DESIGN AND FABRICATION OF POWERTRAIN MOUNTING FOR VEHICLE TRAINER KIT WITH AID OF COMPUTER AIDED ANALYSIS

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in fulfillment of the requirements for the degree of
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DEDICATION

I dedicate this this thesis to the unwavering support and encouragement of my family, whose love has been my anchor and motivation throughout this academic journey, your sacrifies and belief in my potential have fueled my persverance. To my supervisor, Ts. Lukman Hakim Bin Hamzah, technical staff, Tc. Mohd Syakir Bin Mohtarudin, Mohamad Azrul Bin Mamat, and Zuraini Bin Zachariah, thank you for imparting knowledge and guiding me with patience and dedication. Your wisdom has shape my understanding and inspired me to push the boundaries of my capabilities. I extend my gratitude to my friend, Afiq Zakwan, Nabil Ahmad, Arif Lukman, Uwais Nadzmi and collagues who shared this academic adventure with me. Your comraderie and shared experiences have made the challenges more bearable and the triumps more meaningful.

ABSTRACT

In this thesis have explored and addressed the intricacies surrounding the vehicle trainer kit designed by former BMKA students, focusing on its significance in educating students on brake system maintenance. The hands-on experience provided by the kit proves invaluable in enhancing students' comprehension of real-world automotive scenarios, offering practical insights into brake system repairs. However, identified limitations, particularly the lack of a powertrain, necessitate improvements to further enrich the learning experience. The project's objective, as outlined in the introduction, aims to design and build a powertrain mounting system for the trainer kit. The methodology employed in achieving this goal includes an extensive survey to understand the demographics and educational backgrounds of BMKA students, critical analysis of the existing trainer kit, and a detailed examination of proposed enhancements. The proposed improvements involve the integration of a powertrain system, specifically an engine and differential, to provide students with a more comprehensive understanding of automotive technology. The chosen design concepts for the engine and differential case mounting systems have been carefully selected through a rigorous process, considering factors such as safety, maintenance, and cost-effectiveness. Structural analyses of the engine and differential case mountings were conducted under various scenarios. The results demonstrated that both designs exhibit minimal displacements, satisfactory factors of safety, and acceptable percentages of yield, ensuring their resilience under different conditions. The proposed powertrain mounting system serves as a promising addition to the BMKA curriculum, promising students a more immersive learning experience in automotive technology.

ABSTRAK

Dalam disertasi ini dikenal pasti dan menangani kerumitan yang terdapat pada kit pelatih kenderaan yang direka oleh bekas pelajar BMKA, memberi tumpuan kepada fungsinya dalam mendidik pelajar mengenai pemeliharaan sistem brek. Pengalaman praktikal yang disediakan oleh kit ini memberi nilai tak terhingga dalam meningkatkan pemahaman pelajar mengenai senario automotif dunia sebenar, menawarkan wawasan praktikal dalam pembaikan sistem brek. Walau bagaimanapun, keterbatasan yang dikenal pasti, terutamanya kurangnya penggerak, memerlukan penambahbaikan untuk lebih memperkaya pengalaman pembelajaran. Objektif projek, seperti yang dinyatakan dalam pengenalan, bertujuan untuk merancang dan membina sistem pemasangan penggerak untuk kit pelatih. Kaedah yang digunakan untuk mencapai matlamat ini termasuk kajian yang luas untuk memahami latar belakang demografi dan pendidikan pelajar BMKA, analisis kritikal kit jurulatih yang sedia ada, dan kajian terperinci peningkatan yang dicadangkan. Penambahbaikan yang dicadangkan melibatkan integrasi sistem penggerak, khususnya enjin dan pembeza, untuk menyediakan pelajar dengan pemahaman yang lebih komprehensif teknologi automotif. Konsep reka bentuk yang dipilih untuk sistem pemasangan enjin dan kotak perbezaan telah dipilih dengan teliti melalui proses yang ketat, dengan mempertimbangkan faktor-faktor seperti keselamatan, pemeliharaan, dan kos-efektif. Analisis struktur enjin dan pemasangan kotak perbezaan dijalankan di bawah pelbagai senario. Hasilnya menunjukkan bahawa kedua-dua reka bentuk menunjukkan pergeseran minimum, faktor keselamatan yang memuaskan, dan peratusan hasil yang boleh diterima, memastikan ketahanan mereka dalam keadaan yang berbeza. Sistem pemasangan penggerak yang dicadangkan berkhidmat sebagai tambahan yang menjanjikan kepada kurikulum BMKA, menjamin pelajar pengalaman pembelajaran yang lebih merangkumi dalam teknologi automotif.

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LIST OF SYMBOLS AND ABBREVIATIONS

TVET	-	Technical and Vocational Education and Training
NOSS	-	National Occupational Skills Standards
MOHE	-	Ministry of Higher Education
MQA	-	Malaysian Qualifications Agency
DSD	-	Department for Skill Development
PAV	-	Pendidikan Asas Vokasional
MTUN	-	Malaysian Technical University Network
VAK	-	Visual, Auditory and Kinesthetic
SHS	-	Square Hollow Section

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CHAPTER 1

INTRODUCTION

1.1 Background

The vehicle trainer kit, which was constructed by former BMKA students, is a great resource for teaching students how to examine and replace a car's brake pads. Students may also learn how to repair the brake system from scratch, including the master cylinder and caliper, with the trainer kit. These trainer kits, which enable students to study the design of the braking system—specifically, the brake line—in a real automobile, are an impressive accomplishment. This hands-on experience is crucial as it gives students a greater grasp of how the braking system performs in a real-world setting.

Additionally, in the case of system damage, the training kit improves students' capacity to recognize problems within the braking system. Any mechanic or technician has to be proficient in this ability, and the training kit provides a great platform for students to gain this expertise. All things considered, the vehicle training kit is a great addition to the BMKA curriculum, giving students real-world experience and information that will help them in their future employment. It's clear that past BMKA students worked very hard to put this kit together, and it's encouraging to see how it benefits the present students.

Unfortunately, the trainer kit isn't equipped with a powertrain, so it can't move itself forward. As a result, the training kit needs to be physically pushed or dragged anytime it needs to be moved from one place to another.

1.2 Problem Statement

When students are required to use the trainer kit, they mostly find themselves having to push, pull, and guide the kit manually. The Vehicle Brake System regularly uses the trainer kit for their brake system service lab sessions. To make the service sessions more realistic, the trainer kit has to be able to move on its own when testing the brakes on all of its wheels.

Therefore, the decision to include a powertrain in this trainer kit would enable it to drive itself and guarantee that braking tests are successful. By including the engine, the trainer kit becomes an informative resource for educators and learners alike, providing a deeper understanding of how the powertrain operates. The presence of a powertrain in the trainer kit allows students to examine it, which is different from a real automobile where it is usually covered and allows for a deeper comprehension of its functions.

