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BSC Motorsport Engineering

Research Methods and Projects –
Application of a Hybrid-Electric System to
a ‘Classic’ Vehicle

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Abstracts

Non-technical:

For my individual project, I will be talking in-depth about hybrid-electric vehicles and what types of systems you would expect to find on a conventional road vehicle. I have chosen this topic because of the alarming rise in air pollution, especially in built-up areas such as cities, and the increase of hybrid vehicles being released into the automotive market. For this project, I will be using a vehicle that has no emission control system, and I will be aiming to improve its emissions output and lower its fuel consumption by using a type of hybrid system. I will be discussing each system, and will come to a decision on which system would be more suitable for my chosen vehicle. The use of a data logging device will help me to record the behaviour of the vehicle, such as speed and power output. I will then design the hybrid system, using computer software and technical drawings and measurements of the vehicle.

Technical:

For my individual project, I will be using the application of a hybrid-electric system to decrease the emissions output and lower the fuel consumption of a conventional road vehicle with an internal combustion engine. I have chosen this topic because of the alarming increase in air pollution, especially in urban environments such as cities, and the increase in hybrid-electric vehicles being released into the automotive market. I will be discussing in-detail each system, from series hybrids to parallel hybrids, and will come to a consensus on which system is appropriate for the vehicle of my choice. For this project, I have chosen a vehicle that has no emission control system. The primary aim is to be able to use the electric motor at lower speeds or in traffic, which will reduce the fuel consumption of the vehicle and decrease the levels of emissions being emitted from the vehicle. I will be using the data logger to collect data and record a duty cycle of my chosen vehicle, and will then design the chosen hybrid system using CAD software and technical drawings and measurements of the vehicle.

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1. Introduction

The automotive world is constantly evolving. Automotive engineers are constantly working to develop vehicular engine systems that produce fewer emissions and use less fuel. We are seeing more hybrid systems being applied to vehicles than in any other generation, due to strict emissions standards such as Euro 5. As these standards are set to rise in the future, we could be seeing new vehicles being produced that are "effectively zero emission" by 2040, under new plans from the UK government to tackle air pollution (BBC News, 2018).

For my individual project, I will be delving into the technical aspect of vehicle hybrid systems by theoretically installing a hybrid system to a vehicle of my choice. I have decided to use my own vehicle for this project, which is an Austin Mini Advantage. I will be discussing how a hybrid system could benefit the Mini's emissions output and fuel consumption, especially in an urban environment such as a city centre, where air pollution is a constant issue.

2. Literature Review

(2.1)

The Austin Mini Advantage is a 2-door saloon vehicle that was produced in 1987 (Automobile-Catalog, 2018). The vehicle uses an A-Series Plus 998cc internal combustion engine, which produces around 30kW (40bhp) of power (Automobile-Catalog, 2018). The vehicle is front-wheel drive, which could become an issue when designing the hybrid system as I have limited space to install the components. The vehicle weighs 640kg without a driver, but I will have to add the weight of myself and another person to give me the total weight of the vehicle while testing (Automobile-Catalog, 2018).



Image 1 – Austin Mini Advantage (Car-From-UK.com, 2018).

I have chosen this particular vehicle for my project because of the lack of emission control this vehicle has. There is no catalytic converter installed onto the exhaust system, and the vehicle does not use an ECU to monitor the exhaust gases, meaning there are no lambda sensors. Overall, I will be attempting to 'modernise' the Mini in relation to its emissions levels and fuel consumption.

(2.2)

A vehicular hybrid system uses a combination of a conventional internal combustion engine and an electric motor/generator for vehicle propulsion (Chris Mi, 2018). The two power devices can be connected in series, in parallel or in series-parallel, and I will need to consider which system to use for my project.

Series Hybrid-Electric Vehicles

When the internal combustion engine and electric motor are connected in series, the electric motor is the only power provider to the vehicle wheels (Chris Mi, 2018). In this system, the ICE is the main energy converter that converts the original energy in fuel to mechanical power. This mechanical power is then converted into electricity by the use of a generator (Chris Mi, 2018). The electric motor moves the final drive using the electricity generated by the generator or electricity stored in the vehicle's battery. The electric motor can receive electricity directly from the engine, from the battery, or from both (Chris Mi, 2018).

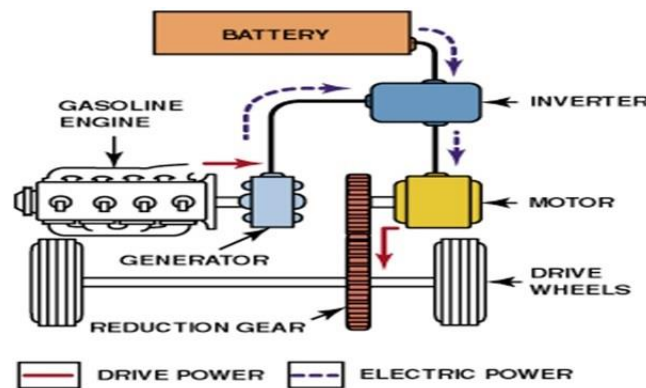


Image 2 – Series Hybrid System ('Praveen', 2015).

