23rd WARMAN DESIGN & BUILD COMPETITION – 2010

Weir Minerals and Engineers Australia

Project "PASS"

THE CONTEXT:
The Gondwanan landscape is again being reshaped by tectonic plate movement and regular thermal eruptions. A major crevice (predicted to grow into a significant crevasse) has formed but valuable materials need to be repositioned by land based means through the region. This is an evolution that must be done with accuracy, safety and security. Transport of the materials must be achieved within a time frame defined by the regular eruptions to avoid the scorching heat that would limit the success of the mission. The exchange is also a potentially dangerous activity that should be done well away from the safe havens of the existing and proposed new storage depots.

THE CHALLENGE:
The challenge is to design a system to move a valuable yet sensitive material stockpile under very difficult circumstances. In the opinion of the Gondwanan engineers, tectonic plate movement may continue for some time. It has already created serious ground surface discontinuities and variability at and near the crevice. Current climate conditions have ruled out the use of air operations. Therefore, and to allow for multiple transfers, the Gondwanan engineers are of the opinion that two vehicles will be needed working together, with one positioned on either side of the crevice. In that case, a way must be found to pass the material between them across the crevice.

Fortunately, teams of engineering students from Earth are about to visit Gondwana as part of their work experience programmes. On previous visits such engineering students have rendered invaluable assistance with solutions to similar engineering problems, and the Gondwanans again are hoping to benefit from the ideas of the innovative budding engineers.

Objective

The objective is to design, build and prove a prototype system in a laboratory environment that serves to transport a payload across a disjointed and cambered track modelling the newly forming landscape. Can you design the most efficient system incorporating two devices and a transferable container carrying the payload ?

Can you assist in Project PASS – re-Position with Accuracy, Safety and Security?

National Organiser

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Details follow:

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

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Competition Rules

(Version 1 Released: 03/02/2010)

ELIGIBILITY

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

***NOTE**: It is recognised that some campuses are using the Warman as a 1st Year project and that team sizes may be necessarily forced for logistic reasons to be larger than 4. Both year and size variations are acceptable.*

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 system devices 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, protective clothing, footwear, safety glasses or full face masks should be worn by students working on devices during construction, during testing, and during competitions.

5. System devices that are deemed by the officials and judges to be hazardous will not be permitted to run. Employing any form of combustion is considered hazardous.

6. Devices which damage the competition site are prohibited.

MATERIALS AND MANUFACTURE

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

COMPETITION TRACK SURFACE, EQUIPMENT AND ENVIRONMENT

8. The competition surface comprises six sections. There are two track segments, two start zones (one on each segment), an exchange zone (spanning the two segments and 2200 mm long) and a crevice (between the track segments of 200 mm). The centrelines of the track segments are parallel and aligned to be collinear in plan view.

9. The competition surface shall be fabricated using primarily two sheets of Medium Density Fibreboard (MDF), each with nominal dimensions 2400 x 1200 x 18 mm, arranged as shown in Figure 1 and Figure 2. The fabrication collectively is referred to as the “track”.

