Maple syrup production is an important industry in Canada with exports exceeding 141 million USD per year. The Province of Quebec is by far the largest producer of maple syrup worldwide, accounting for approximately three quarters of global production. Unfortunately, collecting maple sap in a forest is not an easy task. Maple sap has been traditionally collected using a bucket with a plastic tap, a highly labor-intensive process. During the 1970s, plastic tubing systems began to replace the bucket as the main method for collecting maple sap. These systems rely on a network of plastic tubing which connects the trees. A major concern when implementing such a network is to connect all of the maple trees while minimizing the length of plastic tubing. This minimization reduces blockages, decreases costs and lowers residence time in the tubes. For the 2014 Robotics Student Design Competition, the challenge is to develop a robotic system to simulate installation of a sap pipeline between the maple trees irregularly distributed in a forest.

Rules
A. Board Layout
1. The “forest” shall be constructed using an 8x8 ft board, as shown in the following diagram:
2. There will be three “collecting” points along the starting edge of the forest. Each point will consist of a nail with 1-in. exposed on top of the 2-in. border at the tape junction.

3. “Trees” will be represented by wooden 1-in. diameter dowels that are 1-ft. in length painted red (25005 Fire Red). They will be mounted to the board using 1-in. circular peg holes.

4. At any time, only 12 out of the 20 “tree” spaces will be occupied in a random order.

5. Empty spaces (those without a tree) will be filled with 1-in. wooden discs to prevent the wheels from sticking.

6. Each “tree” will have a 1-in. wide band of Velcro 3-in. from the bottom of the table for connecting the line.

B. Trial Runs

1. Each team is allowed three trial runs, and the highest scoring run will count towards the overall score.

2. Each trial run must be completed within a 5-min time limit, after which no more points will be awarded or deducted (i.e., points for the fastest work).

3. For each round, the layout of trees on the grid will be the same for all teams.

4. Any team may forfeit the right to participate in a trial run.

5. No human interference is allowed once the trial begins; this would result in a significant penalty.

C. Design Restrictions

1. Robots must be fully autonomous (no human input/control).

2. Using multiple robots is permitted and encouraged.

3. All of the robots for a team must be able to fit within a 12-in. x 12-in. x 12-in. box at the beginning and end of the trial.

4. The capability to extend beyond the maximum dimensions during operation is allowed.

5. At least one robot must be capable of spooling a line (e.g. a string). If more than one robot is equipped with a spool, the path length will be the sum of all strings used.

6. Spools will be considered as part of the robotic system and will not be provided.

7. The robots cannot drive over the tops of the trees.

8. No materials with substantial elasticity (e.g. rubber) are allowed for the line.
D. Report and Presentation

1. Each team must submit a report of their design; the report must not be more than 10 pages.

2. Each team must provide three printed copies of their report to the judges at least 48 hours prior to the competition.

3. Each team must give a presentation of their design which will be limited to 10 minutes and this will be followed by a 5 minute question and answer period.

4. A computer and a projector will be available with PowerPoint at the time of the presentations.

E. Scoring

1. The points for each trial run will be awarded based on the number of connected trees at the end of the trial by the following formula:

   \[ \text{Points} = \frac{650 \times (\text{Number of trees connected})^2}{\text{The length of the line (in.)}} \]

2. 50 points will be awarded for developing an application or base-station to remotely display the task progress and/or robot actions in real-time.

1. 30 points will be deducted for each attempt to manually assist the robot(s) during a trial. The minimum possible score is zero and deductions will not result in a negative score.

2. 200 points will be awarded for the presentation. The judges will evaluate the presentation in terms of content, organization, clarity and visual support.

3. 200 points will be awarded for the report. The judge will evaluate the report in terms of content, clarity and general presentation of the information.