WARMAN® Design & Build Competition

35th WARMAN DESIGN & BUILD COMPETITION 2022

ENGINEERS AUSTRALIA

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CONTEXT

Gondwana is a small planet orbiting a star on the outer fringes of the Milky Way. Rich in natural resources, the Gondwanans have mined and distributed precious metals throughout the Galaxy. The first stage of the extraction of the metals from the mined ore is using a metallurgical concentrator. This involves grinding the ore to a fineness which allows the metal bearing particles to be separated from the valueless material or gangue. Water laden with gangue is then pumped to large tailings dams, where the solids settle and the recovered water is returned to the concentrator for reuse. In one application, the gangue has to be pumped across a 2km wide chasm. The pipe is supported by a wire rope spanning the chasm.

Planned maintenance of the slurry pump requires a new impellor to be transported across the chasm. But a recent storm washed out the only bridge, preventing delivery of the urgently needed part. The only way to transport the impellor is by using the wire rope spanning the chasm.

An intergalactic transporter has delivered an impellor to a nearby warehouse but the design of a system to collect, transport and deliver the part using the wire rope has stumped the Gondwanan engineers. Young engineers from Earth have once again been asked to assist by designing a system and proving the concept using a scaled down version.

Over the last 34 years, engineering students have rendered invaluable assistance with such engineering problems, and on this thirty-fifth occasion, the Gondwanans again seek help from a new team of budding engineers to demonstrate a solution.

CHALLENGE

Prototype a reduced scale proof of concept transporter system, later referred to as the “system”, which will precisely deliver a scale representation of the impellor, later referred to as the “package,” from the warehouse to the pump location. Referring to Figure 1, the team will position the package at your chosen location within the warehouse boundaries and the team will install the system within the boundaries of the Start Zone. When activated, the system will autonomously collect the package and deliver it to the defined location D. The system shall then return to finish its run on the right hand side of the Start Zone – Chasm vertical boundary. The maximum time for collection, delivery and return is 120 seconds. No part of the system or package shall touch the horizontal surface marked as “Chasm Zone,” at any time during the run.

OBJECTIVE

The objective is to design, build and demonstrate a proof of concept scaled prototype transporter system in a laboratory environment. Prior to starting, the package shall be located by the team anywhere within the warehouse boundaries and the system shall be assembled within the boundaries of the Start Zone. The system may contact any surfaces within the boundaries of the Start Zone, including the rope. You will earn points when your autonomous system completes the staged tasks of collecting the package, depositing it within the Deposit Zone and the system returning to the Start Zone. A tether cord may be used to retract the system. These tasks include: the system moving the package to within the vertical boundaries of the Start Zone; fully supporting the package above the Start Zone horizontal plane surface; the system and package moving to the left side of the Chasm Boundary; placing the package anywhere in A or B of the Deposit Zone, or on surface C, or into the target recess D; and finally the entire system returning to the right hand side of the Chasm Boundary, Figure 1. Penalties shall be applied for contacting the horizontal Chasm Zone plane and/or the package falling off the track. For maximum points, the system shall deposit the package in recess D and return to the right hand side of the Chasm Boundary, within 120 seconds of the start command. For deposit and return points to be awarded, the entire system, with the exception of the tether, and package shall travel to the left hand side of the imaginary Chasm Boundary during the run.

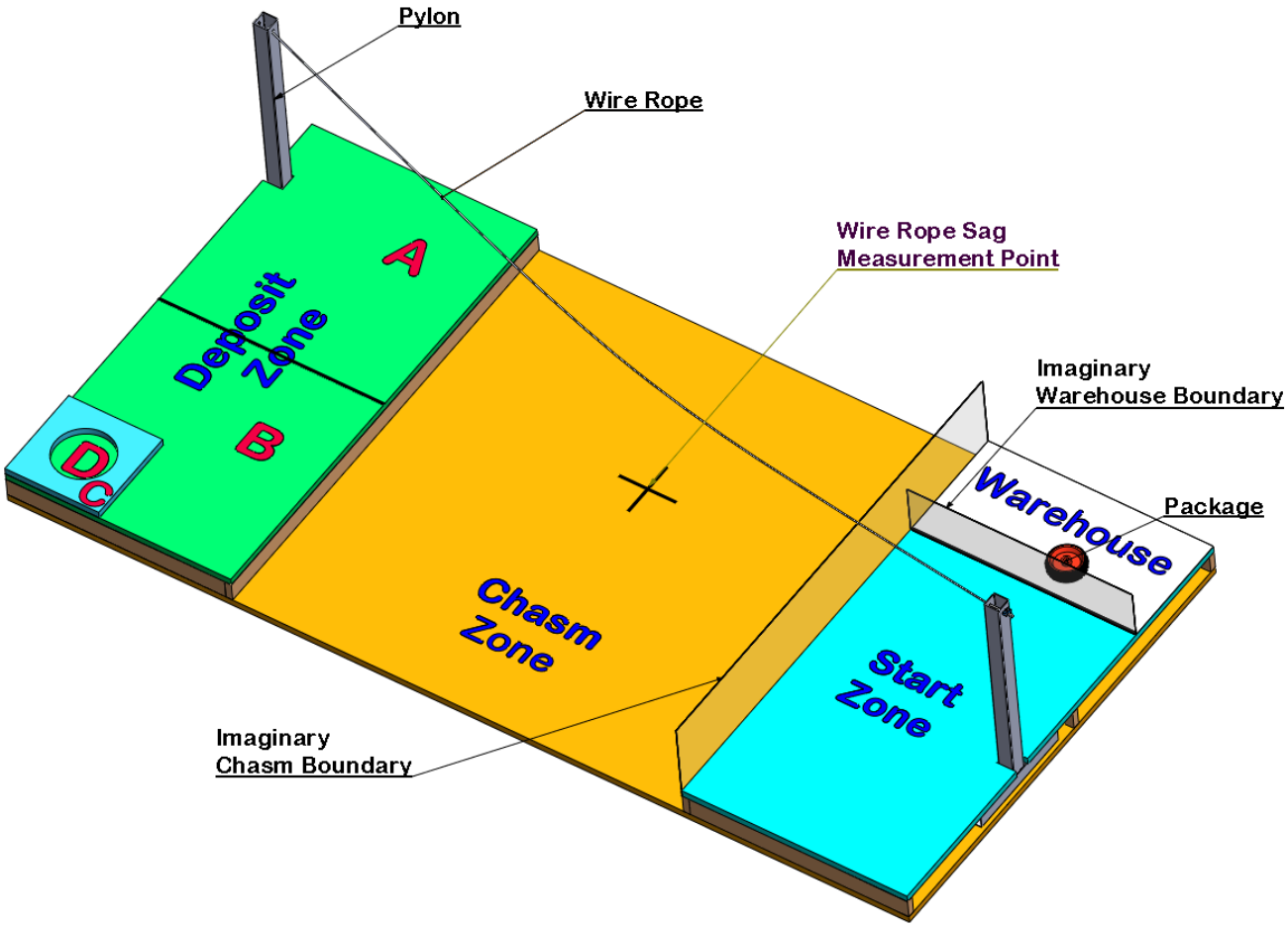

Figure 1. Schematic view of the Competition Track showing the Start Zone, the Warehouse with the package, the wire rope across the Chasm Zone and the Deposit Zone. The boundary planes are shown for clarity.

