22nd WARMAN DESIGN & BUILD COMPETITION – 2009

Weir Minerals and Engineers Australia

Project "BATON"

THE CONTEXT:
The Gondwanan societal leadership is undergoing change as a new generation emerges. To mark the transition, a ceremony symbolising the passing of responsibility from the serving to the newly appointed council members is to be staged in Capital Square. This is expected to be a huge community event and the Gondwanan Office of Protocol (GOP) is keen to show some flair and fanfare within the proceedings.

THE CHALLENGE:
The GOP has devised a design and build competition and has advertised it widely across the galaxy to find a fitting finale to the celebration. Their concept and the competition specification call for two autonomous devices working together in series to pass a sculpture representing the planet's prosperity around two edges of the Square. Symbolically, the sculpture will pass from the retiring leaders to the new both safely and quickly.

Fortunately, teams of engineering students from Earth are about to visit Gondwana as part of their work experience programmes and the GOP is keen to engage them in the competition. 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 innovative budding engineers.

Objective

The objective is to design, build and prove a prototype device in a laboratory environment that serves to automate a baton exchange. Can you win the Gondwanan Office of Protocol's competition? Can you achieve an unbeatable score?

Can you assist in Project BATON?

National Organiser

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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

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Competition Rules

(Version 1 Released: 30/01/2009)

ELIGIBILITY

1. Teams of up to 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.

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, 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. Devices that are deemed by the officials and judges to be hazardous will not be permitted to run. Devices employing any form of combustion are considered hazardous.

6. Devices which damage the competition site are prohibited.

MATERIALS AND MANUFACTURE

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

PROTOTYPE SYSTEM

8. Teams are to present a system comprising two devices. One device at least is to 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.

9. The devices are to implement a relay passing a baton from one device to the other and in so doing transport the baton from one end zone to the other end zone through interaction in the exchange zone.

COMPETITION TRACK SURFACE, EQUIPMENT AND ENVIRONMENT

10. The competition surface, which is nominally horizontal, comprises five areas. There are two end zones, an exchange zone and two track segments. Each track segment

joins an end zone to the exchange area. The centrelines of the track segments are perpendicular to one another.

11. 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, placed in an "L" shape and arranged as shown in Figure 1 and Figure 2. The fabrication collectively is referred to as the "track".

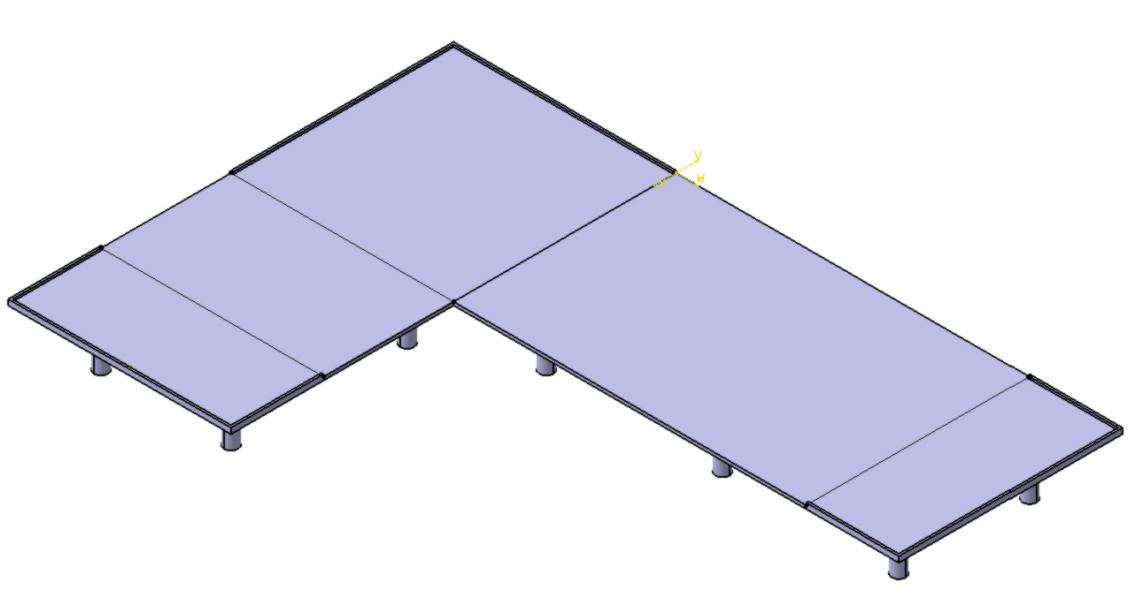

FIGURE 1 - PROJECT "BATON" COMPETITION TRACK
(Pictorial Drawing)

12. One sheet will comprise a track segment measuring 700 mm in length, an end zone of 500 mm nominal length and an exchange zone nominally 1200 x 1200 mm.

