

INTERCOLLEGIATE ROBOTIC FOOTBALL COMBINE
University of Notre Dame
Department of Aerospace and Mechanical Engineering

Sunday, March 29, 2015

1 pm to 4 pm

Northern Dome of the Joyce Athletic and Convocation Center (JACC)

Notre Dame's Intercollegiate Robotic Football Combine is the proving ground for schools that wish to compete for the national championship in robotic football. Upon a successful showing at the combine, teams will be invited to compete in a playoff leading to the national championship the following year. The combine consists of three parts:

- PART I. Combine events styled after the NFL combines to test strength, agility, and maneuverability. Not all events apply to all robots. A minimum of a center, quarterback, and wide receiver are required to be considered for the Grand Prize.
- PART II. Scrimmages between the teams present at the combine.
- PART III. Stress test to measure the robustness of the football-playing robots. Because the test can result in an inoperable robot, it is placed after all other events. The purpose of the stress test is to assess whether the robots have been designed to be robust enough to withstand the hits of a robotic football game.

There are two cash prizes for the 2014 combine (Notre Dame team ineligible):

1. The \$2,000 Grand Prize will be awarded to the team with the best overall performance. The results of the measurable combine events (Part I above) will carry the most weight toward the cash award. The judges may take intangibles into account as well, including factors such as designs free of non-engineering fasteners such as bungee cords or duct tape, the completeness of the team, and any engineering innovations.
2. The \$500 cash prize for "Best of Show" will be awarded to the combine team that best incorporates the following subjective characteristics into their robotic units:
 - A unified look-and-feel for the units (i.e., consistency of aesthetic design across a wide variety of units to achieve the look of a cohesive team).
 - Creative, professional use of school colors.
 - High visibility of each unit's number.

The rest of this document mostly describes the NFL-style combine events in detail. The scrimmage and stress test parts are briefly discussed at the end.

PART I

Robotic Football Combine Drills

TITLE	POSITION	TESTS
60-Foot Shuttle	All but kicker	Speed and controllability
Three-Cone Drill	All but kicker	Agility, maneuverability
Strength Test	All but kicker	Strength and power
Speed test	All but kicker	Pure speed
QB Accuracy Test	QB	Throwing precision/accuracy
Kicker Strength & Accuracy Test	Kicker	Kicking distance & accuracy

The order of the drills may vary from that of this list depending on the number and kind of participants, and some may go on concurrently.

Drill: 60-foot Shuttle (Controllability Test)

Purpose: Measure the ability of the robot to shuttle (reverse direction) in a controlled but speedy manner.

Description: The drill consists of a start line and a finish line halfway in a rectangle 3 x 30 feet. (See Figure 1.) A straight line, marked by tape, is placed 15' from either end, marking the start and finish line. Starting from a standing stop, the robot must shuttle to one end, reverse direction, move to the other end, reverse direction again, and cross the finish line. The time to perform that action shall be measured in seconds. The timing official will measure the time and count the number of times the robot touches either side boundary line (called an infraction). One second shall be added for each infraction.

Measurement: The time taken to shuttle from the starting line to the finish line in the lane.

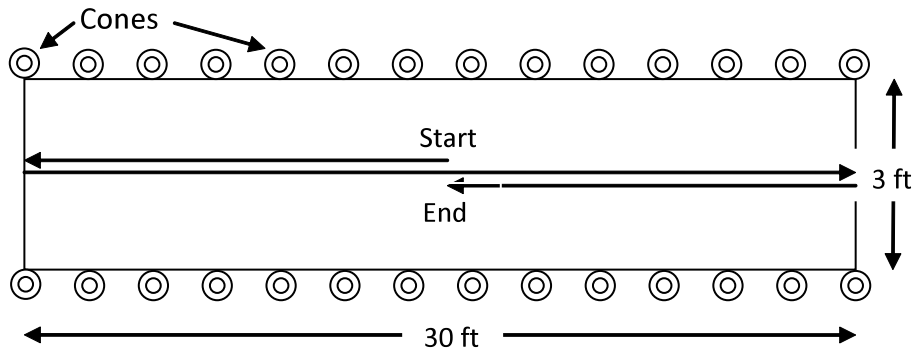


Figure 1. Setup for the Controllability Test

Record:

School/Trials	Robot #/Name	Time (secs)	Penalties +1 pt/cone hit	Score
1				
2				
3				
4				
5				

Drill: Three Cone Drill

Purpose: This drill tests the maneuverability and agility of the robot.

Description: As in an NFL combine, this drill consists of 3 cones in an L-shape and spaced 15 feet apart from each other. The robots start and finish on either side of cone #1. See figure 2 for the path around the cones (the path shown is illustrative and approximate). The robot will start from rest at cone #1 with its front edge just before the start line. The timer is activated when the robot begins to cross the start line. The timer will stop when the robot's leading edge crosses the finish line.