International Competition Coordinators:

A/Prof Don Clucas	don.clucas@canterbury.ac.nz	Phone: +64 3 3692212
Prof Craig Wheeler	craig.wheeler@newcastle.edu.au	Phone: +61 2 4033 9037
Dr Scott Wordley	scott.wordley@monash.edu	Phone: +61 3 9905 3811

International Competition Supervisor:

Dr Michael Lucas	michael@mechatronics.design	Phone: +61 419 737 869

Details follow:

- Competition Guidelines
- Competition Rules
- Frequently Asked Questions
- Further Competition Details
- Spirit of the Competition
- Appendix A – Detailed Drawings of the Competition Track and Relevant Component Details

Document Control:

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Revisions 1.1

- G31, optional sag fine adjustment screw
- R14, clarification of boundaries
- R34, wire rope damage
- Scoring, clarification of MOVEscore boundary
- FAQ 7. Reach over the chasm
- FAQ 8. Clarification of MOVEscore boundary
- FAQ 9. Clarification of deposit location for RUNtime score
- There are no changes to the drawings so they are not published with this revision

Competition Guidelines

Wording: *The language of the guidelines is tiered. Those clauses expressed as "SHALL" are mandatory and failure to comply will attract penalties which in the extreme could lead to a zero RUNscore or disqualification at the International Final. Those expressed as "SHOULD" or "MAY" reflect some level of discretion and choice.*

ELIGIBILITY

G 1. Teams that are eligible to represent their campus in the International Final SHALL consist of students enrolled in the competition year in their first engineering design course/subject/unit in an Australasian (or other countries, by arrangement) mechanical or mechatronics-based BE or 3+2 ME programme. Teams SHALL consist of at least two students, with teams of three or four strongly recommended, but it is recognised that larger teams MAY be educationally appropriate at some universities. If an alternative team structure is envisaged, an International Competition Coordinator should be consulted to ensure that other teams are not unreasonably disadvantaged. While students may be required to participate in the Warman competition more than once at their campus level, students SHALL NOT compete at the International Final more than once.

In registering a team, the Campus Organiser attests to the eligibility of the team and teams found to be ineligible at the International Final SHALL NOT be eligible for an award.

SAFETY

G 2. Safety is of paramount importance when participating in this competition. All engineers SHOULD know that injury and damage to equipment and the environment occur when the control of energy (in any form - whether strain, potential, kinetic or thermal) in a system is lost.

G 3. As appropriate, protective clothing, footwear, safety glasses or full-face masks SHOULD be worn by students working on systems during construction, testing, and competitions. Refer to your campus requirements. Appropriate, protective clothing, footwear, safety glasses or full-face masks SHALL be worn at the International Final.

G 4. Students are encouraged to carry out a risk assessment for their system prior to campus testing. Students are encouraged to embrace risk management in their own activities and MAY need to demonstrate the safe operation and produce risk assessment documentation in order to compete in either the campus heats or at the International Final.

G 5. Appropriate fuses SHALL be used for electrical systems.

G 6. Compressed gas systems MAY be used, but if used, students SHALL gain Campus Organiser approval based on a safety assessment.

Such systems presented at the International Final SHALL be examined against the following principles and in order to run SHALL be found to be acceptable to the International Competition Coordinators.

- Home fabricated pressure system components SHALL NOT be used.

- Commercial components SHALL be used (unions, vessels, cylinders, lines, etc).

- Evidence of proof testing of compressed gas systems SHALL be provided.

To avoid disappointment, students using compressed gas MAY consult with the International Competition Coordinators prior to arrival at the International Final. The International Competition Coordinators' approval decision SHALL be final after examination of the presented system and documentation at the International Final.

G 7. Systems that are deemed by the officials and judges to be hazardous SHALL NOT be permitted to run. For example, employing any form of combustion SHALL be considered hazardous.

COMPETITION TRACK, EQUIPMENT, AND ENVIRONMENT

G 8. The Competition Track base sheet SHALL be fabricated using primarily one sheet of Medium Density Fibreboard (MDF) or equivalent sheet material (MDF SHALL be used at the International Final), with nominal dimensions 2400 x 1200 x 18 mm, arranged as shown in Figure 1 and detailed drawings in Appendix A, refer drawing 1 of 5. The track supporting frame, not shown, for the sheet may be fabricated by any convenient method. The supporting frame SHALL NOT extend beyond the perimeter of the competition track.

***NOTE:** MDF sheets as supplied may be slightly larger than the nominal 2400 x 1200 mm dimensions and are generally 2420 x 1210 mm. All dimensions shown in Appendix A are based on sheet sizes of 2400 x 1200 mm. Competition Tracks at the International Final SHALL be trimmed to be 2400 x 1200 mm sheets in accordance with Appendix A.*

G 9. Raised platforms for the Start and Deposit Zones SHALL be made from Medium Density Fibreboard (MDF) or equivalent sheet material (MDF will be used at the

International Final), with nominal dimensions 600 x 1200 x 18 mm, arranged as shown in Figure 1 and detailed drawings in Appendix A, refer drawings 2 and 3 of 5.

G 10. Each platform, refer G9, SHALL have four supports that SHALL be made from 18mm thick Medium Density Fibreboard (MDF) or equivalent material (MDF will be used at the International Final), arranged as shown in Figure 1 and detailed drawings in Appendix A, refer drawing 5 of 5.

G 11. The target C/D SHALL be made from 18mm thick Medium Density Fibreboard (MDF) or equivalent sheet material (MDF will be used at the International Final), arranged as shown in Figure 1 and detailed drawings in Appendix A, refer drawing 2 of 5. The target MAY be glued or screwed to the deposit zone platform.

G 12. All screw or fastener recesses on the top faces of the Start/Warehouse and Deposit zones SHALL be filled and levelled.

