

**MANUFACTURE TEAM CHALLENGE**

**ISEIW Wales Regional Final**

**COMPETITION BRIEF**

**2020 - 2021**

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**Introduction**

Hundreds of car manufacturers and individuals worldwide are trying to develop more fuel efficient and reliable engines. A combination of the traditional internal combustion engine and an electric motor are used in many Hybrid technologies as the solution for this. But can one power plant do both?

**The project brief**

This brief is for a small model vehicle to compete in a drag race that is powered by a solenoid engine. The engine is required to have at least 4 cylinders each consisting of a solenoid that can be purchased or manufactured prior to the competition. Then complete a series of tests culminating in a straight-line timed drag race.

**Description of Project**

The Solenoid engine drag car must meet the following requirements:

* Have a minimum of a 4 Cylinder solenoid engine.
* The engine must be self-starting and not require an external input to start.
* The engine must be enclosed but visible on the vehicle to ensure it is safe should a failure occur.
* Follow a straight-line trajectory with no course correction allowed.
* Speed control for the engine and vehicle must be demonstrated from the handset.
* The handset must be radio control type and able to all send control signal to the vehicle without the use of wires.
* The vehicle must be as lightweight as possible to allow a high-speed vehicle to be made.
* The Vehicle will have a Battery level monitor showing the battery level as XX%.
* The vehicle must have the ability to be braked from the handset. Mechanical or electrical braking system is acceptable including braking the solenoid engine.
* **Safety**
* The vehicle should be able to be switched off via a key.
* Any mechanisms and surfaces should be free from being a trap, crushing or cutting hazard.
* The system should be able to be stopped by the control handset.
* All electrically conductive parts must be guarded.
* No sharp edges should be evident.

**Drag Race**

The Drag Vehicle must be able to: -

* Run in straight lines set 500mm apart for a distance of 5M without steering input.
* Cover the 5-meter course as fast as possible

**EQUIPMENT, MACHINERY, INSTALLATIONS AND MATERIALS REQUIRED EQUIPMENTS PROVIDED BY ORGANISERS**

All lathes, cut-off saws, pillar drills, fabrication and welding equipment. MIG and TIG and associated tooling, but not Drill bits or Lathe tools.

Testing equipment and testing materials for the Solenoid engine drag vehicle.

**EQUIPMENT AND MATERIALS NOT PERMITTED**

Laptop or portable computers. PDA’s e.g. Palm, IPAQ etc. Memory sticks/MP3 Player/Digital Storage. Walkman radio/CD Player. Electronic organiser/diaries. Wireless communication devices. None approved CDs or floppy discs – approval by Experts or delegate is required for all CDs and floppy discs. Any additional software not supplied by organizers unless approved by Experts. Pre-programmed IC’s. Purchased items modified in any way prior to the Competition. All subassemblies for the track or cart. Equipment that is similar or operates in similar manner as supplied equipment. Example – if a metal cut-off saw is provided by organisers, then no team may provide their own metal cut-off saw.

**ITEMS TO BE PROVIDED BY TEAMS**

It is the responsibility of the team to supply all the components and raw materials to manufacture the Solenoid Engine Drag Vehicle. This may include but is not limited to the following items:

Battery/batteries. Electronic circuit board – not mounted (circuit board components must be assembled on the board at the Competition). 25% of the components by number may be pre-mounted. Radio control handset, receiver and speed controller where applicable. All Electrical and electronic components. Electric cables, connectors and couplings. Readymade cables with connector are not permitted. All connectors must be fitted during the competition. Jigs, fixtures, formers and clamping devices. All materials with which to construct the solenoid engine and Vehicle and all other associated equipment and consumables (sheet metal, screws, nuts, pins, pegs, etc.). Machining consumable tooling required for manufacturing the components. Lathe tools and hand tools for manufacturing components. All hand tools, cutting tools and measuring equipment. All hand tools for assembly. All personal protective equipment. Other specific manufacturing equipment required that is not in the infrastructure list. Bearings (unmodified), Sprockets, pulleys, gears, couplings, chain and belts (as supplied and must not be altered). Catalogue or standard must be provided. Hydraulic or pneumatic components and fittings not assembled.

**Note: you Must arrange for software to program you LCD to be onsite or bring a Laptop and software with you**

DURING THE COMPETITION DURATION, NO TOOLS, EQUIPMENT, STATIONARY, COMPONENTS, MANUALS, DRAWINGS OR DIGITAL STORAGE DEVICES, UNLESS APPROVED BY THE CHIEF EXPERT, MAY BE REMOVED FROM OR BROUGHT INTO THE COMPETITION VENUE.

