WEIR-WARMAN AND ENGINEERS AUSTRALIA DESIGN & BUILD COMPETITION - 2006

Project "ABC"–Autonomously Beautify Countryside

The Gondwanan people are quite proud of their planet and its beauty and while hosting the intergalactic millennium conference wish to make a good impression on visiting dignitaries. It is proposed that an autonomous device be designed and trialled to accurately and rapidly distribute wild flower seeds along the planet's highways and byways.

In the "ACME Pinnacle Laboratory", the Gondwanan Horticultural Society is struggling to arrive at a design that might be feasible. Fortunately, teams of engineering students from Earth are about to visit Gondwana as part of their work experience programmes. On previous visits engineering students have rendered invaluable assistance, and the Gondwanans again seek help from these budding engineers.

National Organiser

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See: http://www.unsw.adfa.edu.au/acme/studentactivities/warman/index.html

Objective

The objective is to design, build and prove a prototype device in a laboratory environment that serves to accurately and rapidly distribute seeds along the planet's highways. Can you assist in Project ABC – **A**utonomously **B**eautify **C**ountryside?

See below for:

- Competition Rules
- Frequently Asked Questions
- Further Competition Details

Document History:
Version 1 Released 14 February, 2006
Version 2 Released 5 April, 2006
Explanation notes added for rules 34 and 35
FAQ's expanded (photos of UNSW@ADFA track provided)

Competition Rules

(Original Released: 14/02/2006

Version 2 – 5 April, 2006 – Explanatory Notes added for Rules 34 and 35)

ELIGIBILITY

1. Teams of up to four, nominally second-year mechanical-engineering students in Australian or New Zealand universities (or other universities by arrangement), may enter the competition. Teams of three or four are recommended.

SAFETY

2. Safety is of paramount importance when participating in this competition. All engineers should know that injury and damage to equipment and the environment occurs when the control of energy in a system is lost.

3. Students are required to carry out a risk assessment for their device prior to campus testing. Students are encouraged to embrace risk management in their own activities and may need to demonstrate safe operation and produce risk assessment documentation in order to compete in either the campus heat or at the Final.

4. As appropriate, safety glasses or full face masks should be worn by students working on devices during construction, during testing, and during competitions.

5. Devices that are deemed by the officials and judges to be hazardous will not be permitted to run.

6. Devices which damage the competition site are prohibited.

MATERIALS AND MANUFACTURE

7. Students shall manufacture their prototype device themselves using commonly available materials, components and methods.

TRACK

8. The competition track modelling a horizontal tree lined "road" and the adjacent fields shall consist primarily of two sheets of Medium Density Fibreboard (MDF). The Start Area and first road segment will be on a board of nominal dimensions 2400 x 1200 x 18 mm. The second road segment and Finish Area will also be on a board of nominal dimensions 2400 x 1200 x 18 mm. The boards will be placed perpendicularly in an L shape (see Figure 1) but separated by a 500 mm long bridge crossing a hypothetical river. The bridge will lie in the same horizontal plane as the road segments and also be made from MDF.

Noting the OH&S issues surrounding the machining of MDF, minimal cutting is required to build the track. "Decor Texture Whiteboard HMR" was considered as an alternative. Views of Campus organisers are sought with reference to its use in future competitions. See http://www.thelaminexgroup.com.au/tradeessentials/index.asp

9. The "ground plane of the track" is defined as the upper horizontal surfaces of the two MDF sheets and the connecting bridge.

10. The ground plane of the track shall be no less than 300 mm above the supporting floor at the national final. *(Campus organisers may choose to set the track directly on the floor for their local competition.)*

11. Line markings will be scribed and highlighted with a fine tip permanent marker. The start and finish areas will be marked at the respective ends of the track. These areas are nominally 1200 x 400 in area (see Figure 1). The "road" on the first road segment will be marked as a lane 400 mm wide down the centre of the track. The "road" on the second road segment will be marked as a lane 600 mm wide on the right hand side of the track with the edge of the road being the edge of the sheet.

12. Bordering the first road segment two rows of "trees" will be modelled (4 trees in each row). Tree containment collars (DWV-PVC 50mm Safe Waste Trays) will be glued and screwed to the track surface with their centrelines 300 mm either side of the road centreline at 400 mm longitudinal centreline spacing beginning 400 mm from the start line. Two self tapping pan-head screws 4 x 12 mm are to be used and aligned on the transverse centreline.