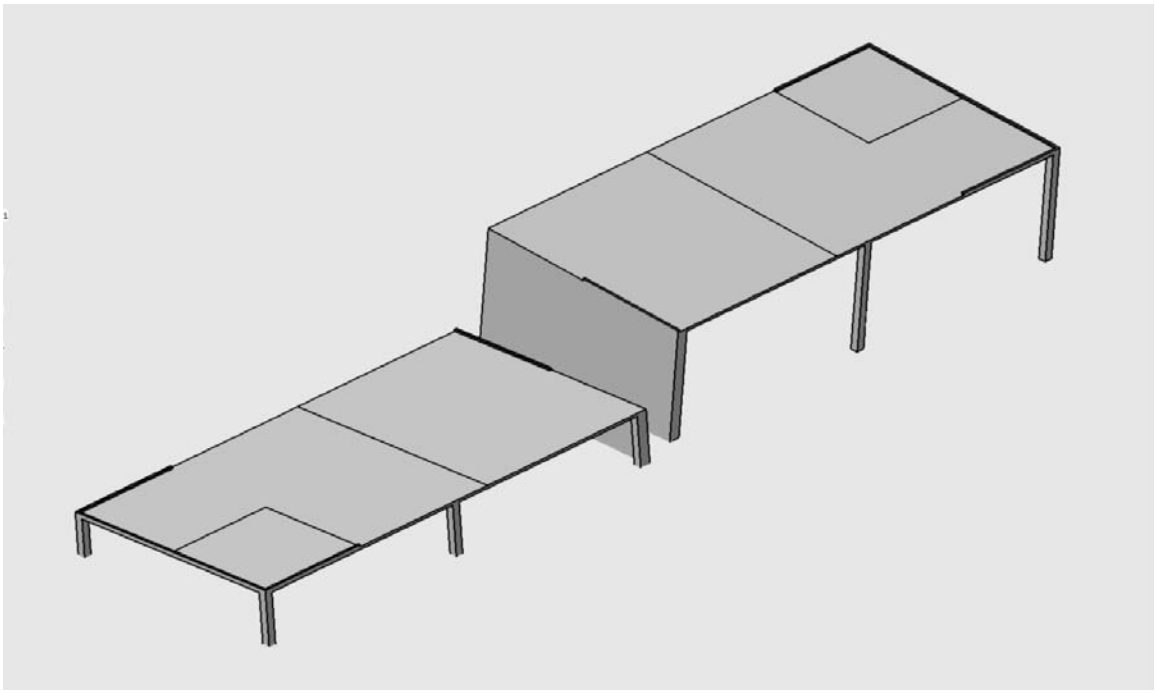

FIGURE 1 - PROJECT "PASS" COMPETITION TRACK

– Note the supporting legs have been drawn perpendicular to the MDF sheets defining the competition surface. This arrangement will be used at the National Final. Adjustable feet or a board or wedges will be placed under the feet on one side to create the required side slope.

10. Both MDF sheets identified individually as Track Segments 1 and 2 are essentially identical. They shall include markings in one corner for a device Start Zone (A or B) measuring 600 mm x 600 mm and a transverse line defining the exchange zone boundary will be marked 1000 mm from the other end. Line markings defining the zones shall be scribed on the sheets and highlighted with a fine tip permanent marker.

NOTE: *The MDF sheets as supplied in the ACT are slightly larger than the nominal 2400 x 1200 dimensions. They are 2420 x 1210. They do not need to be cut down. The 12 x 12 DAR fences (see rules 11 and 12) on the board extremities are flush with the edge of the as supplied boards and are within the boundaries of the relevant zones.*

11. Each track segment sheet shall have the end containing the start zones fenced on three sides with 12 x 12 DAR (Dressed All Round) timber strips mounted on the top surface with its outside edges flush with the sheet edges. The free ends 600 mm along the long edge of the track segment from the corners will be cut square (vertical). The strips will be mounted by countersunk screws (100 mm spacing) on the top surface of the sheets. The strips are considered to be within the start zones.