13. The second sheet will comprise a track segment measuring 1900 mm in length and an end zone of 500 mm nominal length.

14. Along the butted join of the sheets a step height change of 3mm ±1mm will be presented. The sheet containing the exchange zone will be higher.

15. Both end zones shall be fenced on their three open sides with 12 x 12 DAR (Dressed All Round) timber strips mounted on the top surface of the zones with its outside edges flush with the competition surface sheet edges. The free ends will be cut square (vertical). The strips will be mounted by countersunk screws on the top surface of the sheets.

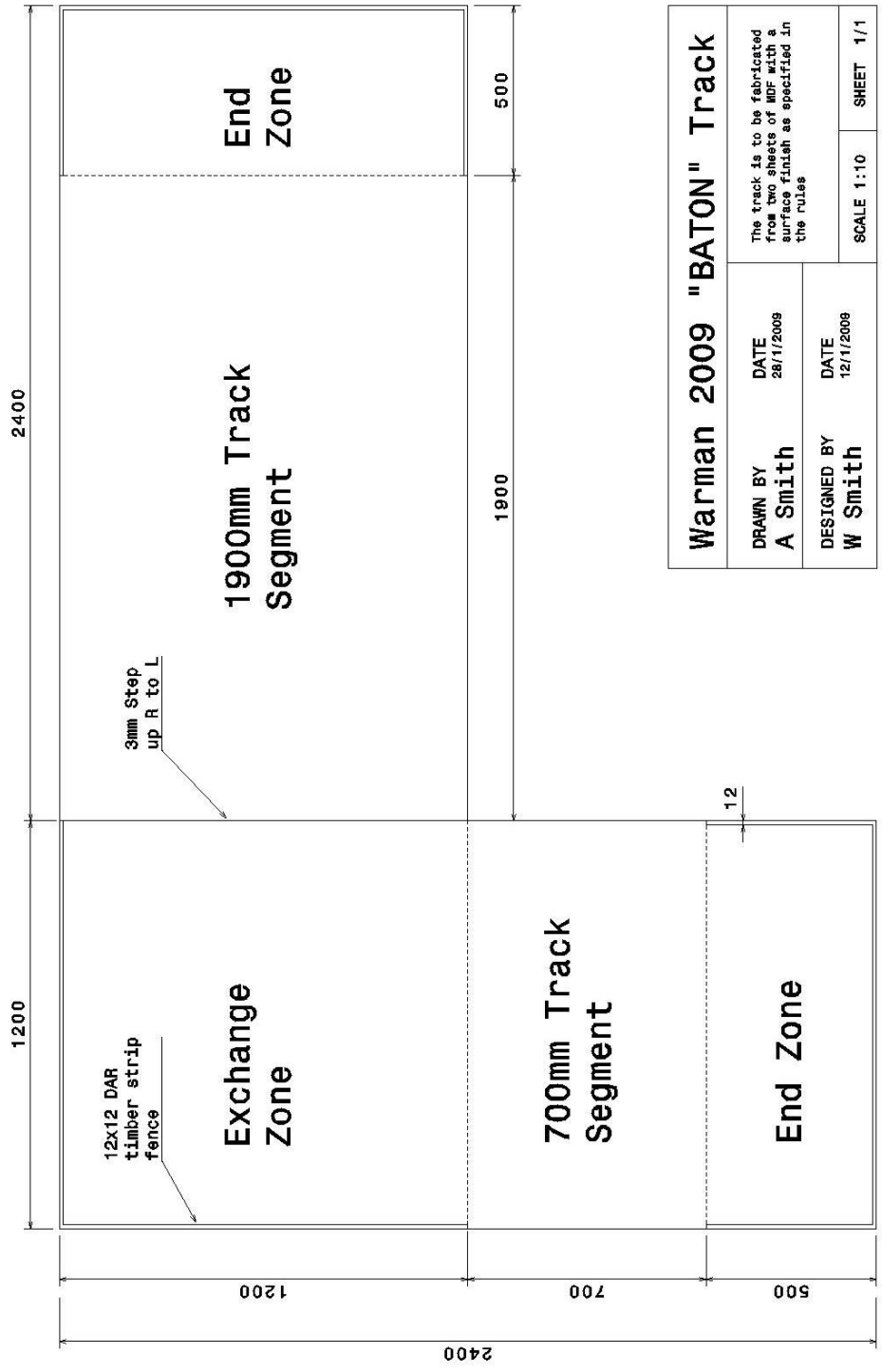

FIGURE 2 - PROJECT "BATON" COMPETITION TRACK
(Plan View)

16. The exchange zone shall be fenced on its two open sides with 12 x 12 DAR (Dressed All Round) timber strips mounted on the top surface of the zone with its outside edges flush with the competition surface sheet edges. The free ends will be cut square (vertical). The strips will be mounted by countersunk screws on the top surface of the sheet.

EXPLANATORY 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 on the board extremities are flush with the edge of the as supplied boards. The additional length is absorbed in the exchange and end zones.*

17. The "ground plane of the competition surface" is defined as the upper horizontal surfaces of the two primary MDF sheets. (It is noted that there is a minor step change in the ground plane as the competition surface is traversed.)

18. The ground plane of the competition surface shall be no less than 300 mm above the supporting floor at the National Final.

19. Transverse line markings defining the exchange and end zones will be scribed on the sheets and highlighted with a fine tip permanent marker.

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. A "Senior" aluminium relay baton (example pictured in Figure 3) complying with the IAAF 2009 Rules will be provided to be carried from one end zone to the other end zone.

IAAF 2009 Rules – Rule 170, Clause 12 The baton shall be a smooth hollow tube, circular in section, made of wood, metal or any other rigid material in one piece, the length of which shall be 28 to 30cm. The circumference shall be 12 to 13cm and it shall not weigh less than 50g. It should be coloured so as to be easily visible during the race.

22. Nominal dimensions of a senior baton are 38mm x 290 ± 10mm. A nominal mass of 50 to 60 grams could be anticipated. Batons made from aluminium are readily available.

Batons are available from many Sports Stores. A set of 8 "International Batons" (as used at the Sydney Olympics) in a bag can be sourced for $35.50 plus postage from www.hartsport.com.au, ***P 1300 764 719***