13. Along the second segment of the road one row of trees (4 trees) will be modelled on the left side of the road. A "river", passing under the bridge is to the right and the bank is not tree lined. On this segment, the collars will be glued and screwed to the track surface with their centrelines 400 mm to the left of the road centreline (i.e. 100 mm to the left of the track centreline) at 400 mm longitudinal spacing.

14. Each tree will be represented by a 400 mm length of PVC pipe (DWV "Vinidex" 40 mm Pipe) with square cut ends standing vertically in a random position within an oversized collar (see Figure 2).

(The plumbing items referred to in Rules 12 and 14 are available from Tradelink and a range of other supply stores. The manufacturer is Vinidex. The Tradelink part for the collar is coded "010869 50mm Safe Waste Tray" and retails in Canberra at $3.22. A 6 m length of 40 mm PVC pipe retails at $22.41.)

15. Fields for planting (15 in total) between but beyond the three tree lines will be fenced with nominally 12 x 12 DAR (Dressed All Round) timber strips as shown in Figure 1. The strips will be mounted by nails or screws on the top surface of the track. The road side longitudinal fences will butt with the outer edge of the containment collars.

16. The bridge between the road segments will have 12 x 12 DAR timber guard rails on both sides. The clear width of the bridge between the guard rails is 400 mm. The ends of the bridge guard rails will be vertical and coincide with the joins to the road.

17. The finishing area shall be framed on three sides with 12 x 12 DAR timber strips to provide a "rest". This frame will be mounted on the top surface of the finishing

area with its outside edges flush with the track sheet edges. The free ends will be vertical.

18. All exposed surfaces of the MDF and DAR timber and will be brush coated with one coat of Wattyl Water Based Estapol Clear – Satin followed by two coats of Wattyl Estapol Matt.