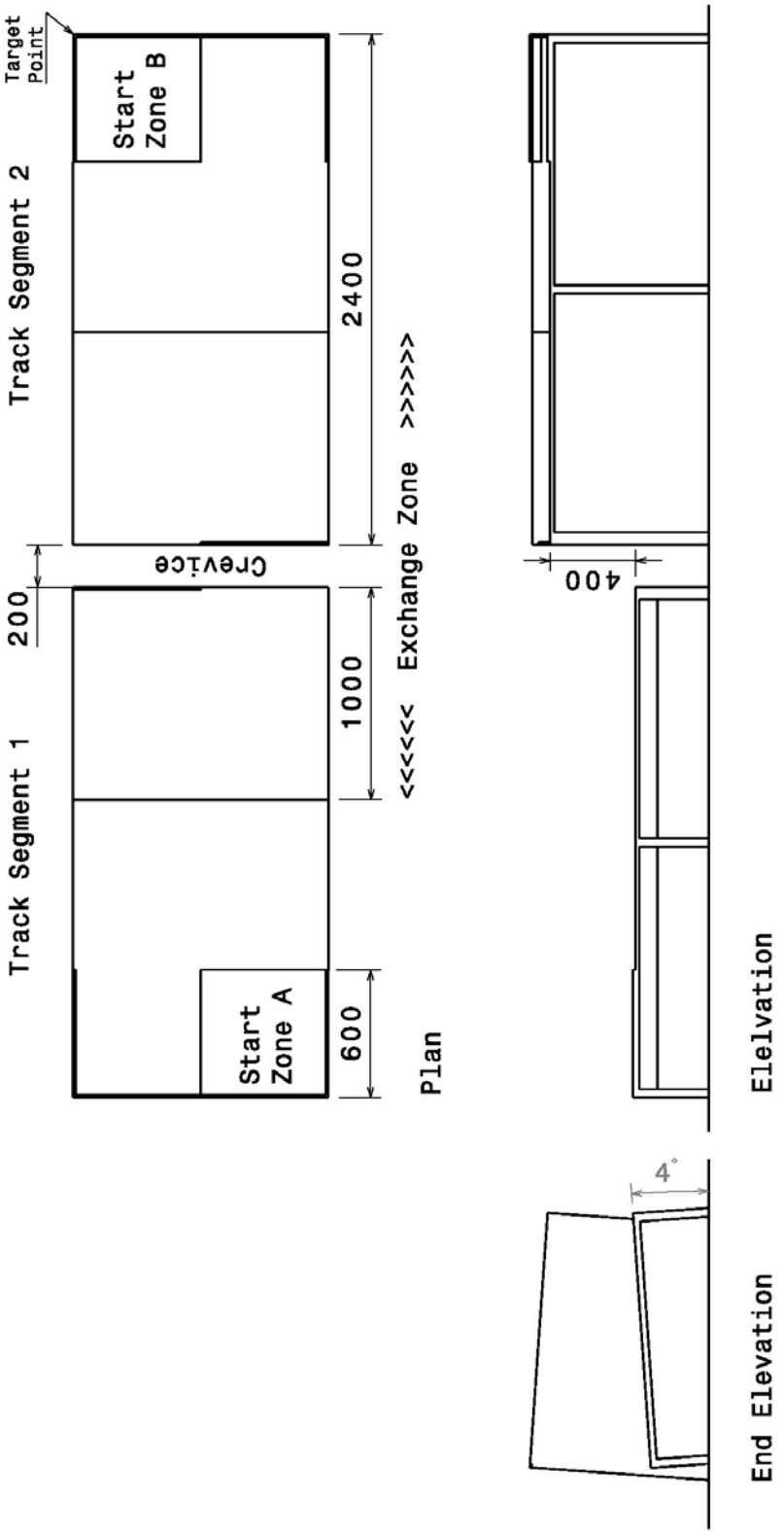

FIGURE 2 - PROJECT “PASS” COMPETITION TRACK (dimensions in mm)

12. Each track segment sheet shall have the end NOT containing the start zones partially fenced with a 600 mm long 12 x 12 DAR (Dressed All Round) timber strip spanning the lower half of the transverse end mounted on the top surface with its outside edges flush with the sheet edge. The free ends will be cut square (vertical). The strips will be mounted by countersunk screws (100 mm spacing) on the top surface of the sheets.

NOTE: *The 12 x 12 DAR fences should be considered as guides rather than barriers built to resist high collision loads. Damaging the fences is considered to be damaging the competition site and will cause a zero run score to be recorded.*

13. Both track segments shall be inclined 4° about the longitudinal axis with the starting zones on the high side. Therefore, the height differential across the track segment translates to 84 mm. A tolerance of ± 5 mm will be applied to this dimension.

14. The long edges of the track segments shall be nominally horizontal.

15. The low long edge of Track Segment 2 will be 400 mm above the high long edge of Track Segment 1.

16. The low edge of Track Segment 1 shall be no less than 300 mm above the supporting floor at the National Final.

17. The transverse vertical surfaces defining the 200 mm wide crevice shall be lined with 18 mm MDF and be flush with the vertical edge of the track segment.