1.3 Project Objective

The goal of this project is to be able to design and build a missing part of the trainer kit based on the background information and issue statement provided above. In particular, the goals are as follows:

a) To fabricate a mounting system for a powertrain system to assist students and lecturer in their lecture and lab session.

b) To design and analyze a mounting system for structure durability using CATIA and Altair Inspire.

1.4 Scope of Project

This project will focus on developing a mounting system for a powertrain unit used in automotive workshop in UTeM. The scope of this project are as follows:

- This project product is limited only to automotive technology students at UTeM.
- Analyze the mounting structure to determine its strength.
- This project will be conducting the manufacturing process of cutting, drilling, welding, and assembling to create the product at the target cost.
- The engine that will be used in this project is a motorcycle engine.
- The product of this project is not road used.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The goal of the literature study is to look at earlier studies that are pertinent to the design and construction of powertrain system mounting, with a focus on the practical applications' educational advantages. The focus of this investigation is Malaysian automotive research, which illuminates data on automobile manufacturing and highlights the vital need for automotive universities to train competent personnel for this rapidly expanding industry. This talk will examine the initiatives that have been put in place inside the school system with the intention of developing a workforce that is highly qualified for the automotive sector.

In addition, the evaluation will examine the importance of the techniques used in teaching students, acknowledging their critical role in improving the efficacy of instruction. One further thing that has to be covered is the difference between drivetrain and powertrain parts in cars, since students may have trouble telling the difference. With a focus on Malaysia, this thorough analysis seeks to give a nuanced perspective of the body of research by providing insightful information on the relationship between powertrain system design, experiential learning applications, and the educational landscape in the automobile industry.

2.2 Skilled Labor

Skilled labor refers to a segment of the labor force that possesses the specialized knowledge, education, and experience required to do more complex physical or mental tasks than are customary for the role. Skilled labor is often characterized by greater or more specialized education, as well as competence levels attained via training and experience; these factors are also frequently correlated with higher compensation. Unskilled labor, on the other hand, refers to people who have a constrained set of skills to employ in the job (Hayes, 2022).

In a world that is ever more competitive, skilled labor is crucial. Asia's developing nations are quickly expanding their labor pools of professionals. The U.S. and Western European nations, which have dominated economic development since the middle of the 1800s, are now putting more emphasis on maintaining and expanding their skilled labor force. In order to enhance the number of skilled workers, they are concentrating on producing their own labor by conducting significant training programs for both new and existing staff (Hayes, 2022).

Additionally, Hayes (2022) notes that unskilled labor is conceptually the antithesis of skilled labor. A worker type with a poor skill set or one that offers little financial value for the work completed is referred to as unskilled labor. One of the most typical characteristics of unskilled labor is poor educational attainment, such as having a high school diploma or not, which often translates into lower compensation. It is important to remember, nevertheless, that some trades that fall under the category of skilled labor just require a high school diploma.

2.2.1 Automotive Sector in Malaysia

The total industry volume (TIV) growth in the Malaysian automotive sector is predicted to expand 12–14% year-over-year (y-o-y) in 2022, according to MIDF Research, because the supply interruption caused by the flood in January 2022 was only transitory. The Malaysian Automotive Association (MAA) reports that TIV for January 2022 decreased to 40,581 units, a month-over-month (m-o-m) decrease of 38% (MIDA, 2022).

MIDF Research predicted in a note that the TIV would be between 570,000 and 580,000 units this year, which is a more cautious estimate than the MAA's 18% year-over-year increase estimate of 600,000 units. The research firm reaffirmed its optimistic assessment of the car industry as a factor in the rebound in domestic spending, which is supported by robust outstanding bookings, the prolongation of the tax holiday, historically low lending rates, and steadily improving job and family income conditions (MIDA, 2022).

In 2006, Malaysia unveiled the inaugural National Automotive Policy (NAP2006). The goal of NAP2006 was to strengthen the sustainability and competitiveness of the indigenous automobile sector. The goals of NAP2009, the update to NAP2006, were to provide a system to encourage investment and to enhance the capabilities of the local automotive sector. The third iteration of the policy, NAP 2014, attempted to fortify the whole automotive ecosystem through supply chains, human capital, and technology advancement while putting a strong emphasis on green efforts and market expansion (Nippon Express, 2020).

Malaysia has an edge in the services and electric and electronic (E&E) industries associated to the mobility industry, according to an input-output study done to design NAP2020. With these national assets, Malaysia has established three difficult new components. According to the NAP2020 vision, integration with the service sector and the electric and electronic sectors is crucial for the automobile industry, which drives the mobility sector to keep growing. The strategy for developing critical component components for the next generation of cars indicates that there will be more collaboration with the electric and electronic sectors. Collaboration with the electrical and electronic sectors will be essential to the automobile industry in the future, starting with the development phase (Nippon Express, 2020).

2.2.2 Skilled Labor in Malaysia

According to the Minister of Science, Technology, and Innovation, Malaysia cannot compete on the world stage until at least 45% of the workforce have advanced skills. This is particularly true, according to Datuk Seri Dr. Adham Baba, because new and developing technologies necessitate highly trained labor, which is in great demand.

He said, “Therefore, it is important for technologists, technicians, scientists, and researchers to be key players in the development of expertise to improve skills, productivity and the country’s competitiveness through science and technology.”

The minister made this statement at a webinar titled “Accelerating Nation's High Skilled Talent,” which covered the value of developing the nation's highly skilled workforce and how crucial it is to Malaysia's progress. The Malaysia Board of Technologists arranged the webinar.

Dr. Adham went on to say that his ministry is dedicated to making sure that innovation, research, and technology will always improve people's socioeconomic conditions. In the second quarter of this year, the country had 62.2% semi-skilled workers, 24.7% skilled workers, and 13.1% low-skilled workers, according to statistics he quoted from the Department of Statistics Malaysia report (Charles, 2021).

The job market in Malaysia has changed dramatically in the last several years. Agriculture used to be the main driver of the country's economy, but it later moved to the industrial and services sectors, which today provide over half of Malaysia's GDP and almost 60% of jobs. Malaysia is experiencing economic expansion and urbanization, which is leading to a labor shortage. When there is not enough supply of workers with specific abilities to fulfill the demand, there are shortages in the labor market (HRDF, 2019).

Malaysia is confronting a manpower crisis in key economic sectors like manufacturing and construction even as the nation eases up on Covid-19 movement rules that should enable workers more mobility to go to work. The shortage is partly ascribed to the foreign workers' soon-to-expire work permits, who make up a sizable portion of the workforce in these vital industries, and partly to the difficulty in recruiting and retaining locals despite the nation's already high unemployment rate, which has been made worse by the pandemic. Owner of a textile mill Wan Imran Alim stated that he has not been successful in keeping Malaysian employees on board. In addition, he notes that although the epidemic has left thousands of people jobless, they come and go and don't appear serious enough to hold the work. The head of Malaysia's National Chamber of Commerce and Industry, Low Kian Chuan, stated to a Singaporean newspaper that the country's migrant worker population has decreased from 1.9 million in 2018 to 1.1 million at present (Lim, 2021).