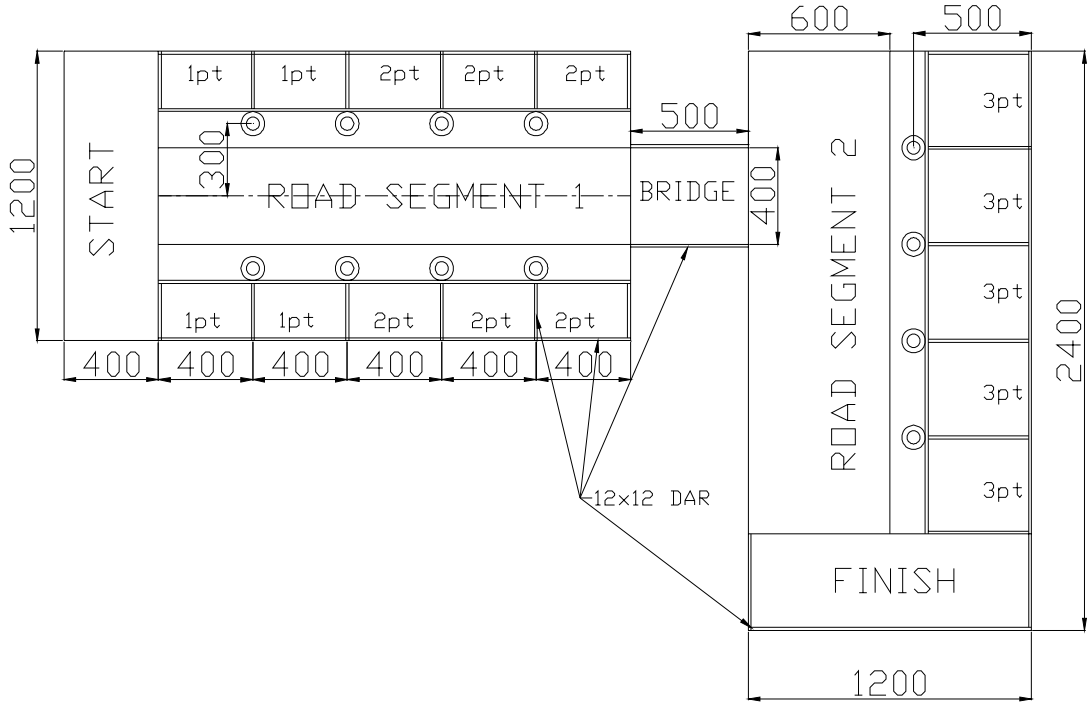

FIGURE 1 - PROJECT "ABC" COMPETITION TRACK CONCEPT

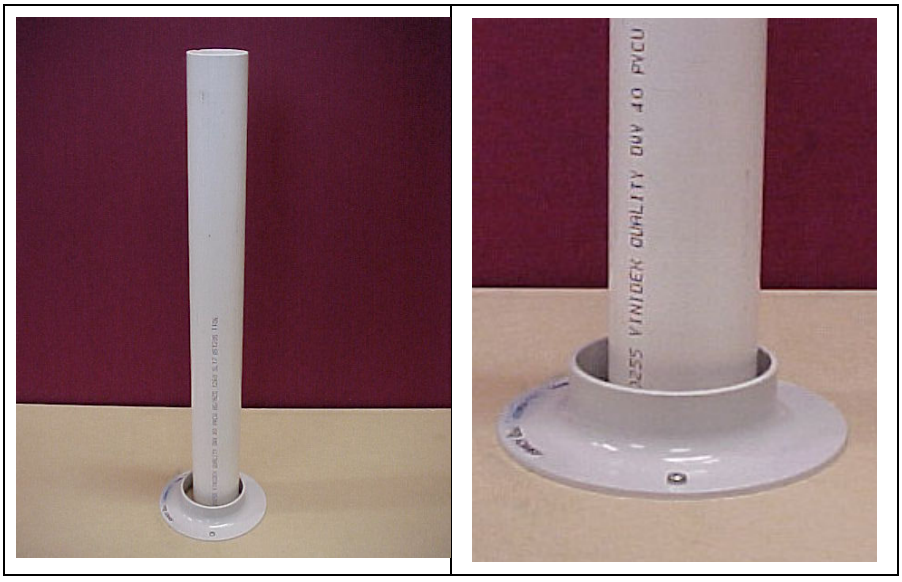

FIGURE 2 - PROJECT "ABC" MODEL TREE

PROCEDURE

19. The "net mass" of the device, will be measured by an official and the mass shall not be greater than 15 kilograms.

20. When the track is clear, the trees will be placed randomly within the oversized collars by an official.

21. The team will be called to the track and when ready, an official will hand the Team 15 "seeds". Each seed will be modelled as a 20mm square cut length of 20mm OD electrical conduit.

(Conduit sample stamped: AussieDuct UPVC AS2053 20mm MD-T. See also http://www.eles.com.au/app.htm, reference number RC20MDGR).

22. The Team will be allowed a maximum of three minutes to set up their device in the starting area measured from the time they are handed the seeds by an official. Contact by Team members or the device with any track surface before setup is prohibited. Contact by Team members or the device with any track surface other than the starting area during setup is prohibited. The Team will indicate to the appropriate official when their setup is complete.

23. Prior to running and after set up, the device including the seeds must be wholly contained within a 400 mm cubic envelope which has two faces parallel with the starting area surface and one of these faces in the ground plane of the starting platform. The device at this time must be stationary and in plan view, must not project beyond the edges of the starting area. After set up, the device can not be held or supported by anything other than the track and it must be ready to start. The volume and positioning conditions will be physically checked by an official.

24. On instruction and by a signal from the "official starter", the run will commence. The device will be started using a single action that does not impart motion or energy to the device.

25. After performing the single action start, Team members shall not control or touch the device in any way until directed by officials after the end of the run. Any interference by Team members will result in a zero score for the run. If team members choose to intervene to protect a device that is malfunctioning, a zero score for the run will be recorded.

26. The run must be completed within 60 seconds. Runs exceeding 60 seconds will result in a zero score for the run being recorded.

27. During the run the device shall not come into contact with anything below the ground plane of the track.

28. At the completion of the run and within the maximum allowable run time, the overall device must become and remain stationary indefinitely relative to the road and any scoring seeds must be secure within the relevant field. Mechanisms within the overall static boundaries of the device (as defined by line-of-sight) may continue to move.

29. The Team shall indicate to the timekeepers when they declare their run to be complete. However, the time keepers will make the final judgment as to when the device becomes stationary and the seeds are deemed to be secure and the recorded time may exceed the Team's declaration.

30. Teams shall not retrieve their device or assist in gathering the sown seeds until directed by an official.

SCORING

31. The seeds should be distributed in the fields along the road. Better devices will achieve the objective without damage to the environment, will distribute seeds to the more difficult fields (as indicated by the "seeded field values"), will implement the task at a reasonable speed and will have greater repeatability.

