition surface will be flat black and is shown in Figure 1. The competition surface, balls and pins will be provided for practice during the project design and construction phase.

Competition Rules:

1. The *system* shall be defined to be that device constructed by the team to perform the designated tasks.
 - a. The *system* shall not include a computer, infrared port or external wires, or any part of the competition surface.
 - b. The *system* shall include the constructed device and any software loaded into the NXT.
 - c. All components of the system must remain connected to all other parts of the system during the match by parts supplied in the LEGO® kits.
2. The tournament is comprised of a seeding round and several elimination rounds. Round 1 is used to determine seeding for the second round of the tournament and it will be based upon the **dry run** conducted on day 17 (9-1), **10/29-10/30/12**, of class.
3. During the second day of the competition, there will be paired matches or heats. The paired match will consist of two competition tables with **one team** per table for each elimination round.
4. Each match will consist of a **2** minute setup period followed by a bowling period lasting up to 3 minutes. The bowling period will consist of a **1 minute** autonomous period and a **2** minute teleoperation period. The match will end 3 minutes after the setup period **ends**, or when both systems have stopped moving, whichever comes first.
5. During the **2** minute setup period, the *system* may be programmed **or** reprogrammed.

6. A match is made of 2 frames where a frame has 10 pins. For each frame, the system is allowed to roll two balls. If the system knocks down all of the pins on the first roll then it is a “strike” indicated with an “X”. If not, then a second roll at the pins still standing is attempted. If all of the remaining pins are knocked down then it is called a “spare” indicated with a “/”. If there are no pins knocked down on a roll then this is called a “miss” indicated with a “-“. If any pins are left standing then it is referred to as an “open frame”.
7. Once a ball is acquired by the system, if any part of the system crosses over the foul line before releasing the ball, this is called a foul and indicated with an “F”. After the system stops moving, it is also a foul if the ball release mechanism extends more than 12 inches past the foul line. Also, balls must be rolled one at a time, if the second ball is rolled before the first ball clears the pins or drops in the pocket then the second roll is a foul. Any pins knocked down when the system commits a foul will not count in the score. If the foul occurs on the first roll then the pins will be reset by the judges. Line paths on the board will be delineated with white tape and the foul line will be delineated with red tape.
8. Two alleys will be set up with 10 pins in each. There will be two balls available in each pair of pits for each alley which yields a total of 4 balls for game play. At the beginning of the autonomous period, the system can be loaded with one ball or both balls can be in the pits. Bonus points will be earned for a system that starts the autonomous period with the balls in the pit. The pit location is shown on the competition field in Figure 1.
9. Any ball that drops during the match onto the competition surface can be reacquired by the system. Any ball that drops from the competition surface during a match can be returned to the competition surface but there will be a 5 point penalty. If a ball from one approach lane drops and hits the pins in the opposite alley then it will not count in the score.
10. The system may be started from any point on the assigned side of the competition surface.
11. No parts may be added to or removed from the system during the match.
12. If parts become detached from the system during the match they may be reattached for a 5 point penalty. In addition, detached part(s) may be reattached during subsequent setup periods or between matches.

Scoring Rules:

1. In an open frame during the teleoperation period, a bowler gets credit for the number of pins knocked down. A strike is worth 40 points and a spare is worth 30 points.
2. During the autonomous period, all points are doubled. Therefore, a pin is worth 2 points, a strike is worth 80 points and a spare is worth 60 points. In order to earn the 60 points for the spare all ten pins must be knocked down in the autonomous mode otherwise the spare is worth 30 points.

3. If a system bowls a perfect game with 2 strikes in a row then there will be a 20 point bonus.

4. Table 1 shows the score card for several sample matches:

1		2	
Auton		Tele	
8	10	7	1
18		26	

1		2	
Auton		Auton/Tele	
	X	6	4
80		90	

1		2	
Auton		Tele	
4	/	7	/
60		90	

1		2	
Auton/Tele		Tele	
5	/		X
30		70	

1		2	
Auton/Tele		Tele	
12	2	7	/
14		44	

1		2	
Auton/Tele		Tele	
	X		X
40		40 + 20	

Table 1: Sample Score Cards

- During the autonomous period, if the balls are preloaded there will be a 5 point deduction.
- Round 1 is the dry run and seeding round. Teams will be placed in heats for round 2 based upon the scores earned in round 1. After round 1, the scores from each round will be ranked and the top half of the teams will progress to the next round. If there is a tie that will affect the ability of a team to progress to the next round then a tie breaking round will take place to determine the winner of the bout. There will be a 30 second sudden death match. Each team is allowed one ball and the team to knock down the most pins will be declared the winner of the bout. This bout is a remote control round.