Sportsmans Warehouse (Club and School) in the eastern states supply batons for $4.80 + GST each.

23. There are regular flashes of lightning in the Gondwana sky and the planned celebration is a public event. In response, teams must accept that the presence of bright lighting and photography including flash and infrared systems define the competition environment.

FIGURE 3 - HART International Relay Baton "Senior" Relay Batons
(*www.hartsport.com.au*)

PROCEDURE

24. The net mass of the system (comprising Device "A" and Device "B", not including the baton) will be measured by an official. The system net mass shall not be greater than 6 kilograms.

25. The Team will then be called to the track side and when ready, an official will hand the Team the baton.

26. The Team has a choice as to which direction they traverse the competition surface and may start from either end zone.

27. The Team will be allowed a maximum of two minutes measured from the time they are handed the baton by an official. In this time they are to set up their devices, one in their chosen start end zone (Device "A") and the other in the exchange zone (Device "B"). Either Device "A" or Device "B" may be the purely mechanical device. The unoccupied end zone at setup will be considered the finish end zone.

28. Contact by Team members or either device with the competition surface before setup is prohibited. Contact by Team members or a device with any track segment or the finish end zone during setup is prohibited. The Team will indicate to the appropriate official when their setup is complete.

29. After setup and prior to running, both devices will be subject to volume constraints. Each device must be wholly contained within a 400 mm cubic envelope having one face on the ground plane of the competition surface, in each relevant zone. The baton must also be contained within the start end zone 400 mm cube. The devices, including the baton at this time must be stationary and, in plan view, must not project over track segments or beyond the edges of the competition surface. After set up, the

devices can not be held or supported or contacted by anything other than the competition surface and they must be ready to start. However, they should be capable of remaining in this condition indefinitely. The volume and positioning conditions will be physically checked by an official.

30. On instruction and by a signal from the "official starter", the run will commence. The device in the end zone 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.

31. After performing the single-action start, Team members shall not control or touch the devices in any way during 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.