**Marking Scheme**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Section** | | **Criteria** | **Marks** | |  |
| A | Main project performances  (Inc. Section B of portfolio) | | | 60  10 | |
| B | Main project costs:  Manufacturing Time  Materials  Machining Time | | | 5  2  3 | |
| C | Portfolio (Section A only) | | | 20 | |
| **Total** |  | | | **100** | |

1. **Main Project (70 Marks)**

**The Solenoid Engine Vehicle will be able to:**

* **Toolbox Weight. (2 Marks)**

Test: before competition starts each team shall have their toolbox weighed. The team that uses the least tools and has the lightest toolbox shall gain 2 marks. The heaviest toolbox shall be awarded 0 marks. All other teams shall gain marks proportional between.

* **The Engine solenoids have been hand made. (2 Marks)**

Test: The teams solenoids shall be inspected by judges prior to start of the competition. Premade solenoids shall score 0 marks. Handmade Solenoids shall be given 2 marks.

* **Demonstrate a 4 cylinder or more Solenoid engine**. **(3 Marks)**

Test: Judges will inspect the Solenoid engine and count the number of Cylinders. Should the engine show 4 or more cylinders 3 marks will be awarded. Should the engine show 3 cylinders, 1.5 marks will be awarded. Should the engine show 2 cylinders 0.5 marks will be awarded. Less than 2 cylinders will result in a 0 score.

* **Demonstrate the start-up of the solenoid engine. (2 Marks)**

Test: The drive wheels of the vehicle shall be propped off the floor. The team will be asked to operate the controls and demonstrate that the solenoid engine is self-starting. Starting without outside influence gains 2 marks. Requiring help to start the engine 0 marks.

* **Demonstrate speed control of the Solenoid engine. (4 Marks)**

Test: The drive wheels of the vehicle shall be propped off the floor. The team will be asked to operate the controls and demonstrate that the solenoid engine has speed control. Functioning speed control gains 2 marks. No or non-functioning speed control gains 0 marks.

* **The Engine is visible but guarded for safety. (3 Marks)**

Test: The Solenoid Engine is fully enclosed in order to ensure safety if there is a failure. However, the solenoid engine can be clearly seen, and its operation can be seen. Contained in such as, but not limited to, a wire cage or Perspex or other clear plastic box. A safely contained Solenoid Engine gains 3 marks, no container or unsafe container scores 0 marks.

* **Drive in a straight line at any speed without course correction. (2 Marks)**

Test: The vehicle will be set by the team at any position on the start line of a 5-meter straight course. The course will be 5 Meters long and be contained by two lines set 500mm apart. The vehicle can have only its speed controlled and no course correction is allowed. If the vehicle makes the 5-meter journey without touching the lines either side with its wheels, then 2 marks are given. If the vehicle touches the line with its wheels, then 0 marks are given.

Note: 1 practice run is allowed prior to the competitive run.

* **The handset must be radio controlled and include speed control of the vehicle (5 Marks)**

Test: The vehicle shall be set on the 5-meter course. The driver of the vehicle shall stand a minimum of 1 meter from the vehicle and operate the radio control handset. The vehicle shall be demonstrated driving as slowly as possible.

* The vehicle demonstrating the use of a radio-controlled handset gains 2 marks.
* The slowest time taken for the team to cover the entire course without stopping shall gain 3 marks. The fastest time for the team to cover the 5-meter course shall score zero, with all other teams graded proportionally between.
* **The vehicle must have an LCD panel showing the remaining battery level in XX%. (5 Marks)**

Test: The LCD battery level will be checked at the start of all tests. The battery level will be checked again at the end of the competition.

* The vehicle has an LCD showing battery level in the form of xx% (2 marks)
* Battery shows a reasonable drop between the beginning and end of the tests. (3 marks)
* **The Solenoid engine drag vehicle shall be as lightweight as possible. (2 Marks)**

Test: The entire vehicle and remote handset complete with batteries shall be weighed. The lightest weight shall receive 2 marks. The heaviest will receive 0 marks. All other teams’ weights shall be graded proportionally between.