2.2.3 Skilled Labor in Automotive Sector

In order for Malaysia's workforce to obtain the necessary Industry 4.0 skills and competence, the automotive industry has been crucial. According to the former Minister of International Trade, Datuk Darell Leiking, this industry has also long served as Malaysia's driving force in developing a critical mass of knowledge workers and skilled labour because it offers the necessary environment for the growth of talent in the technical fields of science, engineering, and technology. He went on to say that the multiple employment functions that make up the automotive value chain, such as automotive style and design, engineering services, manufacturing processes, and after-sales activities, offer plenty of room for high-skilled occupations to thrive. Countries like Japan and Korea have successfully become technical powerhouses in a range of sectors and fields because to the technological spinoffs that were sparked by the continuous backing for a local automotive industry.

Datuk Darell went on to say that as the industry develops its use of automation, robots, and other Industry 4.0-related technologies, there will be an increase in employment openings that must be filled by qualified candidates with advanced degrees. Due to the longer-term career requirement and the fact that these positions require a skilled background of education, Malaysians should fill them.

According to a news article in the New Straits Times, if Malaysia's automobile manufacturing sector is not able to quickly address its severe labor shortage, it might cause the entire national automotive manufacturing (NAM) ecosystem to collapse. According to Datuk Dr. Wan Mohamed Wan Embong, head of the Proton Vendor Association, if the industry's workforce problems are not resolved quickly, the NAM ecosystem might implode, resulting in the loss of over 500,000 jobs and up to 4.5% of the country's GDP.

In order to alleviate the issue, Datuk Dr. Wan Mohamed added that Malaysia should immediately permit the intake of foreign labor and reduce the recalibration costs of around three to five million undocumented immigrants. The present fee of RM4,500 per person for the legalization of undocumented foreign nationals makes this step extremely costly, particularly at a time when businesses are having financial difficulties.

2.3 Technical and Vocational Education and Training (TVET)

The definition of technical and vocational education given by UNESCO includes the study of technologies and allied disciplines, as well as the acquisition of practical skills, attitudes, and information connected to professions in diverse sectors of economic and social life. Along with general education, this phrase is used to describe all of these components of the educational process. It mixes formal and informal learning with an emphasis on industry practices to give young people the knowledge and skills necessary for the workplace.

The National Occupational Skills Standards (NOSS) and other occupational standards should serve as the foundation for Technical and Vocational Education and Training (TVET) programs, with a focus on psychomotor skills, practical components, and exposure to industry training. TVET has a lengthy history in Malaysia. The only difference is that TVET is occasionally mistaken for a secondary option and is only available to students with less than stellar academic records. Because employers are becoming more aware of TVET graduates, the stigma has actually vanished.

2.3.1 Studying TVET Programmes in Malaysia

In Malaysia, Technical and Vocational Education and Training (TVET) programs are offered at the certificate, diploma, and degree levels by seven ministries, including the Ministry of Higher Education (MOHE). The MOHE provides the greatest number of students with TVET programs. At the moment, MOHE's universities, polytechnics, and community colleges offer academic (higher education) and vocational education sectors accredited by the Malaysian Qualifications Agency (MQA), while the skill training programs offered by skill training institutions are accredited by the Department for Skills Development (DSD) of the Ministry of Human Resources.

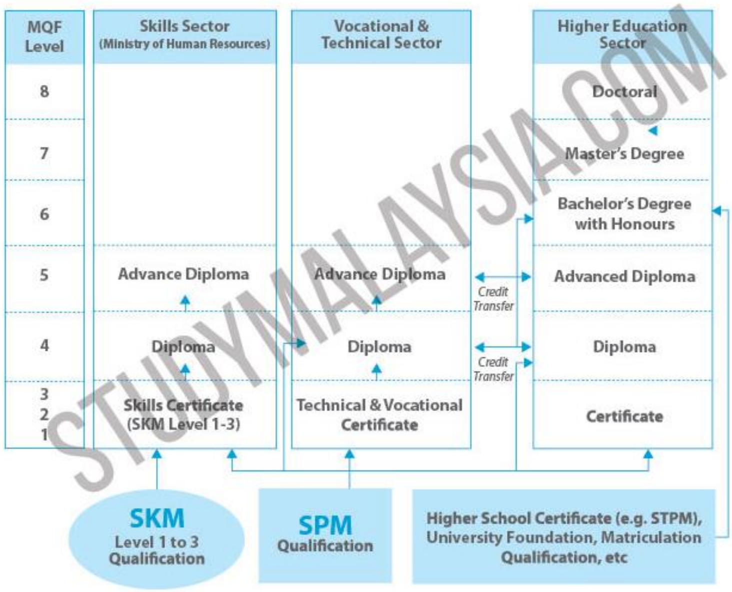


Figure 2.1 Pathways for Vocational Education, Skills Training & Academic Qualification

Three professional routes or sectors—skills, vocational and technical training, and higher education (academic)—are depicted in the above figure for school-leavers. School dropouts with SPM certification are eligible to receive a TVET qualification from a range of providers or universities across all three sectors. There are four different degree levels available: advanced diploma, certificate, diploma, and bachelor's degree. The Ministry of Human Resources' Department for Skills Development bestows certifications in the skills sector. On the other hand, credentials from the other two areas are provided by the Ministry of Higher Education.

2.3.2 TVET Graduate Future

There are many of us who are unaware of the numerous work prospects and occasionally rich wages the Technical and Vocational Education and Training (TVET) industry offers. Based on a survey of Malaysian TVET graduates, graduates with skills are more marketable than graduates with academic credentials (academic diploma, degree, master's degree, or PhD). TVET graduates have profitable opportunities because the country needs a lot of trained labor in the industry as a developing nation. On the other hand, majority of TVET institutes provide skills that are actually in demand by many businesses today. These abilities not only make it simpler for you to find work, but they also provide you with the chance to use your present skills to create new career chances. TVET graduates with additional existing skills also have the chance to start their own businesses.

2.4 Learning Style

More technically speaking, some experts describe various learning styles as the preferred methods that kids use to learn, and some think that, in contrast to intellect, a student's specific learning style is fixed. To put it another way, students will learn more easily if they may employ their chosen learning style and provided the necessary conditions are in place (Sreenidhi & Tay Chinyi, 2017).

One of the most common and widely used categorizations of the various types of learning styles is Fleming's VARK model (sometimes VAK - an acronym for the Visual (V), Auditory (A), and the Kinaesthetic (K) sensory modalities) which provides the learners with a profile of their learning styles, based on the sensory modalities which are involved in taking in information. Previous Neuro-linguistic programming (NLP) models were improved upon by this model. The three categories of senses—visual, auditory, and kinesthetic—that make up NLP are called representational systems (rep systems). This phrase refers to the idea that the brain constructs our internal representation, or model, of the environment around us using the senses. People frequently have a favored method of learning, which might be a combination of all three senses. While some people have a clear taste, others combine two or three different types. An individual can choose the sort of learning that best suits them by being aware of their preferred learning style or styles. This gives him/her the ability to select the most effective learning methods. While some people learn best via visual means, others learn best through auditory means, and still others learn best through tactile or kinesthetic means. Everybody progresses through several phases of each style during infancy. All young children learn best through movement. Preferences for sound and vision develop later. Everybody has inclinations toward a primary style from birth. In various contexts, the dominant style could not necessarily be the same. Depending on the type of activity, it may change or be supplemented with different methods (Sreenidhi & Tay Chinyi, 2017).