18. 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.

19. The payload used for the competition will be long grain rice.

20. Teams must accept that the presence of bright lighting and photography including flash and infrared systems define the competition environment.

PROTOTYPE SYSTEM

21. Teams shall present a system comprising two devices and a container.

22. One device at least shall be “purely mechanical” (using no chemical energy (including batteries) and having no functioning electrical or electronic components). The other device may utilise electrical or electronic power and circuitry.

NOTE*: Compressed gas systems may be used and qualify as “purely mechanical” but students must gain local coordinator approval based on safety assessment. Such systems presented at the National Final will be examined against the following principles and must be acceptable to the National Coordinator:*
- Home fabricated pressure system components are not to be used unless the pressure is considered to be low,
- Commercial components should be used (unions, vessels, cylinders, lines) unless the

pressure is low,
- Up to 550 kPa (approx 80 psi) may be considered low pressure if such pressure is held inside a plastic drink bottle pressurised by a bike pump. Such a system must be well constrained to prevent projectiles exiting in the event of a failure. For example, an outer, non-pressurised shield shall be included over plastic bottle pressure vessels, to take any sting out of a rupture.
- Evidence of proof testing compressed gas systems shall be provided.

23. The container shall be reusable, not powered and perform the function of holding and constraining the payload. The container shall allow for quick and easy emptying.

24. The two devices, to be referred to as "Device A" and "Device B", beginning respectively in Start Zones A and B, are to interact within the Exchange Zone to move the payload held within the container from Start Zone A on Track Segment 1 to a location as close as possible to the defined target point.

25. The target point is the external corner of Start Zone B (see Figure 2). The fence is considered to be within the start zone so the target point is the corner of the MDF sheet.

PROCEDURE

26. The net mass of the team's system (comprising Device A, Device B, and the Container) shall be measured by an official.

27. The team shall nominate how much payload they wish to be transported. This amount of payload shall be added to a standard vessel by an official.

28. The minimum allowable rice payload shall be 200 grams.

29. The system gross mass (comprising Device A, Device B, Container and Payload) shall not be greater than 10 kilograms.

30. The team shall then be called to the track side and when ready, an official shall signal that the setup has commenced and hand the team the payload in the standard vessel. The team shall be allowed a maximum of two minutes for setup. In this time they are to transfer the payload to their container and set up their devices; Device A in Start Zone A complete with container and payload and Device B in Start Zone B.

31. Either Device A or Device B may be the purely mechanical device.

32. Contact by Team members or either device with the competition surface before setup commences is prohibited. Contact during setup by a device with any portion of the track other than the relevant start zone is prohibited. The Team shall indicate to the appropriate official when their setup is complete.

33. During setup, the team may use additional objects not considered part of the "system" to assist with the transfer of rice from the standard vessel to their container.

34. After setup and prior to running, both devices shall be subject to volume constraints. Each device must be wholly contained within a 400 mm cubic envelope

having one face on the plane of the competition surface, in each relevant zone. For Device A, the container and payload must also be contained within the 400 mm cube. The total system at this time must be stationary and, in a view perpendicular with the competition surface, must not project beyond the edges of the start zone. The volume and positioning conditions shall be physically checked by an official.

35. After set up and prior to running, the devices can not be held or supported or contacted by anything other than the competition surface and they must be ready to start. This prohibits team members from restraining by personal contact ready-to-release devices. Devices should be capable of remaining in the set up condition indefinitely.

36. On instruction and by a signal from the “official starter”, the run shall commence.

37. The run shall finish within 120 seconds. This will be judged by an official.

38. Each device shall be started using a single action relevant to that device that does not impart motion or energy to the subject device. A single-action start may employ a simple instrument not considered part of the system.

39. After performing the single-action start of a device, team members shall not control or touch that device in any way during the run. Wireless control is specifically prohibited. Any interference by team members shall 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 shall be recorded.

40. After a device (either Device A or Device B) has been started and before the other device is started, minor adjustments to the other device may be made. However, the volume and positioning constraints within the relevant start zone shall not be violated. This aspect will be monitored by an official during the run.

