

20th WARMAN DESIGN & BUILD COMPETITION – 2007

Weir Minerals and Engineers Australia

Project “REACT” – Reliable Effect At Critical Times

THE CONTEXT:

The Gondwanan people are concerned for their environment and its beauty. They are proud of their culture which attempts to make efficient use of scarce resources, both natural and manufactured and they are passionate about sustainability issues. As an industrialised society, they have committed heavily to environmental protection mechanisms.

THE DILEMMA:

In the “ACME Pinnacle Laboratory”, the Gondwanan Environmental Protection Agency (GEPA) is currently examining its emergency response capability in relation to potential leaks of a particularly volatile yet highly valued chemical resource. A concept for a new autonomous device to respond should an incident occur is being investigated. Self contained “emergency response canisters” that can be packed with the required containment mechanisms or neutralising substances are available to the GEPA. However, they are struggling with how these can be deployed accurately without increasing further the environmental and personnel risk.

THE ENVIRONMENT:

For safety reasons, “ponds” have been created at potential leak sites. Steep levees surround the pond and a perimeter of restricted access fields provides further geographic separation of the hazard from other activity. In the event of an incident, expensive monitoring equipment should be evacuated from the pond.

THE CHALLENGE:

The desire is to develop a single autonomous device to deal with both the deployment and recovery functions required. The GEPA staff are currently struggling to build a laboratory based concept demonstrator for this task. 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 with such engineering problems, and the Gondwanans again seek help from these budding engineers.

Objective

The objective is to design, build and prove a prototype device in a laboratory environment that serves to deploy emergency response packs and recover valuable equipment.

Can you assist in Project REACT – **Reliable Effect At Critical Times**?

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

Details follow:

- Competition Rules
- Frequently Asked Questions
- Further Competition Details
- Spirit of the Competition

Document Control

Version 1.0 08/02/2007

Version 1.a 05/03/2007 *FAQs 6-12 and additional UNSW@ADFA track Photos added*

Version 1.b 27/03/2007 *FAQs 13 added*

Competition Rules

(Original Released: 08/02/2007)

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 National 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.
8. Due to the (hypothetical) risk of explosion, and to avoid a scoring penalty (see scoring), devices shall only source their electrical energy from AA dry cell batteries and carry no more than 4 such cells.

TRACK

9. The competition track consists of a staging area, entry field, pond, exit field and recovery area arranged linearly. The track shall consist primarily of two sheets of Medium Density Fibreboard (MDF) placed end to end, each with nominal dimensions 2400 x 1200 x 18 mm (see Figure 1).
10. The “ground plane of the track” is defined as the upper horizontal surfaces of the two primary MDF sheets.
11. The ground plane of the track shall be no less than 300 mm above the supporting floor at the National Final.

EXPLANATORY NOTE: Campus organisers may choose to set the track directly on the floor for their local competition.

12. The staging and recovery areas shall be framed on three sides with 12 x 12 DAR (Dressed All Round) timber strips mounted on the top surface of the staging and recovery areas with its outside edges flush with the track sheet edges. The free ends will be cut square (vertical). The strips will be mounted by screws on the top surface of the track.
13. In the middle of the track longitudinally, a “pond” of external plan-form dimensions 1200 x 1200 mm will be positioned. The pond will be framed by 65 x 42 DAR timber (with the 65 mm faces aligned vertically) representing a levee bank as shown in Figure 1. Within the pond, a supplementary piece of MDF (nominally 1116 x 1116 x 18 mm) will be placed. The upper surface of this MDF insert sheet defines the pond surface.

EXPLANATORY NOTE: The MDF sheets 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. However, the dimensions of the pond are 1200 x 1200.

14. The pond structure comprising the 65 x 42 timber frame and MDF insert should collectively be a rigid unit which is firmly and centrally located on top of the two primary track sheets using pins, screws or bolts.
15. The supplementary piece of MDF in the pond will have two “side pocket” vertical edged cut-outs (100 radius) as shown in Figure 1. These effectively provide an 18 mm deep recess where the floor of the recess is the ground plane of the track. The pockets represent the “targets” into which “emergency response canisters” are to be deposited.

