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Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Technology 2024



**91360 Demonstrate understanding of redundancy
and reliability in technological systems**

EXEMPLAR


Achievement


TOTAL 03

Reliability and Redundancy of a car.


, according to Wikipedia, "is the highest class of international racing for open-wheel single-seater formula racing cars sanctioned by the Fédération Internationale de l'Automobile (FIA)". It is a fast-paced sport, with teams changing the car's tyres in under 2 seconds, lap times lasting only minutes and cars passing each other with only millimetres to spare. Not to mention all at speeds of around 250 km h. So it isn't surprising when the need for reliability and redundancy is apparent.  cars have been racing since the mid-1920s and the technological advancements change yearly. This means the reliability and redundancy of the cars have to increase along with the technological advancements each year.

The redundancy of a Car.

Redundancy refers to the inclusion of additional components to duplicate a function. Redundancy is applied in  cars in many different ways. In critical systems, it may include double-up circuits of the object, like the brake system, ensuring safe stopping of the car at all times. In the electronic systems of the car, multiple units of the same system may be included, in some places on the car. The fuel system also incorporates redundancy with multiple fuel pumps, lines and filters which allows the car to maintain fuel flow. Probably the most important part of the car to have redundancy is its safety mechanisms, with crumple zones, backed up by survival cells, backed up by harnesses, and multiple other safety features. These all work together to make the car the safest it can be.

Another aspect that helps with the redundancy of the  car is the environmental considerations that the FIA has put in to make the racing as sustainable as possible.

For example, the engines

inside the actual car has been reduced from a V10 to a V6 engine. The engine is also turbocharged which allows for a higher burn rate of the fuel, leading to a cleaner burn. The fuel has also been changed to have less carbon emissions, and as of 2026, it is expected that no carbon will be included in the fuel combination, leading to a carbon free race. However there is still concerns that the tires used in the races go to waste. However after a race, the tires go to  (the tire manufacturer) and get recycled to become concrete material. Critics also identify the burnt rubber left on the track and the carbon emissions of the trucks that bring the trucks and cars to the track.

Some racers are taking personal responsibility in looking after the environment however. [REDACTED] for example, in the 2023 season, elected to drive to all of the circuits rather than fly, like the other drivers. The FIA is constantly evaluating options to help save the environment, and will continue to until there is no carbon emissions. However there is only so far that the FIA can go. [REDACTED] is known for its loud engines and fast speeds as well as use of petrol and tire changes. Without these

[REDACTED] things you fall into a category that already exists; [REDACTED]. [REDACTED] is a bunch of electrically powered cars that race around street circuits, collecting powerups and points for the winners. However, petrol heads argue that if you take the loud engines out of [REDACTED] and the use of carbon emitting engines, it just isn't [REDACTED].

The importance of reliability in [REDACTED] cars:

Reliability in technological systems refers to a system's ability to perform consistently and maintain its expected functions when operated within stated conditions for a stated time. [REDACTED] cars must be reliable due to the cost on the line. This cost can be physical money, points involved in the race, or loss of life. For these reasons, [REDACTED] cars have to be reliable.

[REDACTED]

The cars go through rigorous tests, which make sure the parts and components that make up the car are sturdy and will sustain the strains and pressure of the races. Multiple safety devices inside the car help to keep the driver safe. From the Hans device, which helps maintain the position of the head in the event of a crash, to the actual safety cell that the drivers sit in. These work together to keep the driver safe in the event of a high g- g-force, high-speed crash. This is all incorporated into the design and engineering of the car.

Another thing that helps with the reliability of the cars is the materials used in the fabrication and assembly of the car. Carbon fibre composites are used, as well as aluminium for the chassis. These materials have been specifically chosen to help the car sustain high g-forces and stay as lightweight as possible. Some of these

composites are used in the power unit, or engine assembly, which helps to keep up the theme of light weight and strength.

focuses on testing and developing the cars to the best of their ability, which means the cars have to survive these tests to ensure reliability. These tests include high rpm testing of the engine, to multiple sessions of gruelling test driving of the car to customise it to the driver and ensure

the car can survive the upcoming races of the season.

The robust electronics in an car, ensure the reliability of the car, with many sensors allowing engineers to alter the car to the track conditions. These electronics also help to monitor engine temperature, performance, data acquisition and telemetry and are designed to sustain high vibrations, high temperatures and electromagnetic interference encountered throughout the races.

Driver feedback is an essential part of ensuring the car's reliability because there is no point in making an amazing car if the driver cannot drive it. This happens as the pre-season testing goes on to ensure the reliability of the car and confirm it suits the driving style of the driver.

Lack of Redundancy in other areas

Because is a competitive sport, some areas of the car have been deliberately unreliable. An example of this is the tires on the cars, made by The car's tires are purposely not the best they can be, so the competition aspect is still there. This causes pit crews to spend hours and hours working on pit stops, making them the fastest possible. The pirelli tires however, are the only lack of redundancy on the car, and are in the safety regulations, so there is limited risk of injury to the driver and car. This keeps the fun in the sport, leaving spectators on the edge of their seats.

Bibliography

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Achievement

Subject: Technology

Standard: 91360

Total score: 03

Q	Grade score	Marker commentary
One	A3	<p>The importance of reliability and redundancy (R&R) is clearly explained using a racing car as the technological system.</p> <p>There is some evidence of how R&R was addressed in the technological system chosen, however the descriptions lack depth, and this prevented the candidate from moving into a higher-grade bracket.</p> <p>The candidate could have discussed the implications of these R&R design choices, and their impact on the overall system</p>