32. During the run the device shall not come into contact with anything below the ground plane of the competition surface.

33. The time recorded for the run will be when Device "B" including the baton, has fully entered the finish end zone or when the total system is considered to have ceased translation and the baton is stationary, whichever occurs first. The time recorded will be in whole seconds rounded up.

34. 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.

35. 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 devices cease translation and all functions have ceased and the recorded time may exceed the Team's declaration.

36. The baton at the completion of the run should be visible to ascertain its position relative to the competition surface.

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

SCORING

38. Better devices will achieve the objectives of transporting the baton securely and quickly.

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

If (BATON > 2)
AScore = ADEPART*BDEPART*IEXCHANGE*ICONTROL*
BATON*(30–TIME) + (ABONUS + BBONUS)
Else
AScore = ADEPART*ICONTROL*BATON*(30–TIME) + (ABONUS)

BScore = the greater of the net masses of the system as presented for each of the competition runs

Where:

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

BDEPART = 1.2 if Device B fully leaves exchange zone
1 otherwise

ABONUS = 50 if Device A end state is fully in exchange zone
0 otherwise

BBONUS = 50 if Device B end state is fully in finish end zone
0 otherwise

IEXCHANGE = 1 if baton exchanged legally in exchange zone
0.33 otherwise

ICONTROL = 1.2 if baton in contact with a legally positioned Device B only at end
1 if baton in contact with a legally positioned Device A at end
0.5 if baton at any time independently on or above competition surface
0 if lost from competition surface or in contact with elements below the ground plane

BATON based on baton final position (lower value applies) BUT see rule for suspension beyond competition surface boundary
= 0 if any part in volume above start end zone
0.5 if any part in volume above 1st track segment
2 if any part in volume above exchange zone
4 if any part in volume above 2nd track segment
6 if no part in volume above 2nd track segment and a part in volume above finish end zone
0 otherwise

TIME = Time for complete run or system to cease translation (in whole seconds (rounded up))

40. For the baton to be considered "controlled", it must be in contact with one or more devices. A penalty is applied if the baton is left lying independently on the competition surface or has been thrown during the run. Dropping does not constitute throwing.

41. A legal baton exchange must occur in the exchange zone before any of the plan form projection of Device "B" crosses any boundary of the exchange zone. (This is analogous to a runner in a relay race receiving the baton before leaving the exchange zone.)

42. A legal run will not allow contact between Device "A" and Device "B" outside the exchange zone. (This is analogous to a runner in a relay race not receiving outside assistance.)

43. If the baton is in the volume above the starting end zone or 1st track segment at any time, only Device "A" can be in contact with the baton. A violation leads to a zero run score.

44. If the baton is in the volume above the 2nd track segment or finishing end zone at any time, only Device "B" can be in contact with the baton. A violation leads to BATON being assigned a value of 2.

45. If the baton is suspended beyond the boundaries of the competition surface the value of BATON will be determined based on the external boundary crossed by the plan view projection of the device holding the baton. If multiple boundaries are crossed, the lowest value of BATON will apply.

46. In considering the plan form projection of a device or the baton, the full range swept by motion when translation ceases will be taken into account.

47. Devices that damage or contaminate the competition surface will 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.*

48. 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 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.

49. 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.

50. In the case of a tie for first place based on the Warman Competition Score, tied 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.

51. 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.

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

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

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

Frequently Asked Questions

(Version 1 Released: 30/01/2009)

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.

Currently under construction

FIGURE FAQ 2 - UNSW@ADFA Track Photos

3. Can the device touch the fences?

Yes, you can legally touch anything in and above the "ground plane" of the competition surface.

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 penalty?

Yes, you could have a part in space with no competition surface component under it as long as nothing below the ground plane 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?

Device “A” placed initially in an end zone must fully leave that end zone or a zero score will result. Device “B” placed initially in the exchange zone must fully leave the exchange zone or the score based on the position of the baton will be halved.

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.

Further Competition Details

(Version 1 Released: 30/01/2009)

NATIONAL FINAL

It is planned that the Weir-Warman National Final will be held Friday 25 - Sunday 27 September 2009 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 Warman 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 Ms Pearl Ansley of Engineers Australia: PAnsley@engineersaustralia.org.au, Ph 02 6270 6569, Fax 02 6273 2358, Mob 0420 801 773. Team details are required by no later than 10 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 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.