16. The supplementary piece of MDF in the pond will also have six holes to support stepped plastic golf tees vertically. The holes marked A to F inclusive in Figure 1 will be aligned 300 mm either side of the track longitudinal centreline and on the track centreline and 400 mm and 200 mm ahead of the trailing edge of the exit bank of the pond. The holes of 5.5 mm diameter shall be drilled to a depth of 12 mm. The golf tees used shall be (or be similar to) “Elim” nylon stepped golf tees as shown in Figure 2.

17. At the Team’s choice, up to six golf balls may be placed on golf tees at positions A to F. The golf tees will be of random height selected by the organisers. The balls represent the parcels of monitoring equipment that may be recovered from the pond. The height of support above the pond surface offered by the golf tees may vary in the range of 15 to 40 mm.

18. In the centre of the entry field, another hole of 5.5 mm diameter marked P in Figure 1 shall be drilled to a depth of 12 mm. At the Team’s choice, a golf tee selected from the organiser’s set in the height range of 15 to 40 mm above the ground plane when positioned may be optionally placed in this hole.

19. Note that any hardware above the ground plane of the track securing timber framing materials should be flush with the timber surfaces.

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

21. Transverse line markings defining the staging and recovery areas will be scribed and highlighted with a fine tip permanent marker. These areas are nominally 1200 x 600 in area (see Figure 1).