2.5 Hands-On Learning

Hands-on learning is a teaching method that actively encourages students to participate in an activity in order to learn about it. Essentially, it is "learning by doing." But is it a worthwhile approach to learning, or is it merely a fad? Some of the main advantages and disadvantages of experiential learning are discussed in this article. First and foremost, it should go without saying that there are situations in which only hands-on instruction will work.

Additionally, it promotes initiative in young students, supporting their ability to learn independently in the future. Important life skills like these are frequently missed when children are merely told facts and forced to memorise them. The approach, however, has shortcomings. Students frequently gain a general understanding of how something functions from demonstrations, but they frequently place less emphasis on details. It's possible that students who want to get the best grades should learn more about their subject to better understand it. After mastering the fundamentals, students might feel they don't need to do any additional research, which could hurt their grades. Some subjects simply cannot be taught through hands-on learning.

There is no doubt that involving children would enhance their education. However, it would be more efficient to combine traditional book learning with experiential learning. Although it excels at providing the foundation for knowledge and comprehension, it occasionally fails to raise ideas to a higher level.

2.5.1 Hands-On Approach

The hands-on approach to education promotes experiential learning among students. This means giving the pupils some autonomy over the materials they are learning. In actuality, it's a scientific and math teaching approach that involves student participation throughout the class. A hands-on learning approach, according to Haury and Rillero (2015), entails the child in a thorough learning experience that develops the child's ability for critical thought. Consequently, any effective teaching technique in this domain may be classified as an activity-based teaching strategy (hands-on approach).

It has been argued that allowing students to manipulate objects that might help make abstract information more tangible and intelligible will improve their academic achievement and grasp of scientific topics. Thanks to a hands-on approach, students may take part in real-world instances and witness the impact of adjusting numerous aspects. It gives particular instances of the concepts. Students may see, touch, and engage with items while learning using this learner-centered approach.

2.5.2 Hands-On Experiment

There are three main ways for people to learn about the world, according to Carin and Bass: through personal observations and interactions with the environment, directly from other people, or through the construction of personal knowledge through the transformation of discovered and acquired knowledge in meaningful ways (2001:74). According to Kolb, "knowledge results from the combination of grasping and transforming experience" (1984:41), which is mentioned in the aforementioned phrase. According to Worth (2010), learning encompasses more than just acquiring knowledge and understanding about a certain subject. As it allows students to experience and learn from observation or sensations, learning through practical experiments becomes acceptable as a useful alternative at this point. This will help pupils improve their ability to solve problems, be creative, and learn on their own (Shymansky et al., 1990).

Kolb's theory can be applied to practical experiments to carry out the three primary modes of learning emphasised by Carin and Bass (2001). According to Healey and Jenkins (2000), "The theory presents a way of structuring and sequencing the curriculum and indicates, in particular, how a session or entire course may be taught to improve students learning." The experiential learning cycle developed by Kolb and based on Lewin's social psychology is depicted in the diagram below. Dewey's pragmatism in philosophy and Piaget's genetic epistemology of cognitive development (Kolb, 1984).

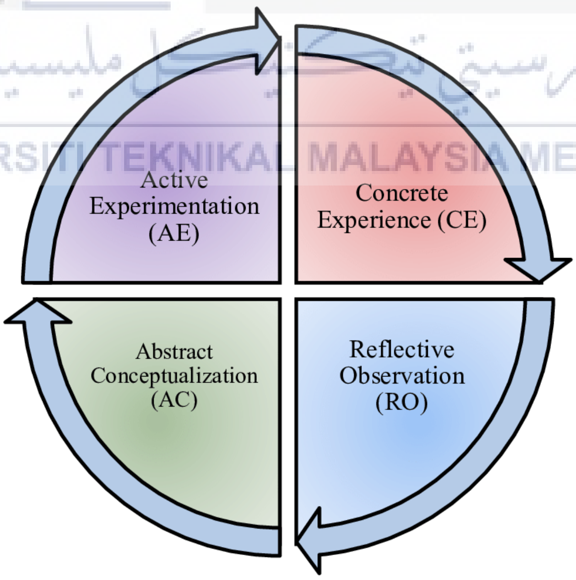


Figure 2.2Kolb's experiential learning cycle (Kolb, 1984)

2.5.3 Kinesthetic and Tactile Learners

Students who prefer to learn through physical activity instead of lectures or demonstrations are known as kinesthetic learners (who must move to understand) or tactile learners (who prefer hands-on learning). Kinesthetic learners are those students who need to move their entire body in order to process new and challenging knowledge (Owen, 2018).

People with kinesthetic learning styles frequently struggle to comprehend through traditional lecture-based education because when they are listening without moving, their bodies don't connect that they are doing something in which their brains are involved but not their bodies, making the information harder for them to process. To commit things to memory, they frequently need to stand up and move. Kinesthetic learners have many strengths that will help them succeed in the classroom, such as excellent experimenters, great hand-eye coordination, quick reactions, excellent motor memory (can duplicate something after doing it once), and high levels of energy (Roell, 2018).

Anyone with kinesthetic inclinations should make the most of their movement and body when learning. Using a variety of muscle parts doesn't have to be really strenuous; the idea is that your body as a whole will cooperate to assist your mind in learning new ways to think. For example, rise up and visualize the floor as an enormous, flattened globe if you have a history examination and need to memorize the names of several countries. Stroll to the point where, approximately, each site corresponds to the others. By doing this, you're giving yourself permission to absorb the knowledge depending on how your body moves in space (Matthew, 2014).

Figure 2.3 Feature of tactile learner (Roell, 2018)

2.6 Hands-On Problem Among BMMA Students Based on Survey

The survey was conducted to identify the knowledge and understanding of the students on some of the components of a car. The survey was distributed to current BMMA students and final year BMMA students that are currently in their Industrial Training. From the survey we can analyze their previous qualification that half of the respondent are from Polytechnic and the other half are from Matriculation, STPM, and others institution as we can see in Figure 2.3.