41. During the run the devices and container shall not come into contact with anything below the primary competition surfaces (defined by the upper faces of the MDF sheets) other than the vertical faces of the crevice. The exposed surfaces of the 12 x 12 DAR fences can be contacted.

42. During the run, losing portions of the payload from the container shall not result in a zero run score.

43. At the completion of the run, the overall system must cease translation on the competition surface and remain in this state indefinitely relative to the competition surface. Mechanisms and items above the surface supporting the devices may continue to move but no further functions can be executed.

44. The team shall indicate to the timekeepers when they declare their run to be complete. However, the time keepers shall make the final judgment as to when the devices cease translation and all functions have ceased and the recorded time may exceed the team’s declaration.

45. At the completion of the run, a measurement in the horizontal plane to the point of the container furthest from the target point shall be made by an official.

46. At the completion of the run, the container shall be visible so as to determine its position relative to the target point.

***NOTE**: At the National Final, it is anticipated that two eye-safe laser pointers will be arranged on sliding mechanisms parallel with the x and y axes of the track to determine the coordinates of the point of the container furthest from the target point.*

47. To ensure that judging has been completed, teams shall not retrieve their devices or assist in gathering other items until directed by an official.

48. At the conclusion of the run, an official may request that the payload be transferred from the container back into a standard vessel to be re-weighed to establish the mass of the payload actually delivered.

SCORING

49. Better systems will achieve the objectives of transporting the payload with higher transportation efficiency and accuracy while adhering to the timing, volume and positioning constraints.

50. The run score is based on the following formula:

Score = INTEGER [ADEPART*BDEPART*IEXCHANGE*ICONTROL* (500-DISTANCE)* SQRT(TRANSEFF)]

Where:

ADEPART = 1 if Device A fully leaves start zone
0 otherwise

BDEPART = 1 if Device B fully leaves start zone
0 otherwise

IEXCHANGE = 1 if container exchanged in exchange zone
0.9 otherwise

ICONTROL = 1 if container in contact with Device B only at end
0.8 if container in contact with Device A at end
0.5 if container at any time independently on or above competition surface
0 if container lost from competition surface or contact made by any part of the system with elements below the competition surface other than the vertical walls of the crevice

DISTANCE = Integer (distance in cm measured in horizontal plane from furthest point of container to target point)

TRANSEFF = Transport Efficiency (rounded to 2 decimal places)
= (PLDELIVER / PLATTEMPT)* PLDELIVER / GROSSMASS

PLDELIVER = Integer (mass of payload delivered in grams)

PLATTEMPT = Integer (mass of payload attempted in grams)

GROSSMASS = Integer (mass of system including attempted payload in grams)

51. For the container with payload to be considered "controlled", it must be in contact with and supported by one or more devices at all times. A penalty is applied if the container is left lying independently on the competition surface or has been thrown during the run. Dropping with no horizontal velocity component through a small distance (less than 100 mm) does not constitute throwing.

***NOTE**: A transfer will not be penalised by the container being deemed to have been "independent" if it undergoes predominantly a short vertical drop between devices where the plan views of the devices overlap during the exchange sequence.*

52. A legal run shall not allow contact between Device A and Device B if either is in contact with their respective start zone. Such contact between devices results in a zero run score.

53. Devices that damage or contaminate the competition surface shall be given a zero run score.

***EXPLANATORY NOTE:** A component of the device left simply on the competition surface 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.*

54. Each team may attempt two runs. The Warman Competition Score shall be the higher Score achieved from either run plus half of the Score achieved from the other run. The highest Warman Competition Score shall be declared the winner. The devices 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.

55. If equal Warman Competition Scores are recorded by teams, teams tied shall be ranked based on their transport efficiency (TRANSEFF).

56. If TRANSEFF of the top ranked teams are within 5% of the highest, the teams in the tie shall participate in a sudden death run-off to define the overall placings.

57. 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.