G 13. The MDF track sheet with relevant features attached, not including the package, SHALL be identified as the Competition Track as shown in Figure 1. The attached features include; the Start/Warehouse platform, the Deposit platform, the Chasm Zone, the two wire rope support pylons, wire rope with four 3mm wire grips and washers, and a target C/D with a recess for the package.

G 14. The Warehouse SHALL be defined by the projected vertical planes of the track sheet edges and the Chasm and Warehouse boundaries, Figure 1.

G 15. The upper surface of the track sheet SHALL define the competition base plane, which is nominally horizontal. Lettering shown on the competition track, Figure 1, are for clarity and SHALL NOT be applied to the track.

G 16. Permanent marker vivid pen lines with knife scribe lines, Appendix A, refer drawings 2 and 3 of 5, SHALL define the boundaries of the Warehouse/Start zones and the boundary between the score graduations A and B.

G 17. The competition base plane SHALL be no less than 300 mm above the supporting floor at the International Final. The supporting table or frame is not shown in Figure 1.

G 18. The wire rope SHALL be Pinnacle 3.2 mm medium flexibility, 316 marine grade stainless multi-strand wire rope, 3.2mm Pinnacle wire rope, refer appendix A, Photo 3.

G 19. Two pylons SHALL support the wire rope, these SHALL be welded and painted assemblies of 40x40x3 SHS steel, Appendix A, refer drawing 4 of 5.

G 20. The two pylons shall be attached to the track base sheet using M8 bolts without washers under the bolt head and washers between the nuts and track sheet.

G 21. The wire rope ends SHALL be restrained using two 3mm wire grips on each end, 3mm Wire Grips, Appendix A, Photo 2. Each end SHALL be looped with at least a 100mm long tail as detailed in Appendix A, Photo 6. An 8mm washer SHALL be fitted between the grip and pylon. For safety the tail SHALL be fed down into the SHS.

G 22. The sag of the wire rope SHALL be measured by firmly pressing down on the rope and using a builder's combination square, or similar, to measure the height above the track sheet at the defined measurement point, refer Figure 1. and Appendix A, drawing 1 of 5. By shifting the rope grips adjust the sag height to 250mm +/- 10mm. *It is recommended to initially apply approximately 10kg load to settle the grips and the sag height should be checked at regular intervals. Avoid using a sharp edge as it may permanently bend the wire.*

G 23. If the MDF track from the 2021 competition is being recycled all the bolt holes and screw holes MAY be filled and the top surface levelled to match the general surface. At the

International Final new or recycled MDF tracks MAY be used but for recycled tracks the holes SHALL be filled and resurfaced according to G24.

G 24. The surfaces of the Deposit, Start, Warehouse and Chasm zones, and the vertical boundaries of the Chasm zone SHALL be brush or roller coated with one coat of ESTAPOL® Water-Based Xtra Clear – Satin as a sealer followed by two coats of Wattyl ESTAPOL® - Polyurethane Matt (in accordance with Wattyl's recommendations for use with MDF - Refer: Estapol Polyurethane Material Specification and Estapol Water-Based Clear Material Specification. Recycled track surfaces SHOULD be lightly sanded and re-coated with two coats of Wattyl ESTAPOL® - Polyurethane Matt. The vivid and scribed lines SHALL be applied following the last coat.

G 25. The package representing the slurry pump impellor SHALL be a 95mm Easy Roll Plastic Centre Rubber Wheel. 95mm Easy Roll Wheel. The black plastic bearing SHALL be removed.

G 26. Teams SHALL accept that the presence of bright lighting and photographic equipment including flash and infrared systems MAY be part of the competition environment.

G 27. Teams SHALL accept that the presence of air conditioning/ventilation induced air movement MAY be part of the competition environment.

G 28. Teams SHALL accept track assembly, components, and the package are made within defined tolerances.

G 29. Campus Organisers MAY modify the rules and or competition track for their local competition but the guidelines and rules as stated SHALL be strictly adhered to at the International Final.

G 30. At the International Finals, video recording SHALL be used to determine placings if potential podium winning time scores are within 5 seconds.

G 31. To enable fast fine adjustment of the wire rope sag, a screw arrangement MAY be used, Photo 7. Drill an 8mm diameter hole thorough a standard M12 x 50 full thread bolt and increase the size of the outer face 4mm diameter hole of the pylon to 12.5mm diameter. This MAY be applied to one or both ends. The track at the International Final SHALL have this modification.

PROOF OF CONCEPT SYSTEM

G 32. The system SHALL cease all operations within 120 seconds. The system MAY use an identifying signal, for example a LED, to indicate when all electrical and/or mechanical functions have ceased.

G 33. Untethered or tethered flying systems SHALL NOT be used, refer G2. The system SHALL be fully supported by the competition track and/or rope.

G 34. After the start signal, the system and/or the package MAY contact all surfaces within the Start, Warehouse, Deposit Zones and the vertical faces of the chasm boundary.

G 35. To earn points for MOVEscore, DEPOSITscore, RETURNscore or RUNtime the entire system, with the exception of a tether refer G38, SHALL move to the left hand side of the Chasm Boundary, Figure 1, during the run.

G 36. The team, system or package SHALL NOT contact the track surface identified as the Chasm Zone, Figure 1, at any time after setup has commenced.

G 37. The package location relative to scribed lines and boundaries SHALL be checked using a square on the platform surface, refer Appendix A, Photo 5.

G 38. The system MAY comprise multiple separable sub systems.

G 39. The system MAY include a cord tether of up to diameter 3mm for the purpose of returning the system to the Start Zone at the end of the run. The tether SHALL only contact the surfaces of the system, rope, grips and pylon and SHALL only be used to return the system.

G 40. To commence setup a track official SHALL call the team to the track and on the command of a track official the setup SHALL begin. The maximum setup time SHALL be 120 seconds.

COMPETITION RULES

R 1. Points will be awarded for achieving particular milestones including; moving and fully supporting the package, the system and package moving to the left hand side of the Chasm Boundary, Figure 1., depositing the package on the Deposit Zone horizontal surfaces or depositing the package in the target D, the whole system returning to be entirely on the right hand side of the Chasm boundary, Figure 1., and the time to complete the task. Refer to the SCORING section.

R 2. Students SHALL manufacture and fabricate their "proof of concept prototype" system themselves using commonly available materials, components and methods.

R 3. NOTE: At the International Final Campus Organisers MAY be required to confirm that the system presented has been appropriately manufactured in keeping with the spirit of the competition. While students MAY purchase components "off-the-shelf", it is not intended that they purchase systems / major subsystems as solutions directly.