32. The run scores are based on the following formula:

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Run Score = (SUM("field value(i)" * "field seeded(i)") +
           "end state") * "time factor" * "tree value"

Where
 field value  = 1, 2 or 3 as defined in Figure 1
                for field(i), i=1 to 15

 field seeded = 1 if field seeded
                0 if field NOT seeded
                for field(i), i=1 to 15

 end state    = 20 for finish area
                15 for segment 2
                10 for bridge
                5 for segment 1
                0 for start area

 time factor  = 2.0 for run time < 10 sec
                1.5 for 10 sec < run time < 20 sec
                1.0 for 20 sec < run time < 60 sec

 tree value   = (number of standing trees at end of run)^2 / 144
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33. For a field to be considered seeded, at least one seed shall be in contact with the ground plane of the track surface within that field.

34. The device "end state" will be judged by the plan form projection of the device onto the competition track and the lowest value track component partially covered will apply.

VERSION 2 EXPLANATION NOTE: The total track is made up of 5 zones and each 2400 x 1200 sheet is representative of two zones. The first sheet contains the defined start area and the remainder of the sheet for the purposes of defining the end state value is deemed segment 1 (including the road, verge and fields). The second sheet similarly contains segment 2 (including the road, verge and fields) and the finish area. The 5th zone is the bridge between the two sheets.
It is legal to leave elements of a device anywhere on the track as long as rule 35 is not violated. However, items left influence the end state value. Everything placed within the legal starting volume and remaining at the completion of setup other than the seeds as supplied by the official are considered part of the device.

35. Devices that damage or contaminate the competition track will be given a zero run score. A fallen tree does not constitute damage to the track.

VERSION 2 EXPLANATION NOTE: A component of the device left simply on the track does not constitute contamination. An example of contamination would be a sticky residue requiring significant effort to remove with the possibility of permanent change occurring to the surface finish.

36. Each team may attempt two runs. The Weir-Warman Competition Score will be the best score achieved from either run plus half of the score achieved from the other run. The highest Weir-Warman Competition Score will be declared the winner. The device may be modified between runs but the mass, volume and time constraints must be satisfied for a run to achieve a non zero run score.

37. In the event of a run-off, each team will make one run. If an equal score is again recorded, each team will make another run. If after a third such run, the score is still equal, the team with the shortest run time in the third run-off run will be declared the winner.

38. If additional runs are required, teams will be asked to rerun with a minimum five-minute interval.

39. The judges' decisions on all matters pertaining to the competition will be final**.**

40. Campus organisers are free to modify the rules and or track for their local competition but the rules as stated will be strictly adhered to at the Weir-Warman Final.

Frequently Asked Questions

(Last Updated: 05/04/2006)

1. Does the device have to stay in contact with the track surface at all times?

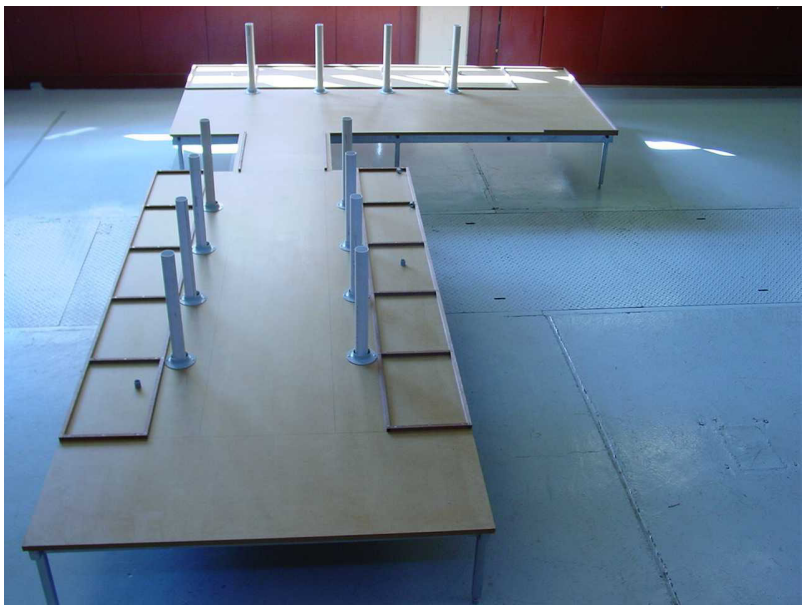
No but the rules do define what can be legally contacted.

2. What is the width of the base of the tree holders\waste trays? How wide does this make the paddocks on the first section of the track?