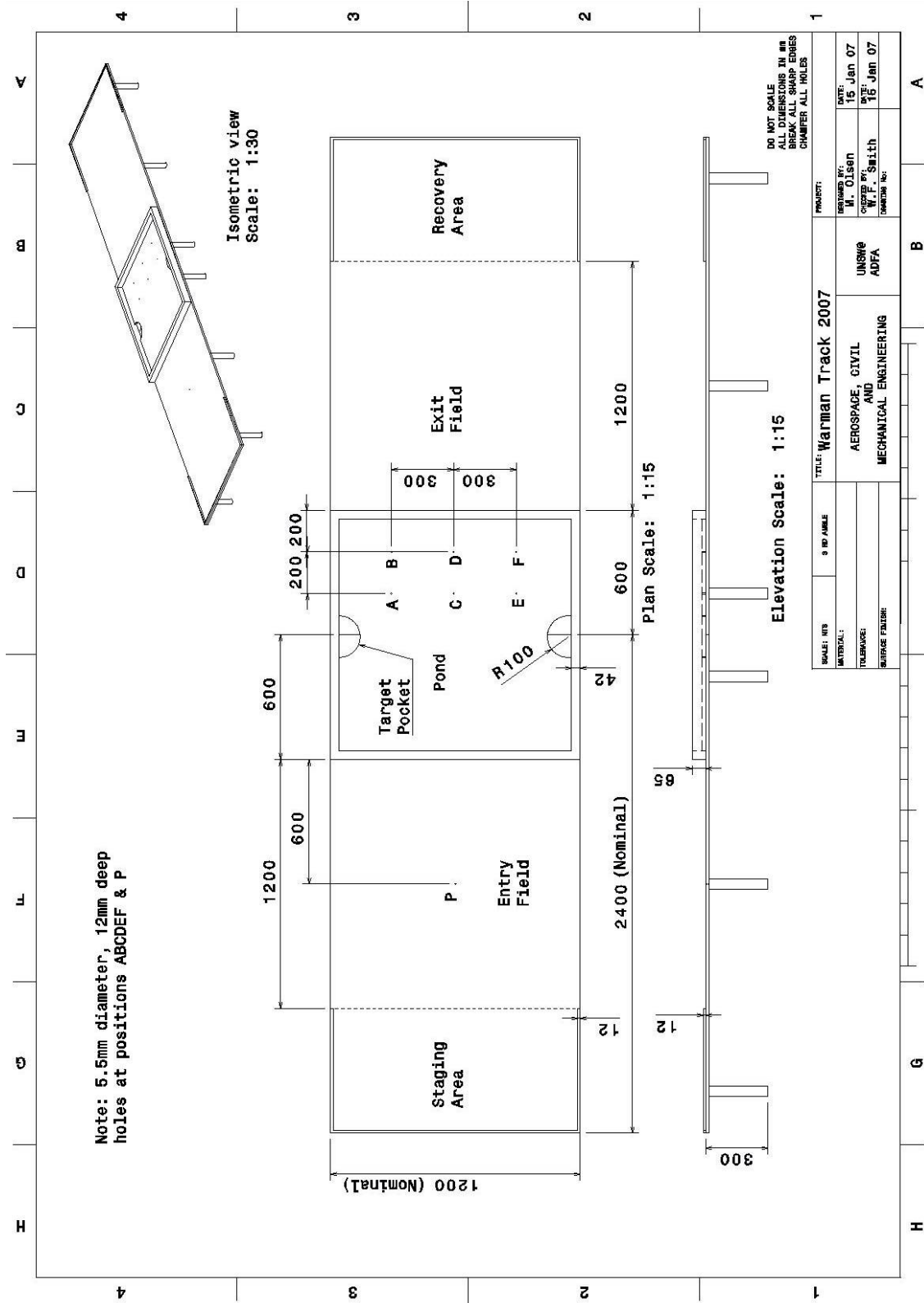


FIGURE 1 - PROJECT "REACT" COMPETITION TRACK



FIGURE 2 - ELIM NYLON GOLF TEES

PROCEDURE

22. The “net mass” of the device will be measured by an official. The mass shall not be greater than 10 kilograms.
23. The Team will indicate if it is attempting to recover parcels and if so, from which of the six positions (A-F). An official will then place a golf ball on a randomly selected height tee in each of the requested positions. Tees will only be placed in these positions if they are supporting balls. The official will have six tees providing relative heights above the pond surface of nominally 15, 20, 25, 30, 35 and 40 mm. The configuration of the tee shanks and steps may be variable.
24. The Team will indicate if it desires a golf tee to be placed in the centre of the entry field. The team can nominate which tee from a set (15, 20, 25, 30, 35 or 40 mm high) they wish to use. An official will then place the tee. The configuration of the tee shanks and steps may be variable.
25. The Team will then be called to the track and when ready, an official will hand the Team six “emergency response pack canisters”. Each canister will be modelled by a plastic ball. The balls used shall be (or be similar to) “Reliance” plastic whiffle baseballs as shown in Figure 3.

EXPLANATORY NOTE: A pack of 6 Reliance whiffle base balls was sourced in Canberra from Sportsman’s Warehouse at a cost of \$11.99.



FIGURE 3 - RELIANCE PLASTIC PERFORATED WHIFFLE BASEBALLS

26. The Team will be allowed a maximum of three minutes to set up their device in the staging area measured from the time they are handed the response pack canisters 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 staging area during setup is prohibited. The Team will indicate to the appropriate official when their setup is complete.
27. After set up and prior to running, the device including all six response pack canisters 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 staging area (which includes the frame). After set up, the device can not be held or supported or contacted 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.
28. 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. The single-action start may employ a simple instrument not considered part of the device.
29. 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.
30. The run must be completed within 60 seconds. Runs exceeding 60 seconds will result in a zero score for the run being recorded.
31. During the run the device shall not come into contact with anything below the ground plane of the track.
32. 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 track and any recovered parcels must be secure within the device, above the ground plane of the track. Mechanisms and items within the overall static boundaries of the device (as defined by line-of-sight) may continue to move.
33. 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 balls are deemed to be secure and the recorded time may exceed the Team’s declaration.
34. Teams shall not retrieve their device or assist in gathering other items until directed by an official.

SCORING

35. Better devices will achieve the objectives of: minimising further damage to the environment (by depositing canisters); using resources efficiently (not waste canisters), maximising recovery of monitoring equipment; responding to an emergency at a reasonable speed; and will be reliable with repeatable operation.

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

$$\text{AScore} = (10 \times \text{NTARGET} + 0.5 \times \text{NPOND} + 1.5 \times \text{NONBOARD} + 3 \times \text{NRECOVERED}) \times (\text{ENDSTATE} \times \text{TIMEFAC} \times \text{IDEPART} \times \text{IBATTERY})$$

Bscore = The greater of the net masses of the device as presented for each of the competition runs

Where:

NTARGET (number of targets with canister(s) deposited) = 0, 1, 2

NPOND (number of canisters anywhere in pond) = 0, 1, ..., 6

NONBOARD (number of canisters onboard at run end) = 0, 1, ..., 6
Note that the canisters have three states, two of which score - in the pond, onboard the device or "lost"

NRECOVERED (number of parcels recovered) = 0, 1, ..., 6

ENDSTATE = 3.0 for device in recovery area
2.5 for device in exit field
1.0 for device in pond
1.0 for device in entry field
1.5 for device in staging area

TIMEFAC = 1.5 for run time < 15 sec
1.0 for 15 sec =< run time < 60 sec

IDEPART = 1.0 if Device fully leaves staging area during run
0.0 otherwise

IBATTERY = 1.0 if all electrical power sourced from no more than 4 AA dry cell batteries
0.8 otherwise

37. To achieve a target, at least one canister (whiffle baseball) shall be in contact with the ground plane of the track within that target "pocket".