Measurement: The time required, in seconds, to travel from the start cone along the path in Figure 2 to the finish line, with one second added for each time the robot touches a cone with any part of its surface.

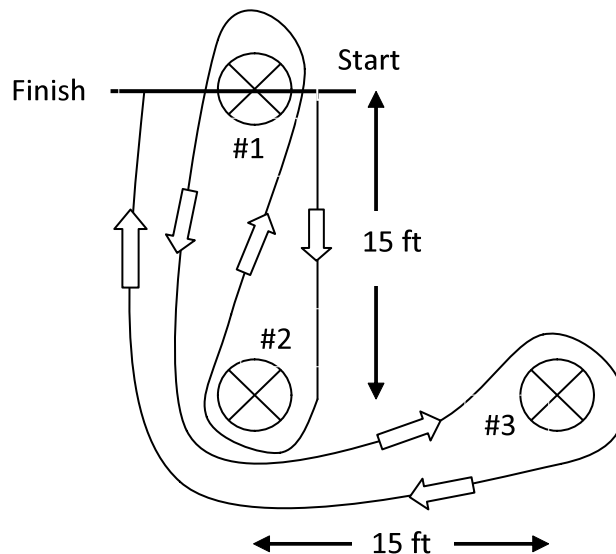


Figure 2. Three Cone Drill

Record:

School/Trials	Robot #/Name	Time (secs)	Penalties +1 pt/cone hit	Score
1				
2				
3				
4				
5				

Drill: Strength Test

Purpose: This drill tests the overall strength of the robot, similar to a bench press.

Description: The robot will start from rest next to a 30-lb weight on a box with four free-wheeling casters. The robot must push the weight a distance of 10 feet. Time to cover the distance will be measured in seconds. The time is stopped when any part of the 30-lb weight crosses the finish line. The robot must start from rest barely touching the box to take momentum out of the test. See Figure 3 for a diagram. The robot does not have to follow a straight line, but any deviation from the shortest path inherently increases the time needed to cross the finish line.

Measurement: The time required to push the 30 pounds a distance of 10 feet.

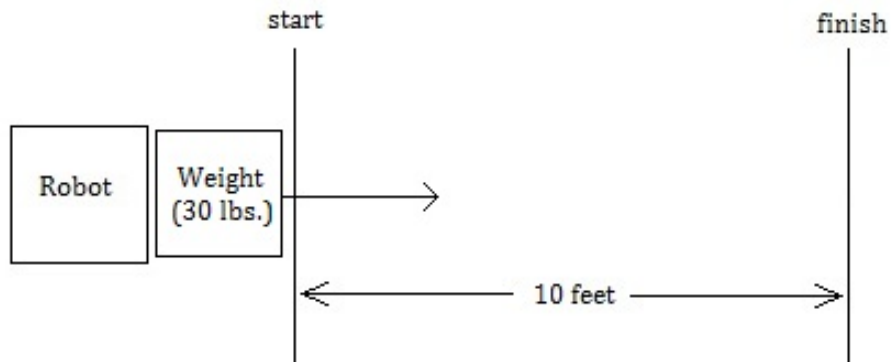


Figure 3. Strength Test Setup

Record:

School/Trials	Robot #/Name	Time (secs)
1		
2		
3		
4		
5		

Drill: QB Accuracy Test

Purpose: This drill tests how accurate the quarterback can throw to a specific location.

Description: A number of "X" marks are placed on the floor at varying distances and angles from a line where the QB begins. The Center is on the other side of the line in position to make a handoff to the QB. The WR is maneuvered remotely so that it sits over an "X". The quarterback attempts passes to the wide receiver in the time allotted. If the football is truly caught by the receiver, the QB is awarded 14 points. If the football hits any part of the receiver but is not caught, the QB is awarded 7 points. No points are awarded for a miss. If the Center is inoperable, or missing, three points shall be deducted for each completed pass. Once a catch or touch-catch is made, the WR must move to another "X". See Figure 5 for a diagram of the drill.

Measurement: The number of short passes completed and the number of long passes completed (successful attempt).