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

59. Campus organisers are free to modify the rules and or competition surface for their local competition but the rules as stated shall be strictly adhered to at the National Final.

Frequently Asked Questions

(Version 1 Released: 03/02/2010)

1. Does the device have to stay in contact with the competition 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.

To be built

FIGURE FAQ 2 - UNSW@ADFA Track Photos

3. Can the device touch the fences?

Yes, you can legally touch anything in and above the competition surfaces defined by the upper surfaces of the MDF sheets.

4. Can part of a device be "discarded" off the track without penalty?

No, this would violate the rules and lead to a zero run score.

5. Could a device be supported on the competition surface and have a part over the "outside" edges of the track in plan form projection and not receive a penalty?

Yes, you could have a part in space with no competition surface component under it as long as nothing is contacted.

6. When is a device deemed to be stationary at the completion of the run?

The stop instant will be interpreted as the later of when all the contact points between the devices 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 wobbling in the structure is acceptable.

7. Autonomous – does this mean that the device 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.

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. No remote-to-the-track control systems of any sort can be used (manual or pre-programmed, hard wired or wireless). Such systems would be considered to be part of the device.

8. Are we allowed to use a programmable chip?

Yes, you can use a programmable chip in one of the devices, but there is to be no remote communication during the run.

9. If during the run part(s) of a device get left in different areas of the competition surface, what is the impact on the scoring?

The Devices A and B placed initially in the start zones must both fully leave their respective start zones or a zero score shall result. Leaving implies no physical contact with the start zones. Having left, devices may return.

10. What is the allowable voltage and power of a mechatronic device?

There are no restrictions this year but it clearly needs to be safe.

11. Maintaining constant contact with the container and dropping the container seem contradictory. Please explain

Dropping from one device to the other is acceptable. If the two devices themselves are in contact or if one is above the other and there is an instant where the container is not in contact with either, this would be acceptable. If the container is translated significantly horizontally while not in contact with and supported by a device, the container shall be considered to have been thrown.

12. Do compressed gas systems qualify as mechanical systems and are they allowed?

Compressed gas systems are allowed in the competition and are considered “mechanical” However, any such system MUST be judged to be safe by competition officials. Students should prepare risk assessment documentation to aid this process. At the campus level, the judgement of safety will be made by the Campus Coordinator or his or her delegate. Similarly, at the National Final, all presented devices will need to be appropriately cleared for use by the National Coordinator or his delegate.

Further Competition Details

(Version 1 Released: 03/02/2010)

NATIONAL FINAL

It is planned that the Weir-Warman National Final will be held Friday 24 - Sunday 26 September 2010 in Sydney at the Powerhouse Museum (PHM).

Prizes for Campus Winners and National Podium Places will be awarded at the National Final. A National Final "Judges' Prize" may also be awarded.

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 Minerals Ltd will follow on Friday afternoon. An initial competition welcome and briefing will be held on Friday Morning. The PHM closes at 5 PM. Scrutineering will be conducted on Saturday 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 Susan Pieterse of Engineers Australia: SPieterse@engineersaustralia.org.au, Ph(02) 6270 6539, Fax 02 6273 2358. Team details are required by no later than 9 August (unless otherwise advised).

Teams registering and accepting the invitation and sponsorship to participate at the Final also accept that their names and photographs and video of them can be used for publicity purposes by both Engineers Australia and Weir Minerals. All team members and attending campus organisers will be required to sign an appropriate authority in relation to this use.

Travel arrangements are coordinated by EA. Students and Campus Organisers attending will be booked to arrive in Sydney on Friday 25 September (morning) and to return home on Monday 28 September also in the morning. For some students and Campus Organisers, due to home locations, they will be flown into Sydney on Thursday 24 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 Pearl prior to Monday 31 August 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, it is hoped that Campus organisers will 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

Although the rules may look rigid you will find that they have been written in a way which allows, and in fact encourages, creative solutions. This is not always the case in real-world engineering projects. In this project and competition, the rules are there because we have tried to be very clear on points which will be important when student groups come together for the National Final. For this reason, 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 it is accepted at the 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 longitudinal 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.