R 4. In keeping with the spirit of the competition, teams SHALL NOT use LEGO ® Mindstorms ® or similar comprehensive kitted systems at the International Final.

R 5. In keeping with the spirit of the competition, teams MAY use Arduino or similar PIC based components.

R 6. In keeping with the spirit of the competition, teams MAY adapt / modify / integrate elements sourced "off-the-shelf".

R 7. Systems using electric battery storage devices SHALL have an appropriately sized fuse connected to one of the battery leads.

R 8. The mass of the team's system (SYSTEMmass) SHALL be measured by an official. The system mass does not include the package and system or package positioning equipment. The system mass SHALL NOT be greater than 6 kilograms.

NOTE: *A maximum system mass of 6 kg has been selected to reflect carry on allowances by Jetstar and Virgin airlines so as not to disadvantage interstate and international teams traveling to the International Final who MAY wish to transport their system as carry on. Teams must appropriately satisfy the airline's restrictions/limitations for carry on and/or checked luggage, including restrictions for transporting dangerous goods such as batteries.*

R 9. The team SHALL then be called to the trackside.

R 10. There SHALL be no contact by team members or their system with the Competition Track before setup commences.

R 11. When ready, an official will signal that the setup SHALL commence. The team SHALL be allowed a maximum of 120 seconds for setup. In this time they are to set up their system in the Start Zone and place the package in the warehouse.

R 12. During setup, the team MAY use additional objects not considered part of the "system" to assist with setup. Any additional objects used SHALL be removed from the competition track during setup. The mass of these additional objects SHALL NOT be included in the SYSTEMmass.

R 13. During setup, physical contact SHALL NOT be made by team members, their system, or any additional objects used to assist with setup, with any portion of the competition track other than surfaces to the right hand side of the Chasm Boundary, Figure 1. Contact with the track edges below the track base plane of the Start/End zone is permitted. Refer to Figure 1 and Appendix A.

R 14. After setup, the system SHALL be fully contained within and supported by any surface(s) within the Start Zone vertical boundaries defined by the Warehouse and Chasm boundaries, Figure 1, and the edge of the track. This is limited to the horizontal Start Zone platform, the pylon, the wire rope and grips.

R 15. The installed system SHALL NOT exceed a height of 600mm above the horizontal Start Zone platform surface at the conclusion of the set-up time.

R 16. During setup, the package SHALL be placed by the team anywhere within the Warehouse defined by projected vertical planes of the Chasm and Warehouse boundaries, Figure 1, and edges of the track. The package MAY be placed at an orientation and location chosen by the team. For example, the wheel rim MAY be vertical or horizontal. Setup package alignment tools MAY be used. After setup has completed, there SHALL only be the package in the Warehouse.

R 17. The Team SHALL indicate to the appropriate "official" when their setup is complete.

R 18. After setup, and prior to running, everything placed and left on the competition track, except the package, SHALL be considered to be part of the system.

R 19. After setup, the system SHALL be one combination of components. The system MAY separate during the run.

R 20. To achieve the RETURNscore all components of the system and package, except a tether for retraction, SHALL have first moved to the left hand side of the Chasm boundary and secondly moved to the right hand side of the Chasm Boundary. It MAY contact any surface of the right hand side of the Chasm boundary, Figure 1, when the run has completed. The system MAY extend over the track edges. There is no height restriction for the RETURNscore.

R 21. On instruction by a clapper board type signal from a track official the run SHALL commence. The start SHALL be counted 3-2-1-clap at nominally one-second intervals.

R 22. The system SHALL be started using a single action of a team member that does not impart motion or energy to the system. Attaching wires, fitting electrical terminals, or fitting plugs SHALL NOT be used.

R 23. If a part or surface of the system does not move into the Warehouse or the team member prematurely starts the system, by the instruction of a track official the system MAY ONE TIME ONLY for each run be removed from the track and IMMEDIATELY reset and started again after 120 seconds setup time. Rules R2 to R22 SHALL be adhered to. This rule SHALL NOT be used to extend the setup time. This rule SHALL NOT apply to systems that do not comply with the volume constraints.

R 24. The run SHALL be designed to finish within 120 seconds. For timing, the run SHALL be deemed to be complete when all functions of the system have ceased. The system MAY be swinging on the wire rope after the run is deemed complete. An LED or similar MAY be used to indicate when the micro controller program has ended.

R 25. After performing the single action start, team members SHALL NOT control or touch the system in any way during the run. Wireless control SHALL not be used. Team members SHALL NOT interfere with the system. If team members choose to intervene to protect a system that is malfunctioning, a zero RUNscore SHALL be recorded.

R 26. During the run, the system and/or package SHALL NOT come into contact with any surface below the outer track edges, refer G13. The system MAY contact any surface within the boundaries of the Start, Warehouse and Deposit zones. The system or package MAY contact the vertical chasm walls. The system or package SHALL NOT contact the Chasm Zone horizontal surface of the competition sheet, refer to Figure 1.

R 27. After the run commences the system or package MAY extend beyond the edges of the perimeter of the Competition Track and for a non-zero RETURNscore the system SHALL stop within the defined constraints, refer rule R20.

R 28. At the completion of the run, all parts of the system SHALL cease controlled translation and remain in this state indefinitely relative to the competition base plane. Mechanisms and items within the system MAY continue to move but no further functions will be executed. Natural swinging of the system on the rope SHALL be permitted.

R 29. The team or system MAY indicate to the timekeepers when they declare their run to be complete. However, the track officials SHALL make the final judgment as to when the system ceases translation and all functions have ceased and the recorded time MAY exceed the team's or system's declaration.

R 30. The DEPOSITscore SHALL NOT be awarded if the system is still in contact with the package after the run ceases.

R 31. The DEPOSITscore SHALL be awarded if the package overhangs the edges of the Deposit Zone platform or surface C, Figure 1.

R 32. After the deposit and end of the run, if the package partially crosses the scribed line between A and B DEPOSITscore SHALL be the higher score. If in doubt a square SHALL be used, refer Appendix A, Photo 5.

R 33. To ensure that judging has been completed teams SHALL NOT retrieve their system or assist in gathering other items until directed by a track official.

R 34. The system SHALL NOT damage or contaminate the competition track. The setup or run SHALL NOT contaminate or damage the package. The setup or run SHALL NOT damage or contaminate the wire rope. Teams presenting a system that damages or is deemed to have the potential to damage the competition track or package MAY be disqualified from the competition. *Note, excessive force on the wire rope may permanently deform the wire, causing permanent damage to the wire rope which is part of the track.*

R 35. As directed, teams MAY attempt two runs.