* **The vehicle shall have a braking mechanism. (3 Marks)**

Test: The vehicle shall be set moving at walking pace. The team will stop the vehicle once they reach the braking line. If the vehicle can stop within 1-meter, then 3 marks are awarded. If the vehicle does not stop before passing a distance of 1 meter the 0 marks are awarded

* **The stopping distance shall be as short as possible. (4 Marks)**

Test: The team will drive the vehicle down the 5-meter course as fast as possible. When the vehicle reaches the end of the track they shall apply the braking system.

The shortest stopping distance shall be awarded 4 marks. The longest shall be awarded 0 marks. With all other teams graded proportionally between.

* **Quality of finish (2 Marks)**

Test: The judges shall inspect each Vehicle. Using the following criteria, the vehicle will be graded from 0-3 by each judge.

1. Below industry standard. Vehicle is unfinished, the vehicle is poorly assembled and lacks quality.
2. Meets industry standard. Vehicle is fully assembled and operational. Minor errors in assembly and a poor-quality finish.
3. Meets market standard. Vehicle is fully assembled with a nice appearance and only minor assembly errors.
4. Exceeds market standard. Vehicle is fully assembled and operational. Vehicle has a fully finished appearance. Body is painted or decorated, and the project is of saleable finish.

* **Safety**
* The electrical system can be switched off via a key.

**(2 Marks)**

Test: The Solenoid engine vehicle shall be switched off, with the radio control handset remaining active and all controls demonstrated to be inactive. 2 Marks.

* All mechanisms and surfaces are free from being a trap, crushing or cutting hazard.

**(3 Marks reduce by 0.5 marks for each problem found)**

Test: Judges shall check the surfaces for cutting hazards and that the moving parts are suitably guarded. 2 Marks awarded for no problems found. 0.5 marks deducted for each problem found.

* All electrically conductive parts are guarded.

**(3 Marks** **reduce by 0.5 marks for each problem found)**

Test: Judges check the Crane for all conductive parts. No unguarded conductive parts 2 Marks. Reduce by 0.5 for each unguarded conductive part found.

* No sharp edges are evident. **(3 Marks reduce by 0.5 marks for each problem found)**

Test: Judges check the Crane for sharp edges. No sharp edges found 3 Marks. Reduce by 0.5 for each sharp edge found.

* **5-meter drag race**  **(10 Marks)**

Test: The vehicle shall be lined up at the start of the 5-meter course. The Judge shall give a 3-2-1 countdown followed by “go”. 2 or more judges shall time the run across the 5-meter course taken by the vehicle.

On go the team shall drive as fast as possible down the 5-meter course.

The fastest time shall receive 10 Marks minus any penalties listed below.

The slowest team shall receive 5 marks less any penalties listed below.

All other teams shall receive a proportional mark in between less any penalties listed below.

Penalties:

False start. False starts shall be reset but receive a 1-mark reduction penalty for each.

Crossing the white side lines. Wheels touching or crossing the white side lines of the course shall receive a 1-mark reduction penalty.

**Portfolio B – to be presented at the start of the competition (10 Marks)**

The teams will bring with them in their portfolio:

* Manufacturing drawings for all components to be made. (Autodesk Inventor, AutoCAD or similar)
* 3D Assembly drawing(s). (Autodesk Inventor or similar)
* Electronic block diagrams/drawings. (AutoCAD Electrical or similar)

1. **Manufacturing Costs (10 Marks)**

**Working hours**

For every 10% more expensive than the team with the lowest calculated working hours cost (see note below), 0.5 Marks will be deducted proportionally. **(5 Marks)**

**Additional cost for using equipment**

For every 10% more expensive than the team with the lowest additional equipment cost (see note below), 0.3 Marks will be deducted proportionally. **(3 Marks)**

**Raw materials**

For every 10% more expensive than the team with the lowest additional equipment cost (see note below), 0.2 Marks will be deducted proportionally. **(2 Marks)**

**Compliance.**

**The total cost of equipment, materials and labour will be modified by project** **compliance to specification**.

Compliance to specification means that your marks for your built project will be calculated as a percentage and adjust your costings as follows.

Final build cost = Total cost x 100 .

% compliance to specification

Examples

If total cost is £2,500 and compliance is 100% then build cost would be £2,500

If total cost is £2,500 and compliance is 80% then build cost would be £3,125

If total cost is £2,500 and compliance is 60% then build cost would be £4,167

If total cost is £2,500 and compliance is 40% then build cost would be £6,2500

If total cost is £2,500 and compliance is 20% then build cost would be £12,500

If total cost is £2,500 and compliance is 0% then no marks awarded for cost section.