Judging:

- Judges shall be provided by Berry, Ltd., and the ECE Department.
- Judges will serve as officials and scorekeepers. Therefore, judges will be responsible for insuring that the teams abide by the rules of competition, scoring each round and giving the score sheet to the official scorekeeper. Judges will also be responsible for removing any balls or fallen pins during the match as long as it will not disturb the pins left standing. Judges will stand the pins back up in their original position if there is a foul on the first roll. Judges will also clear knocked over pins from the lane that may inter with subsequent rolls.
- The decision of the officials shall be final. Decisions may be challenged for factual or interpretive errors; but, the officials have the final decision on the validity of challenges.
- Teams shall ask the instructor for rule interpretations in a timely fashion. Requests for rule interpretations made after 5:00 p.m. on November 1, 2012 will be rejected.

Other Requirements:

1. All students shall participate with their team in the competition.
2. All students shall participate with their team in the design process for this project.
3. All team members shall participate equally in the project work.
4. All team members shall receive a grade on the project based upon the entire team's work as well as their individual work.
5. Students shall respect the creativity of others.
6. Students shall in no way interfere with another team's project work or interfere with another team during the competition.
7. Teams caught exhibiting un-sportsman like behavior will receive a warning. The second infraction conduct will earn a 50 point penalty for the current match or if they are in between matches for their subsequent match. If the behavior continues, the third infraction will have a detrimental effect on the team's project grade.

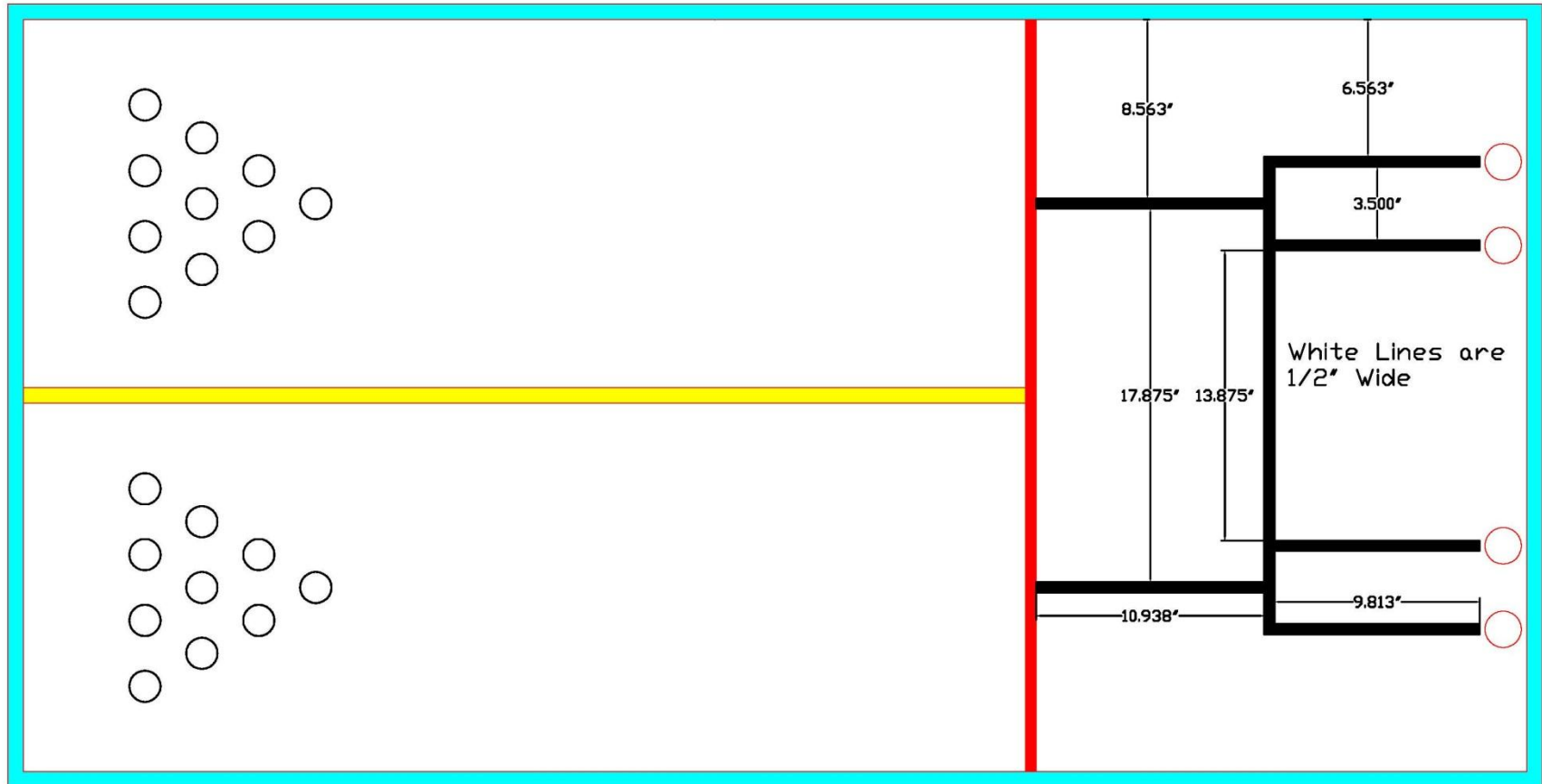


Figure 1: Competition Surface



Figure 2: Bowling Pins and Balls