R 36. The system MAY be modified between runs but the mass and time constraints must be satisfied for a run to achieve a valid non-zero score. SYSTEMmass SHALL be recorded before each run.

R 37. Violations of procedural rules SHALL result in a zero RUNscore being recorded.

R 38. The judges' decisions on all matters pertaining to the competition SHALL be final.

R 39. Better systems will achieve the objective of depositing the package into the target hole D, Figure 1, and returning to right hand side of the Chasm boundary in the shortest time. Either side of the rim of the package SHALL be coincident with the track surface.

R 40. If two or more teams have equal COMPETITIONscores the team competition placing SHALL be determined by the SYSTEMmass of the run achieving the highest RUNscore. The lower SYSTEMmass SHALL be preferred.

SCORING

The COMPETITIONscore SHALL be calculated using the following:

COMPETITIONscore = Max RUNscore + Min RUNscore/2

$$RUNscore = \big((SHIFTscore + SUPPORTscore + MOVEscore + DEPOSITscore + RETURNscore) + (120 - RUNtime)\ x\ 0.5\big)$$

SHIFTscore: 10 if the system moves the package to be fully outside the warehouse zone. The system SHALL be in control of the package.

SUPPORTscore: 10 if the system fully supports the package. The package SHALL be supported by the system above the track top surfaces.

MOVEscore: 20 if the entire system and package moves to be entirely past the left hand side of the Start Zone/Chasm Boundary, Figure 1.

DEPOSITscore: The highest score achieved will apply:

20 if the package is only supported by the surface defined as A (refer R32)

30 if the package is only supported by the surface defined as B (refer R32)

40 if the package is only supported by the surfaces B and C

50 if the package is only supported by surface C

60 if the package is only supported by surfaces C and D

100 if the package is fully deposited in the target D and the rim is nominally parallel to the track surface.

RETURNscore: 20 if the system has fully returned to be on the right hand side of the Chasm boundary, Figure 1. The system SHALL have previously moved to be entirely to the left hand side of the Chasm boundary, Figure 1.

RUNtime: time in seconds for a run that correctly deposits the package, see DEPOSITscore, within 120 seconds AND fully returns to the Start zone, refer RETURNscore.

Otherwise = 120

Notes: RUNtime is measured from the 'Start Clap' command until the system has ceased functions. The system MAY swing on the wire rope but there SHALL NOT be translational motion relative to the competition track.

RUNtime SHALL be rounded up to the nearest half-second. For example, 15.2s becomes 15.5s and 15.7s becomes 16s

RUNtime SHALL only be recorded for systems that deposit the package in D and return to the start zone.

SYSTEMmass = the net mass, in grams, of the system. Excludes the package and setup tools.

Example score calculations:

The package is delivered to D and the system returns in 15 seconds: 10+10+20+100+20+(120-15)x0.5 = 212.5

The package is supported by B and C and does not return:

10+10+20+40+0+0 = 80

As above but the system is still in contact with the package:

10+10+20+0+0+0 = 40

Frequently Asked Questions

1. Can part of a system be "discarded" off the competition track without penalty?

No. If the system, or part of the system, is discarded off the competition track this would lead to a zero RUNscore (R26).

2. Can part of the system overhang the extremities of the competition track without penalty when negotiating the track?

Yes, (see R27). After the run commences the system or package MAY extend beyond the edges of the perimeter of the Competition Track. Contact between the system and anything below the track base plane is not permitted at any time.

3. Autonomous – does this mean that the system on the competition track cannot receive input or instructions from a Subsystem off the track (such as a computer)? Or does it mean that the system on the competition track can receive input from a Subsystem off the track (such as a computer) but that Subsystem (computer) cannot be manipulated by a team member during the run? An example of the second would be if the system 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 system is to be part of the system on the competition track that fits 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).

4. Are programmable chips or microcontrollers allowed?

Yes. You can use a programmable chip or microcontroller, but there is to be no remote communication during the run. However, LEGO ® Mindstorms ® or similarly kitted systems are not allowed (see R4 and R5).

5. What is the allowable voltage and power of any employed electrical systems?

There are no restrictions this year but it clearly needs to be safe. Refer G2.

6. Can off-the-shelf items be used?

Commonly available components such as toy and machine parts are able to be used, however full kits or systems such as LEGO ® Mindstorms ® are not allowed. The spirit of the competition is that students manufacture and fabricate their system themselves, meaning that professionals are not engaged to do it for them. It is possible for some assistance to be

obtained (e.g.; for a weld) but this should be minimal or where possible be done by the students themselves. The production of major components should not be outsourced.

7. Can the system stay in the start zone and reach over the chasm?

Whilst it would be technically feasible, there is no specific rule preventing this but the competition scenario should be considered. The task is to produce a scale prototype of a system to deliver a package over a 2km wide chasm. So a full size system would have to reach across 2km which seems an unlikely solution. Also, both MOVEscore and RETURNscore would be sacrificed.

8. Does the entire system have to move beyond the Chasm/End Zone boundary to receive the MOVEscore?

No. Only past the Start/Chasm zone boundary. Refer Figure 1.

9. **Does RUNtime apply for a deposit other than fully supported within D?** No, the package must be fully within the hole D and fully supported by the green track surface, refer Figure 1.

Further Competition Details

INTERNATIONAL COMPETITION FINAL

In 2022, due to travel and social distancing rules it is the intention of the International Competition organisers and sponsors to hold a coordinated series of State and/or Country semi-finals leading to a virtual International Competition Final. Details of the finals format will be agreed with campus organisers and may include a video link from the State finals.

SPIRIT OF THE COMPETITION

Although the rules may look rigid you will find that they have been written in a way that allows, and in fact encourages creative and innovative 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 International 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 International Competition Coordinators 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 the competition. Even if it is accepted at the local level, you might be in for a shock at the International Final 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 International Competition Coordinators, this is sought by the Campus Organiser. Students SHOULD NOT contact the International Competition Coordinators directly for an individual ruling.

The competition tracks, at the Campus Competitions, State/Country semi-finals and the International Final, 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 competition base plane might have a slight longitudinal slope. Your team is expected to consider these possibilities in your design and develop a system that can function even if the competition track has slight imperfections and inaccuracies. In other words, you are not allowed to blame failure of your system on some minor imperfection with the competition track.

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 Subsystem 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.

Personal Protective Equipment, PPE, required for the competition is determined by campus organisers for the campus heats. For the International final, it will be the International Final organisers.