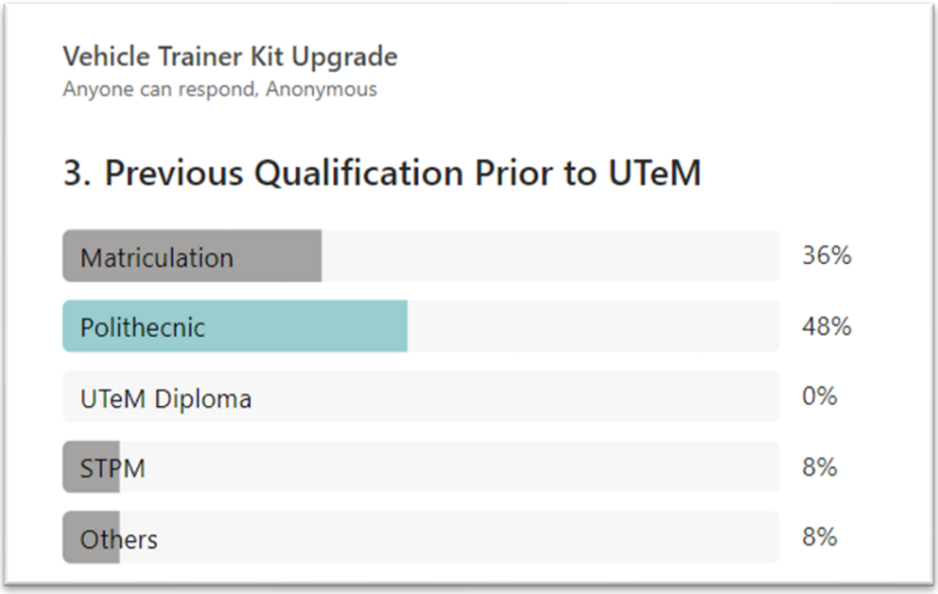


Figure 2.4 Respondent previous qualification

Most of the students are aware that the students in BMMA program are mostly from Polytechnic qualification. However, in the next question of the survey will be more shocking to us and it is a normal trend for the students when choosing for their next level education.

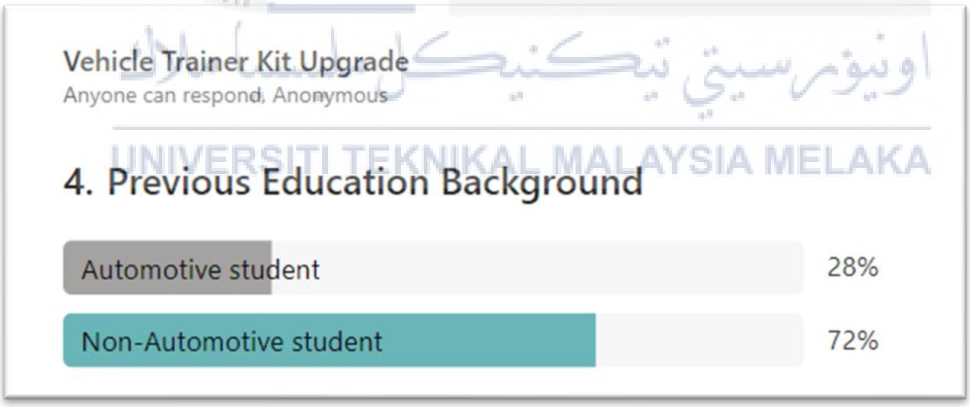


Figure 2.5 Respondent previous education background

Figure 2.5 above show that most of the respondent are not an automotive student before. Only 28 percent of BMKA students are automotive students in their previous study. This observation leads to a plausible assumption that a substantial portion of BMMA students may not possess familiarity with, nor knowledge of, various automotive components. In stark contrast, BMKA students, specializing in automotive technology, are presumed to be well-versed in the nomenclature and functions of these components. Consequently, the incorporation of a powertrain system becomes particularly crucial for BMKA students, as it serves as an essential educational tool to enhance their understanding of the intricacies of the powertrain system.

2.7 Powertrain System

Everything that gives the car power is called the powertrain. Stated differently, the powertrain consists of all the parts that work together to drive the car. Usually, it takes engine power and transfers it to the ground-level wheels (Iyas, 2022).

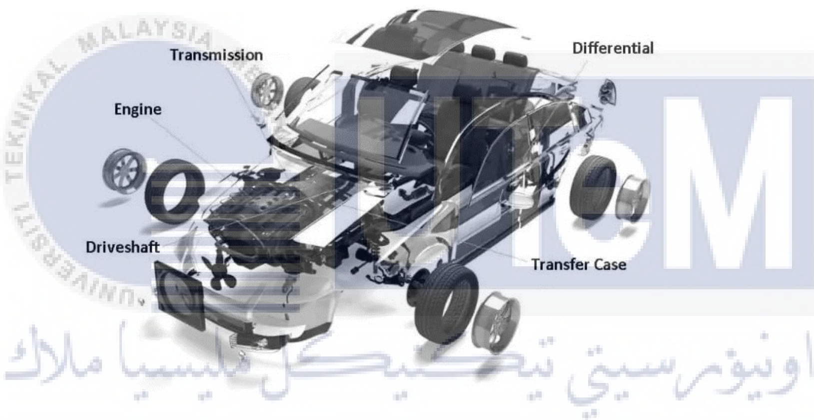


Figure 2.6 Powertrain component

Powertrain is a device that delivers the drive from the engine of a vehicle to its axle. It has all of the mechanical parts required to move the car forward. What comes from the engine is the basis for electricity generation. Controlled explosions in the combustion chamber of the engine push pistons up and down, converting linear motion into fast rotation of the crankshaft. Its hundreds of working pieces combine to create the force and power needed to move a vehicle forward. The engine rotation is converted into useable force via the complex gearbox that is the transmission. Depending on the input the driver chooses—forward, reverse, neutral, or park—the gearbox manages the power. After that, drive shafts, sometimes referred to as axles, transfer power from the gearbox to the wheels. The driving shaft can rotate at a varied speed on bends thanks to an axle found on the majority of axles (Unrau, 2016).

2.7.1 Powertrain Mount System

A component that joins the chassis and powertrain—which includes the engine and transmission—is called a powertrain mount. It is employed to sustain the powertrain and lessen and regulate the transmission of engine vibrations. It also has a big impact on how rough a car is and how much noise and vibration it produces. The significant variation in a vehicle's transmission torque during acceleration, deceleration, and other standard operating circumstances results in torsional and deformation motion of the mount, which negatively impacts passenger comfort (Guo et al., 2022). The crucial job of engine mounts is to securely hold a vehicle's powertrain components in place. A decent ride quality and performance are ensured by the mount brackets' proper geometry and location on the chassis. The engine support brackets on the frame experience extreme vibrations and severe static and dynamic loads. Hence, careful mount bracket design and analysis is necessary to dissipate vibrational energy and maintain strains below a predefined level of safety. Dhillon & Associates, 2014.