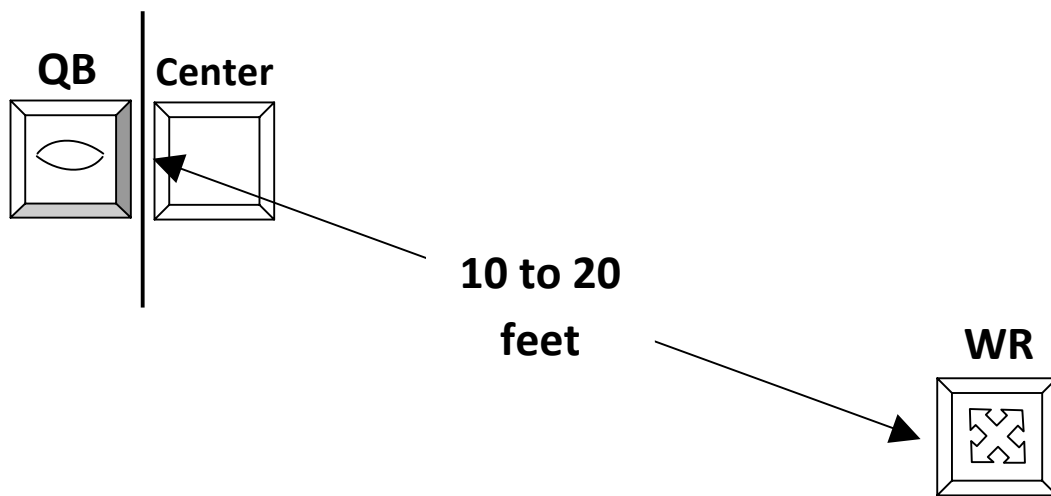


Figure 5. *Quarterback Passing Accuracy Test*

Record:

School/Trials	Robot #s/Names	Distance (Short, Med, Long)	Points	Penalties -3 for hand-feed	Score
1					
2					
3					
4					
5					

Drill: Speed Test

Purpose: This drill measures pure speed.

Description: A robot runs the length of a roughly 60-foot lane and is timed, starting from a dead stop. There is no penalty for deviating from the lane or a straight line, as the recorded time will necessarily reflect any deviation from a straight line.

Measurement: The time in seconds taken to run the lane from start to finish.

Record:

School/Trials	Robot #/Name	Time (secs)
1		
2		
3		
4		
5		

Drill: Kicker Strength and Accuracy Test

Purpose: This drill tests the accuracy of the kicker to kick the ball in between two goal posts.

Description: The kicker has three tries to kick the ball through the uprights from distances of 30 feet (a point-after), and 50 feet (a field goal). The time it takes to perform the three attempts, from the first kick through the moment when the third and final ball hits the ground, is recorded to measure speed of preparing the kicker and the speed of the kicker itself to move from one location to the other.

Measurement: The number of successful attempts at each location. One point is awarded for each successful PAT; three points are awarded for each successful field goal. If a kicker makes all its kicks, its raw score would be 12 points. One point is subtracted for each 60 seconds (rounded to the nearest 30 seconds) of time required to complete the event. (Example: if the kicker completes 3 PATs and 3 FGs in four minutes, it would receive $12 - 4 = 8$ points.)

School/Trials	Kicker #/Name	Distance (feet)	Points (depends on distance)	Start time	Score = Total points less number of minutes
				End time	
1		30 (1 pt)			
2		30 (1 pt)			
3		30 (1 pt)			
4		50 (3 pts)			
5		50 (3 pts)			
6		50 (3 pts)			

PART II

Scrimmage

To provide participating teams with as close to a real game experience as possible,, the teams attending will be matched up as best as possible in a series of scrimmages. If full or nearly full teams are present, they will play each other. For partial teams, various school units will be asked to fill in so all may experience some game time.

The game will be played on a hard-mat playing surface roughly the size of a basketball court. The exact dimensions and layout of the field can be found on the [ND RFC Website](#). The rules are the same as NCAA rules for collegiate football except where noted in the rules on the website to accommodate the robotic nature of the players. Penalties and fouls will be called according to those rules, but anything involving robots that haven't been designed (kickers, for instance) will simply be dropped from the game. The length of the game(s) will be set at the time, taking into account the number of teams, robots participating, and time permitting.

PART III

Stress Test

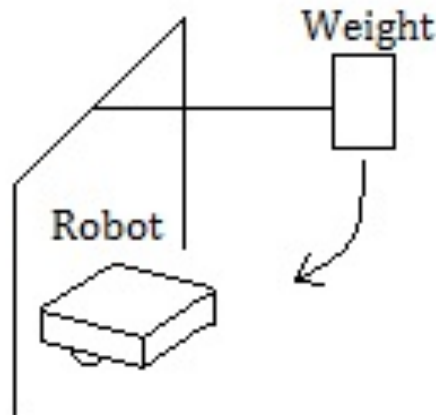
Drill: Stress Test

Purpose: This drill tests how the robot will perform after experiencing an elastic collision. This test is pass/fail. The kicker is exempt from this test.

Description: A 30-lb weight will be held at 90 degrees from a bar that allows the weight to swing down as a pendulum. The weight strikes the robot sitting under still under the bar, the force of which is designed to duplicate forces experienced in robotic football games.

Measurement: The test is pass/fail. A point is awarded if the robot can “walk away” from the collision under its own power. The tackle sensor light, if there is one, must light up to register a tackle and be operable after the collision. If the robot is a QB or Center, an extra point is awarded if the robot can still perform its primary function (the QB must throw a pass; the Center must hand off a ball).

Depiction of “The Terminator”



School/Trials	Pass/Fail	Extra Points if Applicable	Score
1			
2			
3			
4			
5			