*All participants **SHALL** use appropriate PPE during the building and development of their system. Refer to campus organisers for campus requirements.*

Appendix A – Photos, General Arrangement and Detailed Drawings of the Competition Track

Sheet 1 – Drawing 1 of 5. Track Base

Sheet 2 – Drawing 2 of 5. Deposit Zone

Sheet 3 – Drawing 3 of 5. Start Zone

Sheet 4 –Drawing 4 of 5. Pylon

Sheet 5 – Drawing 5 of 5. Zone Platform Packer

***Photo 1**. The package. Do not use the black plastic bearing.*

***Photo 2**. Zenith 3mm Wire Rope Grips.*

***Photo 3**. Wire rope.*

***Photo 4**. Measuring the sag of the wire rope. 250mm +/- 10mm.*

Photo 5. *Determining if the package crosses the Warehouse boundary or A/B deposit zones*

Photo 6*. Wire rope/pylon/grips/washer assembly. Preferably, there is no gap between the two grips.*

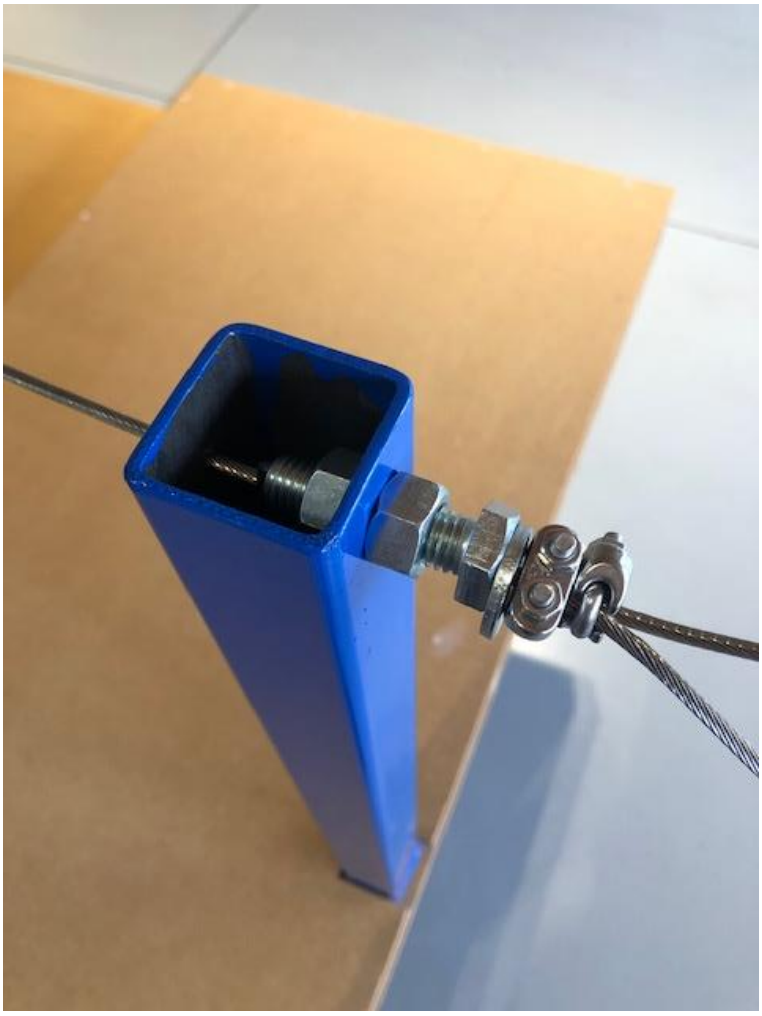
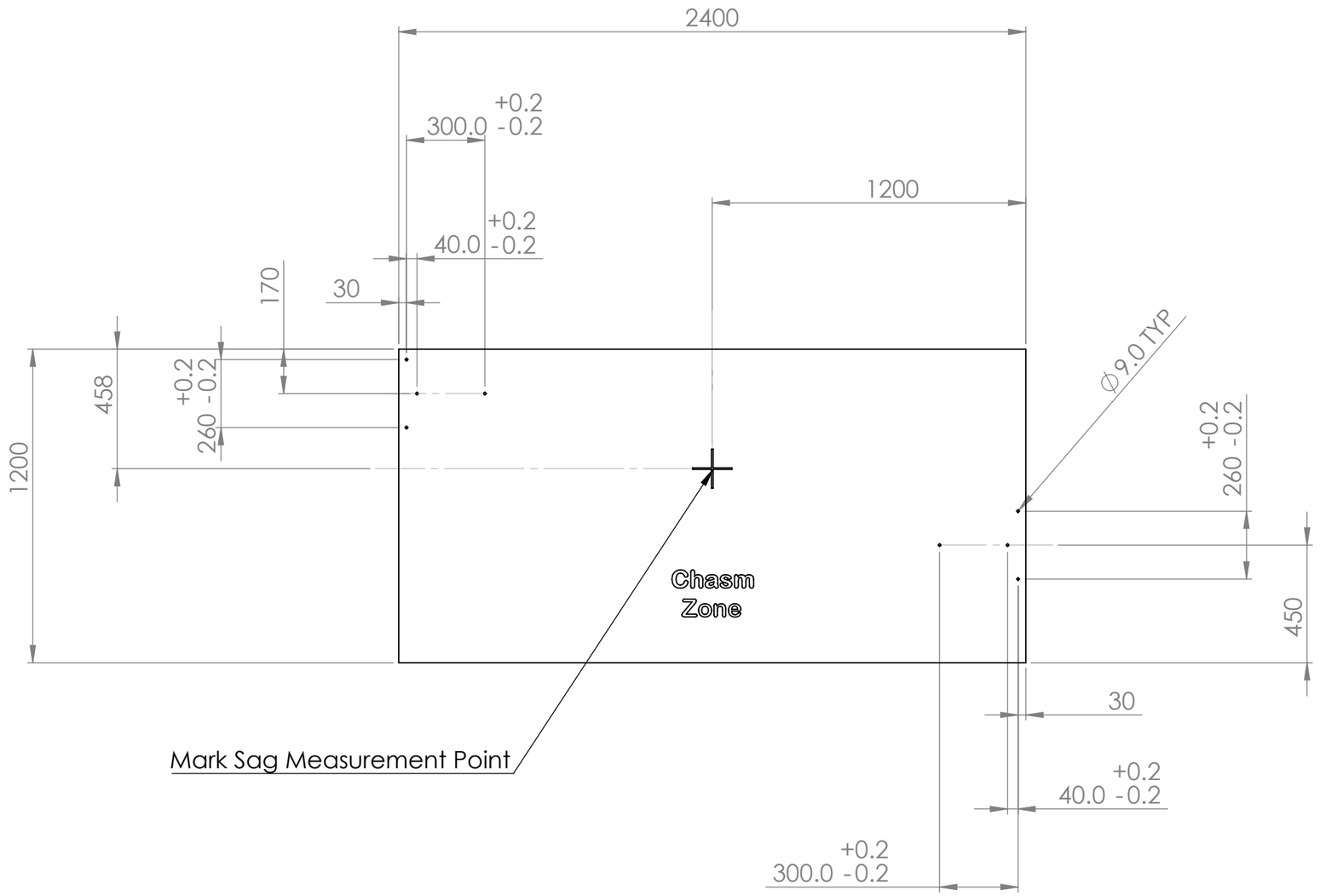
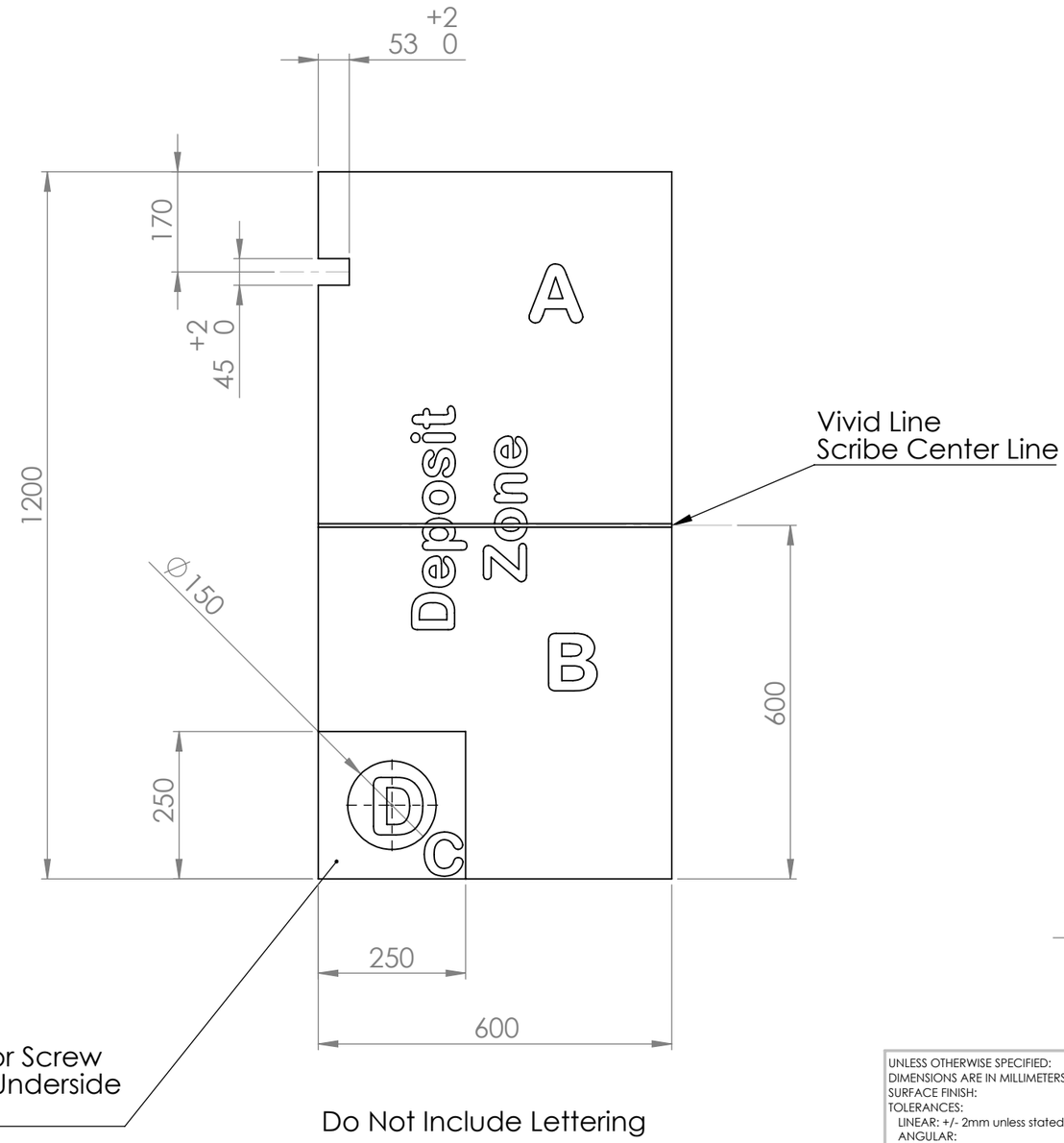