38. For a canister to be considered onboard at the end of the run, it shall be contained within the device and the canister shall not be in direct contact with any part of the track.

39. For a canister to be considered in the pond at the end of the run, it shall be in contact with the ground plane of the track within a “pocket” or in contact with the surface of the pond.

40. For a parcel (golf ball) to be considered recovered, it shall be contained within the device and the parcel shall not be in direct contact with any part of the track or the supporting golf tees. A ball may be in contact with a non-supporting golf tee.

41. 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 by the device will apply.

42. Devices that damage or contaminate the competition track will be given a zero run score.

EXPLANATORY NOTE: A component of the device left simply on the track does not constitute contamination. Nor does a golf tee lying on the track 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 track surface finish.

43. Each team may attempt two runs. The Warman Competition Score will be the higher AScore achieved from either run plus half of the AScore achieved from the other run. The highest 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.

44. If equal Warman Competition Scores, based on AScores, are recorded by teams, teams will be ranked in their AScore groups based on their BScore with lower BScores preferred.

45. In the case of a tie for first place based on the Warman Competition Score, those teams with BScores that are within 1.25 times the minimum BScore of the set of teams in the tie shall participate in a sudden death run-off to define the overall placings.

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

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

48. The judges’ decisions on all matters pertaining to the competition will be final.

49. 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: 27/03/2007)

05/03/2007 FAQs 6-12 and additional UNSW@ADFA track Photos added

27/03/2007 FAQs 13 added

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

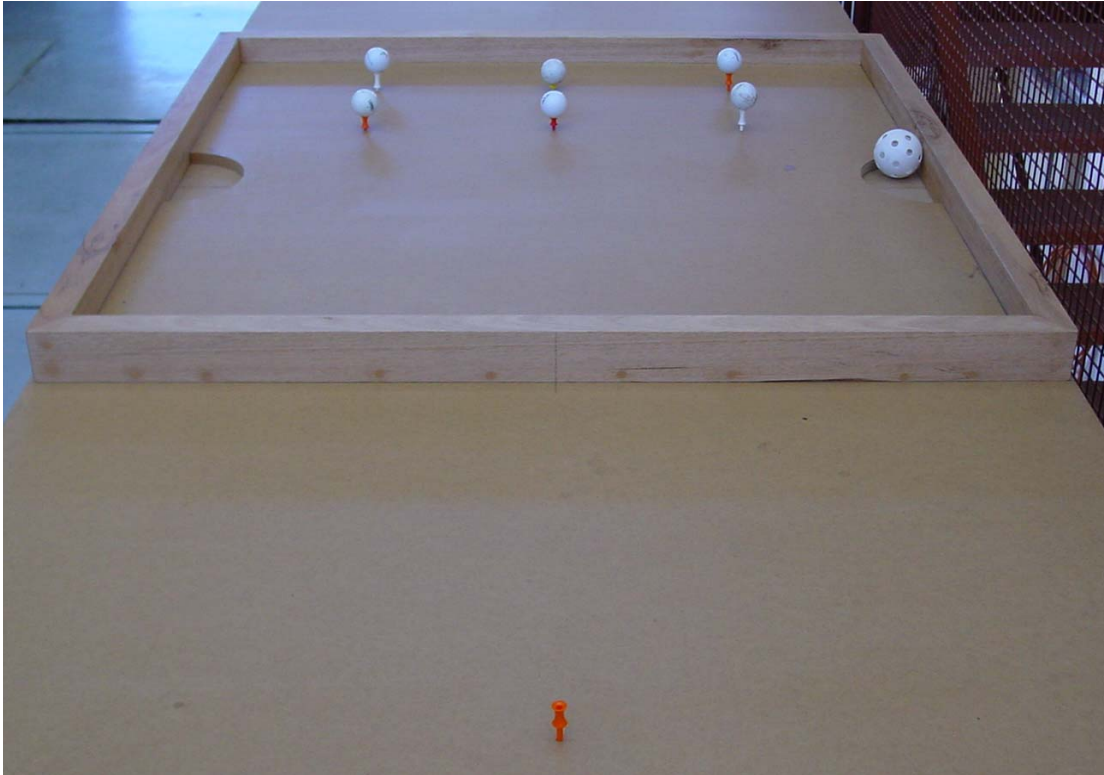
No but the rules do define what can be legally contacted.