2.8 Drivetrain

One of a car's least understood components can be the drivetrain. This is caused by a number of things, one of which is that powertrain and driveline are frequently used interchangeably with the phrase “drivetrain.” The wheels, axles, driveshaft, and transmission make up the drivetrain. To put it simply, it moves the wheels in tandem with the engine. A car's powertrain system is a crucial component, and the gearbox is a drivetrain component (Mister gearbox, n.d.). The group of parts in a car that move the vehicle forward by transferring power from the gearbox to the wheels is called the drivetrain. The driveshaft, CV joints, differential, axle shafts, and U-joints are some of these parts. A driveshaft is a long steel tube that is connected to the wheels and the vehicle's gearbox at opposite ends. It transmits the mechanical force from the transmission to the car's other parts. A U-joint, sometimes called a universal joint, is a power-transmitting pivot point that is flexible and permits the driveshaft to be angled at different times. Constant-velocity joints, or CV joints, are found on the driveshaft. These joints are made to be flexible enough to bend in any direction while maintaining a steady speed of rotation for the driving wheels. A differential is a type of gear train that enables the wheels of a car to revolve at various speeds while still transferring power from the engine to them. It is particularly useful whenever you turn a corner (Mister Transmission, n.d.).

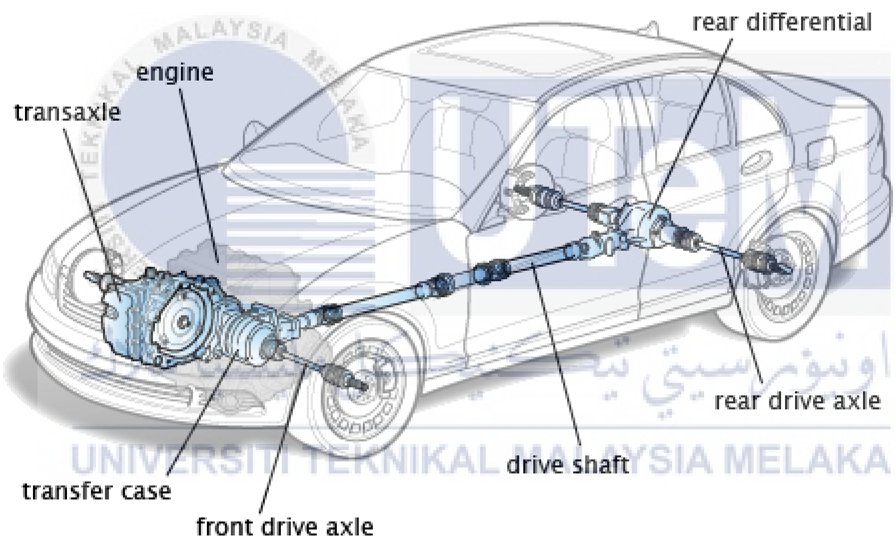


Figure 2.7 Front wheel drivetrain

2.9 Differential

In cars, the engine often uses a bevel gear to drive the wheels. This permits the rotational motion from the engine to the wheels to be diverted by 90°. However, there would be issues while cornering if the wheels were fixedly attached to one another by a single shaft. The outer wheel must go a greater distance than the inner wheel in this scenario. The outer wheel must spin more quickly than the inner wheel, though, since both wheels must make the turn at the same time. A common shaft connecting the two wheels would twist as a result of their varying rotational rates. One of the wheels will eventually slip in order to compensate for the twist. In addition to decreasing driving safety, this slippage in the curve causes significant tire wear and, over time, shaft breaking (Tec-Science, 2021).

2.9.1 Open Differential

An open differential is essentially made up of two axle halves with a gear on each end that are joined by a third gear to form three sides of a square. Fourth gear is added to complete the square and boost strength. The addition of a ring gear to the differential case containing the fundamental core gears increases its robustness. This ring gear permits the wheels to be driven by connecting the driving shaft through a pinion (Godwin, 2020).

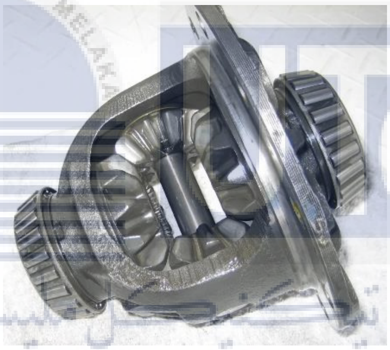


Figure 2.8 Open differential

2.9.2 Locked Differential

An off-road vehicle is likely to have a locked kind of differential. In essence, it's an open differential that locks the axle into position, creating a fixed differential as opposed to an independent one. The car may produce this effect manually or electrically (Godwin, 2020).

Figure 2.9 Locked differential

2.9.3 Limited Slip Differential

The term "LSD" refers to this kind of difference. Via a more intricate mechanism, it combines the advantages of both open and locked differential. In this differential, the same result is obtained by using a different kind of resistance. They fall into two categories: viscous LSD and mechanical clutch LSD (Godwin, 2020).

Figure 2.10 Limited slip differential assembly

2.10 Brake System

A car's braking system is a necessary component. We wouldn't be able to manage our car if we couldn't stop and slow down, which would eventually lead to accidents. For this reason, every automobile needs a sturdy braking system. It dissipates the moving vehicle's kinetic energy and stops it with a variety of devices that turn it into heat energy.

When the brake pedal is pressed, it activates the master cylinder, which generates hydraulic pressure in the brake line. This pressure is transmitted to the brake calipers sot wheel cylinders, which in turn apply the brake pads or shoes against the rotors or drum. The resulting friction between the pads or shoes and the rotors or drums slows down or stops the vehicle.

It is crucial to regularly maintain and inspect the brake system to ensure its proper functioning and safety. Brake pads and shoes wear out over time and need replacement, and brake fluid should be periodically checked and replaced as recommended by the vehicle manufacturer.

2.10.1 Vehicle Hydraulic Brake System Testing

It goes without saying that car braking systems are crucial and need to be extensively tested before going into production. To provide a smooth and controlled stop, the driver must apply enough force to the brake pedal to give enough braking power (Validyne Engineering, n.d.). Brake system testing is required in Lithuania; these tests are performed during technical inspections. The approaches that may be used to achieve these change depending on the type of vehicle (Surblys & Sokolovskij, 2016).

It is a truth that the higher speeds of contemporary automobiles on the road may be mostly ascribed to recent advancements in the braking system. Numerous research have looked at the behavior of the braking process as well as the experimental performance of the brake systems (Ghazaly & Makrahy, 2014). Automobile engineers are very interested in the performance and design of braking systems. The numerous articles that have been written about the architecture of braking systems and the variables affecting braking performance make this clear. In addition to sparking the curiosity of automotive engineers, effective braking is a necessary condition for road safety. The capacity of a vehicle to stop rapidly when necessary is undoubtedly crucial from a safety perspective, even if it might be challenging to find trustworthy data on the impact of braking capability on accidents (Starks, 1953).

2.11 Summary

In this literature review, the research direction is more focused on powertrain of a vehicle. The component is the main system that propels the vehicle, begin with the engine goes through gearbox, drive shaft and wheel. The modification of existing trainer kit can improve students understanding the subject they take that will use this trainer kit as their learning tool.