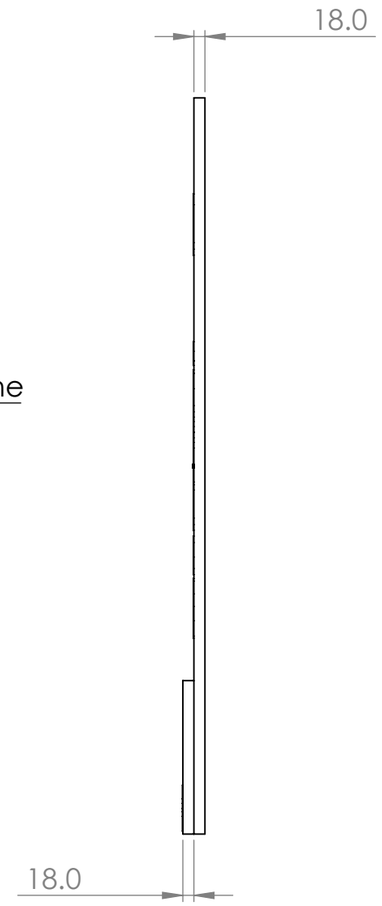
Photo 7*. Optional wire rope fine adjustment assembly using an M12 bolt. Only drill the 12.5mm hole through the right hand side of the SHS as shown.*