1. **Portfolio A (20 Marks)**

A portfolio is to be presented prior to the competition start. This portfolio is to be assessed as a component of this project. The portfolio is to be presented in hard copy in a folder and to include: -

* Team member details.
* Team work schedule.
* Design calculations and sketches/drawings.
* The size and type of power supply used.
* A Spreadsheet list of materials and components used with catalogue prices.
* Evidence of material and component costs.
* Operation and maintenance manual.

To include: -

* Troubleshooting guide
* Operation of the solenoid engine including how it works and is timed and controls
* Replacement of any batteries or power supplies
* Safe operating procedures
* A poster display 1000mm x 600mm (minimum size) detailing each team member’s details and their employers, a description of the project solution including a 3D model of their solenoid engine and a separate 3D model of the vehicle with engine installed, which will be presented prior to the competition and displayed during the competition.

**Appendix 1**

**Additional rules**

* Teams may have any notes and sketches they require to build the project, but these must be handwritten/drawn and not printed.

Printed circuit diagrams are acceptable

* Teams are required to provide all the tools and raw materials they require for the project. Teams may borrow tools and equipment from other teams, if they are willing, but will incur a 15-minute time penalty added to their build time for each tool or piece of equipment borrowed.
* Any areas that are not fully understood should be queried prior to the competition. Any misreading of the rules of the competition will be deemed as your own fault and the judge’s decisions as to interpretation will be final.
* You are required to wear Safety Goggles/Glasses and Steel Toe Cap Boots/Shoes as a minimum at all times during the competition.
* As a guide you will be able to work from 9:30AM to 2PM on the day of the competition. You are expected to design and schedule your activities to fit within this time. Failure to complete all elements within this time will lead to the forfeiture of marks for uncompleted areas. Extra time can be given to all teams at the Judge's discretion.
* All of the components and parts should be manufactured during the competition by the team. Items it is not possible to manufacture such as wheels, batteries, solar panels etc. will be allowed. Any item that the Judges deem the team could have made will incur a penalty. See penalty table.
* A technical forum is also available via google community, where questions can be asked, and any areas discussed. Search Skills Wales MTC. However, support is also available via Email. [Daytun.unitt@cambria.ac.uk](mailto:Daytun.unitt@cambria.ac.uk)

**Penalties:**

* Penalties may be incurred by activities, seeking help, or noncompliance to the rules, these are as follows:

|  |  |
| --- | --- |
| **Penalty** | **Incurred** |
| Seeking help from an expert | 15 minutes of time or any part of £20 cost addition |
| Health and safety minor infraction  Non-use of PPE  Unsafe use of tools and equipment  etc. | 15 minutes added to team working time |
| Health and safety dangerous infraction  Non-use of guards  Dangerous horseplay  etc. | You may be stopped from working for the remainder of the competition |
| Interfering with other teams | 1 hour added to working time |
| Borrowing of tools or equipment from other teams | 15 minutes team working time added for each piece of equipment or tool borrowed |
| Not properly cleaning down machinery after use | 15 minutes working time added to the team |
| Use of pre-made items that the team could have manufactured and/or programmed | Judges will estimate the time taken to manufacture the item and add a time penalty to the teams working time equal to three times this figure. |
| Noncompliance to instructions given by any judge during the competition | 15 minutes working time will be added to the team |
| Discretionary penalty for any other situation that may occur | A working time penalty will be added to suit the infraction, based on the judge's opinion of its severity |

**Costings**

|  |  |
| --- | --- |
| **Item** | **Cost** |
| Working time: If one team member is working it is costed as all are working. | £90 per hour |
| Use of Lathe and Welding equipment | £40 per hour |
| Use of Pillar Drill, cut off Saw, Box and Pan, or Guillotine | £20 per hour |
| Pre-Manufacture of Printed circuit boards (unmounted) | £0.25/cm2 |

The minimum time for booking each machine is fifteen (15) minutes, and 15-minute intervals thereafter.

All of the materials that the team will require to manufacture the track and cart will be put into the spreadsheet at VAT free prices, with a section evidencing this in the team portfolio.

NOTE: After using a machine, the machine must be cleaned, i.e. swarf removed from working area of the machine. Each machine will be inspected by an Expert after each team’s use of that machine and a penalty of 15 minutes of cleaning time will be applied if the machine is not cleaned. If a machine is considered not cleaned, Experts will be called to inspect that machine. Their decision is final. Equipment use costs only to be applied to equipment supplied by the organisers. No cost for using portable equipment provided by teams.