Additionally, students can use these trainer kits to apply their theoretical knowledge that they acquired in classes. Using this trainer kit students have learned how to do a proper service off a vehicle and know the correct way to do a job using the proper tool. In this literature review also has explain a little about the component of a powertrain system that consist of an engine, gearbox, drive shaft, knuckle, and wheel.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the methodology used in the creation of an extra system that is incorporated into the current trainer kit. A thorough grasp of the product's existing status and careful preparation before starting the production of a fresh design are crucial to this attempt. To ensure that the suggested system integrates seamlessly, it is essential to examine the shape and structure of the original product. Following this rigorous methodological approach will make it easier to conceptualize and implement ideas later on. The process for developing an additional system that is included in the present trainer kit is covered in this chapter. This endeavor will not succeed unless a complete understanding of the product's current state is obtained, and meticulous planning is done prior to beginning the manufacturing of a new design. Analyzing the form and composition of the original product is crucial to guaranteeing a smooth integration of the proposed system. Using this strict methodological approach will facilitate the subsequent conceptualization and implementation of concepts.

3.2 Methodology Flowchart

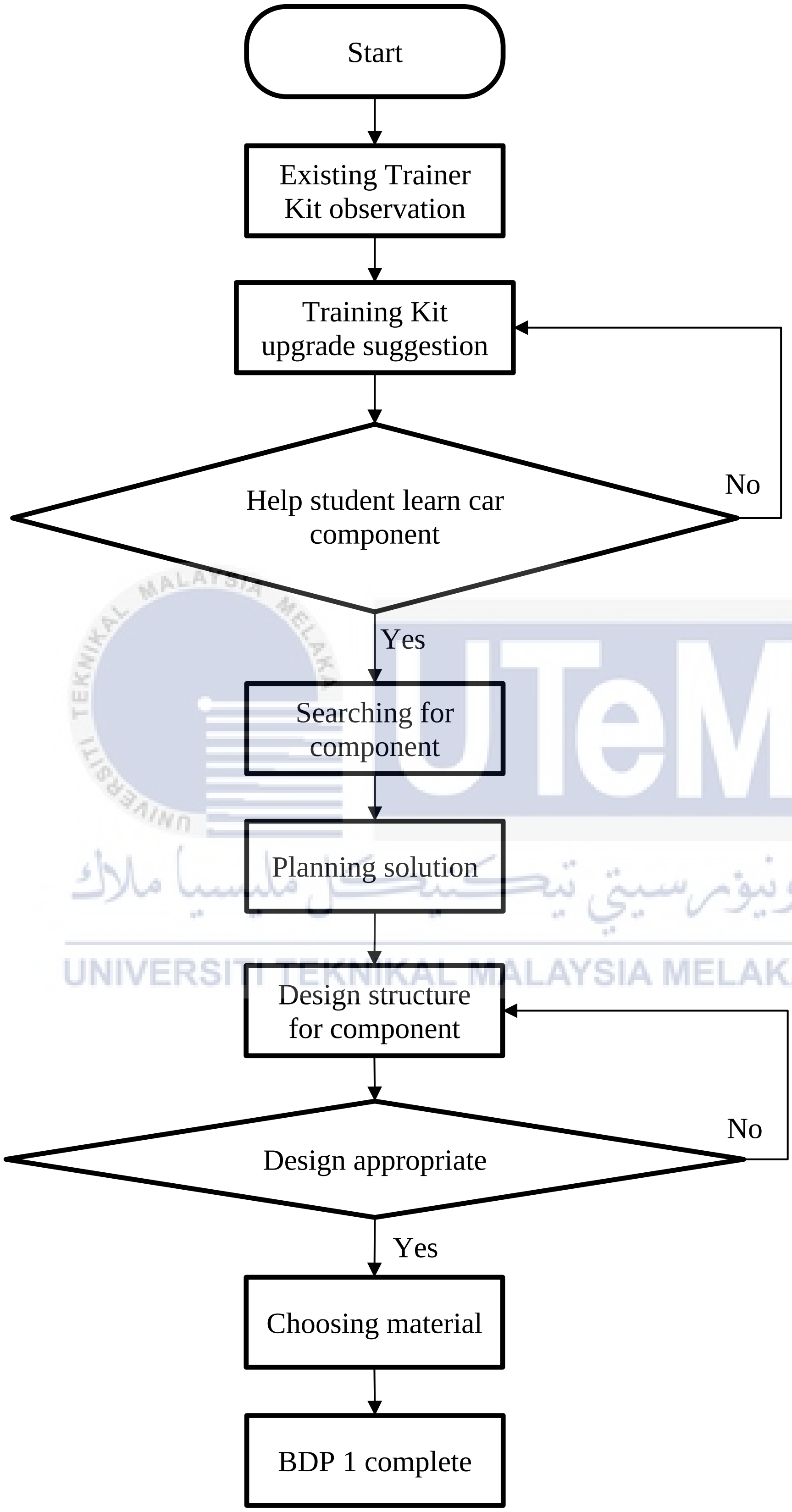


Figure 3.1 BDP 1 Flow Chart

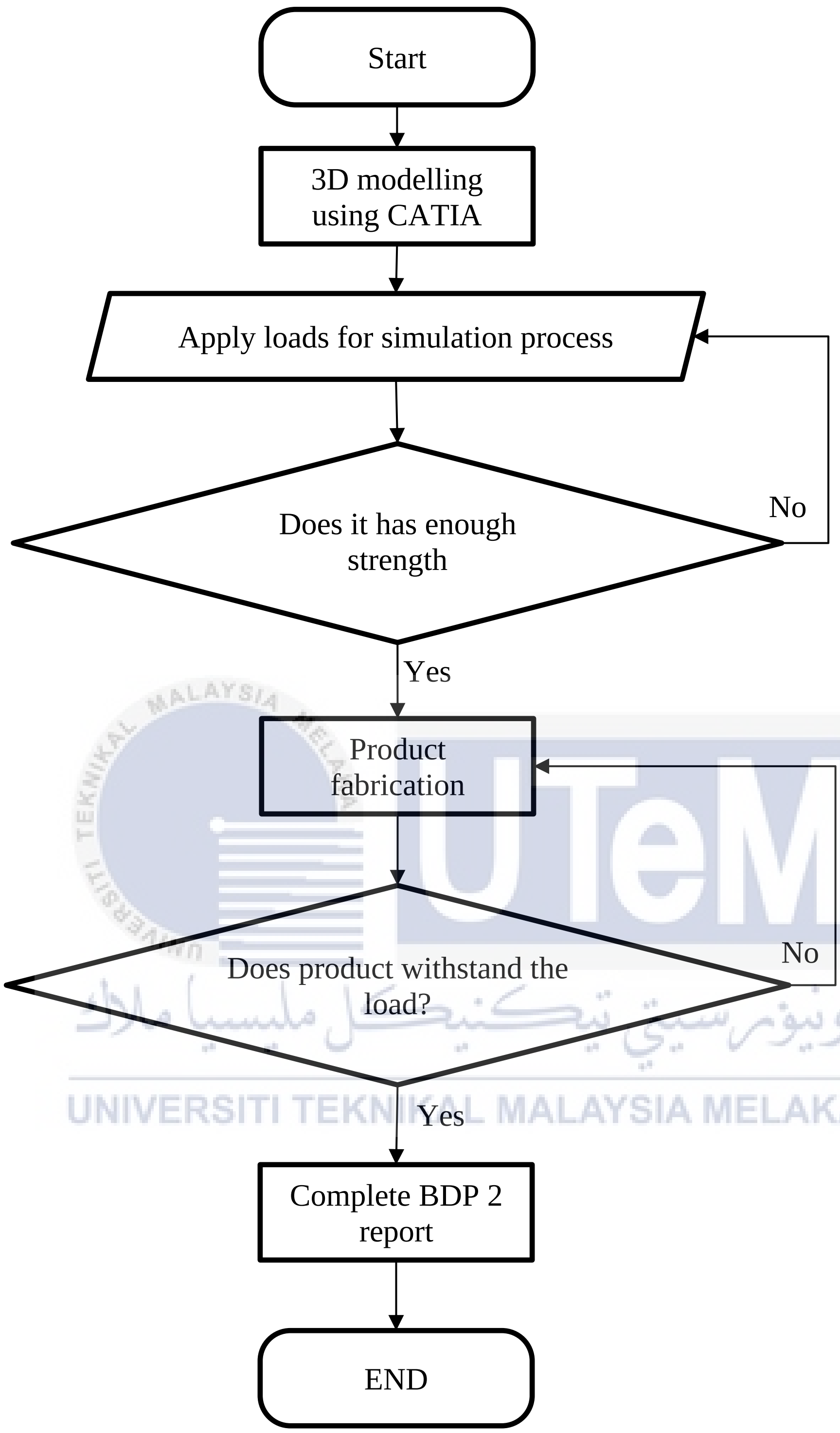


Figure 3.2 BDP 2 Flow Chart

3.3 Gantt Chart

A Gantt chart was created and used to make sure the project work progress is streamlined. Appendix C

3.4 Identify the Problem Using Survey

A survey conducted and distributed among BMKA students will play a key role in gathering valuable data and then can be analyzed to the student's understanding of automotive related knowledge. This survey will be a valuable tool for identifying the knowledge gaps and areas where students may need additional tools to improve their understanding of powertrain concepts. It is important to note that not all BMKA students have automotive related knowledge as they come from different educational backgrounds. As a result, this study will provide valuable insight into student's historical education and understanding of automotive skills. Analyzing the survey result will give a better understanding of student strengths and weaknesses in the powertrain system. This information can be used to better understand the students' needs and develop tools to help students improve their understanding of powertrain systems. Refer Appendix A for all the survey questions.

3.5 Design Criteria Needed to Fabricate the Powertrain System

3.5.1 Product Design Specifications

The Product Design Specifications (PDS) will provide guidance on how the product will be produced. Just like a blueprint, it shows an outline of how the product will be built, what it is going to look like, and the specific product requirements and functionality.

Table 3.1 Project Design Specification (PDS)

Criteria	**Explanation**
Function	For Automotive Student hands on experience
Cost	Below RM 200 if possible
Weight	Weight of the powertrain must be light as possible for maintenance
Reliability	Should be able to support powertrain weight and force acted by it

	Engine weight 21.1kg
Safety	Differential case must be partially closed
Maintenance	Differential mounting and Engine mounting can be dismantled from the frame Engine oil plug can be reach with ease Differential can be dismount from its case

3.5.2 Details description of the PDS list

- Function - This powertrain system will be utilized by BMKA students and lecturers as a teaching aid during lecture or laboratory sessions. With this project product students will be able to visualize working principles of a powertrain system.