2. 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.



UNSW@ADFA Track (staging area in fore ground)



UNSW@ADFA Track showing: a “canister” on the right side-pocket target; “parcels” in Positions A-F and a tee in Position P in Entry Field

FIGURE FAQ 2 - UNSW@ADFA Track Photos

3. Can the device touch the frames?

Yes, you can legally touch anything above the “ground plane” of the track.

4. Can part of the device be “discarded” off the track without penalty?

No, this would violate the rules. (see Rule 31)

5. Could a device be in the recovery 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 nothing below the track ground plane is contacted.

6. What is the diameter of the waffle baseballs? (05/03/07)

Baseball size - 73 mm diameter.

7. What are the exact dimensions of the UNSW@ADFA Track? (05/03/07)

Our boards are 2420 x 1210.

8. Is there a parcel on post P? (05/03/07)

Position P provides an optional post but there is no parcel associated with it. There are a maximum of 6 parcels placed at positions A-F.

9. When is a device deemed to be stationary at the completion of the run? (05/03/07)

This is broadly addressed in Rules 32 and 33. The stop instant will be interpreted as the later of when all the contact points between the device and the competition site come to rest and when the functions being performed are observed to have ceased. It must be clear that the system could remain in the end state indefinitely. Some minor wobbling in the structure is acceptable.

10. If a canister is deployed into the target area within the pond, does it score only 10 points for the NTARGET component or does it score for both NTARGET and NPOND, that is 10.5 points? (refer to rule 39) (05/03/07)

A ball in the pocket attracts 10.5 points.

11. Autonomous – does this mean that the device that is put on the track can not receive input or instructions from a device off the track (such as a computer)? Or does it mean that the device on the track can receive input from a device off the track (such as a computer) but that device (computer) can not be manipulated by a team member during the run? An example of the second would be if the device was controlled by motors that ran to a pre-programmed route transmitted from the computer. (05/03/07)

Autonomous in this competition implies every control system for the device is to be part of the device on the track and fit within the start volume (Rule 27). No remote-to-the-track control systems of any sort can be used (manual or pre-programmed). Such systems would be considered to be part of the device and violate Rule 27.

12. If, at the end of the run, part(s) of the original device get disposed (left) in different zones of the track, is the ENDSTATE defined by the main part of the device containing the canisters? (05/03/07)

All parts of the device will be considered in defining the endstate. For example, if something is left in the pond (other than canisters), then the endstate is the pond.

13. There is a stipulation that electrical energy shall come from AA batteries (Rule 8). Does this preclude other batteries or energy sources? (27/03/07)

As per the scoring algorithm, use of anything other than up to 4 AA's for ELECTRICAL POWER leads to an IBATTERY value of 0.8. However, use of anything that is safe is legal (more electrical power, alternatively packaged electrical power, mechanical systems, etc). Students can use what they like noting the application of IBATTERY. The "shall" in Rule 8 with reference to ELECTRICAL POWER is qualified by the phrase "to avoid a scoring penalty".

Further Competition Details

(Last Updated: 08/02/2007)

NATIONAL FINAL

It is planned that the Weir-Warman National Final will be held Friday 21 - Sunday 23 September 2007 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 13 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 21 September (morning) and to return home on Monday 24 September also in the morning. For some students and Campus Organisers, due to home locations, they will be flown into Sydney on Thursday 20 September, arriving early evening. It is essential that any students and Campus Organisers who 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 03 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.

As the 2007 Competition is the 20th, it is planned that a celebratory cruise on Sydney harbour will be held on the Friday night for all students, campus organisers and guests.

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.

It is highly recommended that all students communicate with their campus organiser and that if a ruling is required by the National Organiser, this is sought by the campus organiser. Students should not contact the National Organiser directly for an individual ruling.

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 surfaces 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.