The OD of the collar is 100 mm. With the collar centrelines 300 mm from the board edge on road segment 1, this makes the paddocks nominally 250 x 400 (ignoring the timber 12 x 12 DAR fence). Similarly on road segment 2, the paddocks will nominally be 450 x 400.

3. Please provide some details of a constructed track.

The following photos are of the track fabricated for the UNSW@ADFA campus competition. This is likely to be the track used for the National Final. Note that the boards as supplied are slightly larger than the nominal 2400 x 1200 dimensions. They have not been cut down. The 12 x 12 DAR fences on the board extremities are flush with the edge of the as supplied boards. The implication is that the fields are slightly deeper. Rule 17 defines the finish area fences to be aligned with the board edges.



UNSW@ADFA Track (start area in fore ground)

UNSW@ADFA Track (from extreme right hand corner of start area)

UNSW@ADFA Track (segment 2 with finish area in distance)

FIGURE FAQ 3 - UNSW@ADFA Track Photos

4. Can "fertilizer" be added to the seeds?

Yes, you can legally add material to the seeds but the implication is that your "end state" value may be affected. Anything left with the seeds is considered part of the device. See the explanation note provided to Rule 34.

5. Can the device touch the fences?

Yes, you can legally touch anything above the "ground plane" of the track (refer to Rule 9 for the definition).

6. Can part of the device be "discarded" off the track e.g. into the "river" without penalty?

No, this would violate rule 27.

7. Could a device be in the finish area and have a part over the "outside" end of the track in plan form projection and not receive penalty?

Yes, you could have a part in space with no track component under it as long as Rule 27 is not violated.

Further Competition Details

(Last Updated: 14/02/2006)

NATIONAL FINAL

It is planned that the Weir-Warman National Final will be held Friday 22 - Sunday 24 September 2006 in Sydney at the Powerhouse Museum (PHM). The format will have students gathering for an initial welcome at the PHM on Friday morning (11.15 AM). Students should be able to gain access to the PHM and their "pit" area from 9 AM and are asked to be present at the PHM by 11 AM at the latest. A tour of Weir Warman Ltd will follow on Friday afternoon. An initial competition briefing will be held on Friday afternoon after the Warman tour. The PHM closes at 5 PM. Scrutineering will be conducted on Saturday morning and there will be briefings, presentations and practice sessions held on Saturday. The actual running of the final and the National Finals Dinner will be on Sunday.

A team registration form is available on the competition web site – submit to Nina Lenz of Engineers Australia: NLenz@engineersaustralia.org.au, Ph 02 6270 6548, Fax 02 6273 2358, Mob 0409 304 447. Team details are required by no later than 28 August (unless otherwise advised).

Travel arrangements are coordinated by Nina Lenz. Students and Campus Organisers attending will be booked to arrive in Sydney on Friday 22 September (morning) and to return home on Monday 25 September also in the morning. For some students and Campus Organisers, due to home locations, they will be flown into Sydney on Thursday 21 September, arriving early evening. It is essential that any students and Campus Organisers that wish to arrive and depart from Sydney at any specific times or who wish to extend their stays in Sydney notify Nina prior to Monday 4 September otherwise flight times will be decided by the travel agent based on the Competition program and available flights.

In meeting costs, the competition sponsorship funds two students per team. Depending on EA funding, Campus organisers may also be funded. Campuses will be billed for additional students and for people who do not travel but for whom arrangements are made.

SPIRIT OF THE COMPETITION

The rules look rigid because we have tried to be very clear on the important points. Engineering reality is rarely so specific. It is essential to work with your campus organiser from an early stage, and for the campus organiser to verify decisions with the National Organiser so that everyone has the same understanding of the meaning of the rules. If you think you see a loophole, clear it with your campus organiser before you rely on it in competition. Even if you get away with it at local level, you might be in for a shock at the national level where the interpretation might be different. Provision will be made for confidentiality, so your idea will not be passed on to other students.

The competition site will be made with reasonable care but because it is a real engineering object it may well be "wrong" in various small ways. For example the planes of the slope might not be exactly at the specified angle, or might have a slight transverse slope. Your team is expected to consider these possibilities in your design, and develop a device that can function even if the competition site has slight imperfections. In other words, you are not allowed to blame failure of your device on some minor imperfection with the competition site.

A FINAL COMMENT ON SAFETY

Please be aware that in 2003 during a campus competition, a student was lucky to escape serious eye injury when a device went off unexpectedly. While Campus organisers run their own competitions independently, they are strongly encouraged to consider all aspects of safety in relation to the conduct of their competition.