Parallel Hybrid-Electric Vehicles

When the internal combustion engine and electric motor are connected in parallel, both power devices are used to provide power to the vehicle wheels. The ICE and electric motor are coupled together to the final drive through a mechanism such as clutches, belts, pulleys and gears (Chris Mi, 2018). Both the ICE and the electric motor can be used provide power to the final drive, either separately or combined together.

The electric motor can be used as a generator to recover the kinetic energy during braking or by absorbing a portion of power from the ICE (Chris Mi, 2018). This is called a Kinetic Energy Recovery (KERS) system. These systems are currently being used in motorsport applications, such as Formula One cars (Racecar Engineering, 2018).

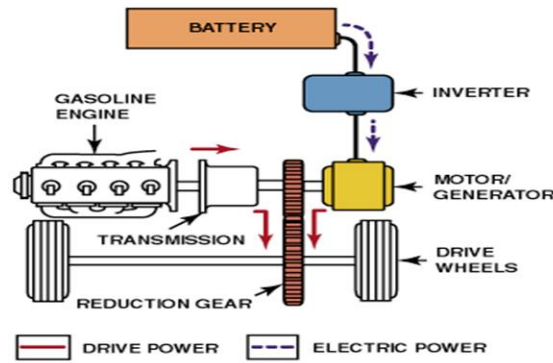


Image 3 – Parallel Hybrid System ('Praveen', 2015).

Series-Parallel Hybrid-Electric Vehicles

A series-parallel hybrid system incorporates the features from both series and parallel hybrid systems. Therefore, it can be operated as either a series or parallel system (Chris Mi, 2018). Because of this, the fuel efficiency and driveability can be optimized based on the vehicle's operating condition, which makes it a popular choice for automotive manufacturers (Chris Mi, 2018).

In comparison to a series hybrid system, this system adds a mechanical link between the ICE and the final drive, which means the engine can provide power to vehicle wheels directly. When compared to a parallel hybrid system, this system adds a second electric motor that serves primarily as a generator (Chris Mi, 2018). Due to the additional components and increased complexity, this system is generally more expensive than a series or parallel hybrid system. Therefore, I will not be using this system for my project (Chris Mi, 2018).

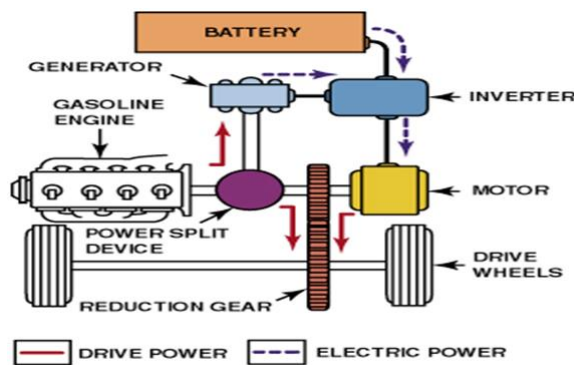


Image 4 – Series-Parallel Hybrid System ('Praveen', 2015).

3. Methodology

Unfortunately, no practical testing has been carried out yet. However, I have created a test plan that will be carried out as soon as I can acquire the data logger. My test plan consists of:

- Installing the data logger (DL1) software to my laptop from Race Technology website and connecting the data logger to the vehicle.
- Taking the vehicle for an ordinary drive around an urban environment, while recording the data through the data logger. I will also need to perform a 'coast-down' test with the vehicle on a flat surface. The location is yet to be decided.
- Weigh the chosen vehicle, or acquire the specific weight from a trusted online source. I will also need to consider the weight of an additional person in the vehicle during the test.
- Create a spreadsheet consisting of the data recorded from the data logger. I will expect the spreadsheet to be relatively large, as I plan to record every second of the drive. With these values, I will be able to create a suitable duty cycle of the vehicle.

Once testing is complete, I will be researching for the ideal electric motor to install to the vehicle. With the help of technical drawings and accurate measurements of the vehicle, I will be able to determine the maximum allowable size of the electric motor and where the best location is to install it onto the vehicle. For example, I will be measuring the boot space of the vehicle to see if I can install the additional electric motor in the boot. However, this does compromise the practicality of vehicle, so I will need to consider using a compact and relatively small electric motor.



Image 5 – Austin Mini Advantage Rear Boot (Car-From-UK.com, 2013).

4. Conclusion

In this seminar paper, I have discussed in detail what I will be doing for my individual project. I have shown a keen interest in improving the 'classic' vehicle, by using modern technology to make the vehicle more environmentally friendly in urban environments. I have created a set test plan, which will produce a series of duty cycles of my chosen vehicle once testing is complete.

I have chosen to use the parallel hybrid system for my project, which means I will still be able to use the A Series Plus engine while travelling at high speeds, such as a motorway. The electric motor is to be primarily used when the vehicle is at lower speeds or is in traffic, reducing fuel consumption and thus producing less harmful gases in urban environments. In addition to this, the use of a kinetic energy recovery system (KERS) will become beneficial as the system will be able to recover kinetic energy through braking and store the recovered energy for future use.

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