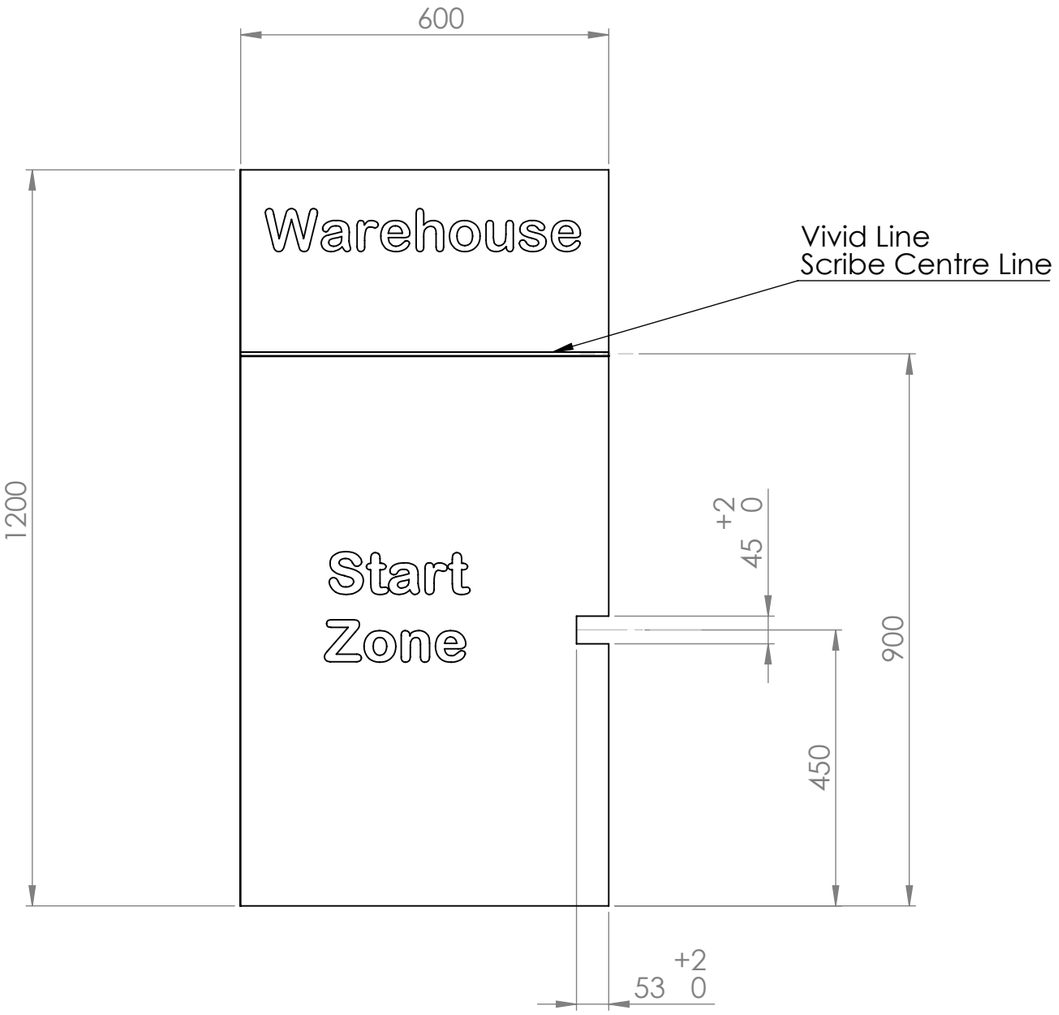
Do Not Include Lettering

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2 Unless Stated ANGULAR:		FINISH: Refer To Guidelines		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE: 2022 Warman Competition Track Base	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF		DWG NO. 1 of 5	A3
				WEIGHT:		SCALE:1:20	SHEET 1 OF 1



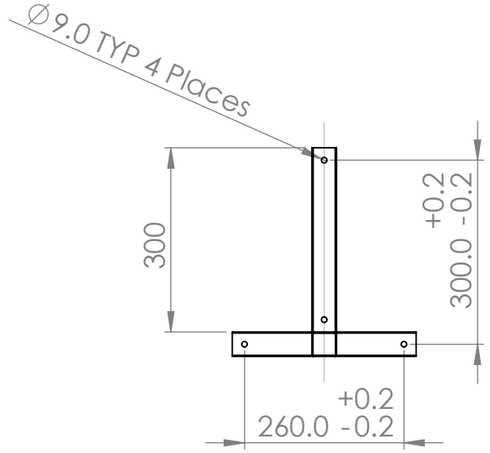


UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2mm unless stated ANGULAR:		FINISH: Refer to Guidelines		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE: 2022 Warman Competition Deposit Zone	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF		DWG NO. 2 of 5	A3
				WEIGHT:		SCALE:1:10	SHEET 1 OF 1

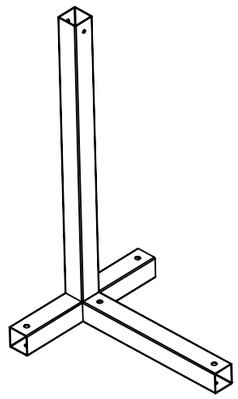


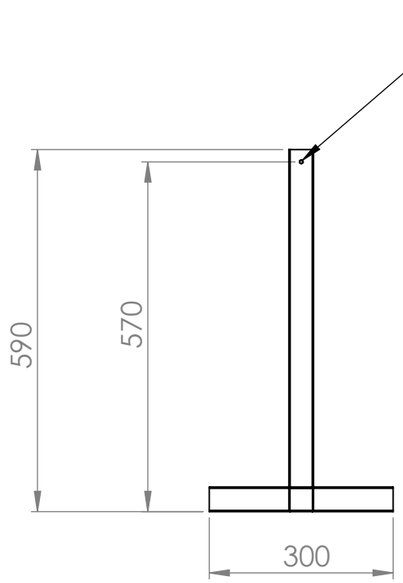
Do Not Include Lettering

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2mm Unless Stated ANGULAR:	FINISH: Refer to Guidelines		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION	
	NAME	SIGNATURE	DATE				TITLE: 2022 Warman Competition Start Zone
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF		DWG NO. 3 of 5	A3
				WEIGHT:		SCALE:1:10	SHEET 1 OF 1

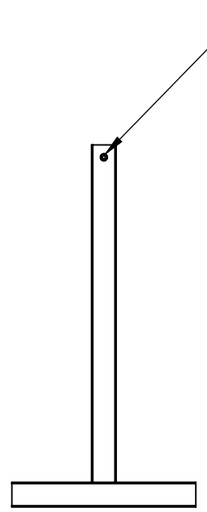


Plan





Elevation



End Elevation

2 Off

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2mm Unless Stated ANGULAR:		FINISH: Enamel Gloss Paint		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE: 2022 Warman Competition Pylon	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 40 x 40 x 3 Mild Steel SHS		DWG NO. 4 of 5	A3
				WEIGHT:		SCALE:1:10	SHEET 1 OF 1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: +/- 2 Unless Stated ANGULAR:	FINISH: Refer to Guidelines				DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE			TITLE: 2022 Warman Competition Packers	
DRAWN							
CHK'D							
APPV'D							
MFG							
Q.A				MATERIAL: 18mm MDF or Equivalent		DWG NO. 5 of 5	A3
				WEIGHT:		SCALE:1:10	SHEET 1 OF 1