- Cost - The cost of a product is one of the crucial aspects to focus on. Without proper monitoring of the cost can be a problem when creating a product because it could be a problem when buying the materials needed. The less money spent on a product is better because as a student we have limited resources. To reduce the costs borne by the student, the university has provided a budget of RM 200 for each student that can be claimed. Initially, the budget for this project is estimated to be below RM 300. After subtracting the budget provided by the university from my budget, a contribution of RM 200 will be put as an extra in order to achieve completion of this project.
- Weight - The weight of the whole powertrain system should not be a problem as it is made to fasten and supported by the frame. But the weight of the system still needs to be considered for future maintenance so that it can be detached from the frame easily with minimum effort.
- Reliability - Each of the mounting must be designed to withstand each component weight. The weight of the engine and differential is 21.1kg and 8kg respectively. The force produced by the engine also must be taken count.

The engine mounting should be able to withstand 8.62Nm of maximum torque produced by the engine. Torque acting on the differential case transferred through chain connecting the engine also must be taken into count.

- Safety - Safety of the user is also important so that no casualties happen when carrying lab session or when someone operating the product. The safety aspect of the differential case is focused more because this component is the most closed to operator foot. Therefore, the differential case is designed partially closed to prevent any object stuck in between the differential but not to closed so that differential cannot be seen.
- Maintenance - Future maintenance is planned ahead of the production of the system. Therefore, the engine mounting must be well designed for easy access of oil drain plug. The same goes for the differential future maintenance, the differential case must be designed so that the differential can be taken out from the case.

3.6 Observation to The Trainer Kit

Upon the observation of the existing trainer kit, it has the potential to be improved so that can help BMKA students to know and understand the work of some car components. On the existing trainer kit, it has the basic car component that attach to the trainer kit such as:

a) Wheel
b) Knuckle asembly
c) Brake disc and drum system assembly
d) Suspension assembly

e) Steering system

Figure 3.3 Trainer kit

With the existing trainer kit, some courses that BMMA students take have used it as their hands-on material such as Vehicle Suspension System and Vehicle Brake System course. It has helped students to recognize some vital brake components easily thanks to how it was built without hidden in between vehicle chassis, engine, and wheel well liner.

After thorough observation of the existing trainer kit, some aspects of the trainer kit can be added to better improve its function and give the students that used it to know the additional component. The component that can be added to the trainer kit is the powertrain system which includes the engine, drive axle, and differential to help the students to expand their theoretical knowledge and have a chance to engage with the part directly.

3.7 Research and Selection of Powertrain Component

The trainer kit was built based on one car model which is Proton Perdana. The wheel track of the trainer kit was the exact width of the original car, so using the exact similar car model component are the best option because it will fit like a glove.

Figure 3.4 Drive shaft

The drive shaft and differential are obtained from storage unit that are left by previous student because he doesn't have enough time to install it to the trainer kit. As for the engine that will be used, moped engine will be used after considering the frame and space that available to fit an engine. Honda EX5 engine provided by En. Lukman will be used.

Figure 3.5 Honda EX5 engine

3.8 Differential and Engine Measurement

- Differential dimensions measurement

To create the differential case, the dimension of differential is measured in millimeter precisions, in order to use less material and cost without ignoring the ability to detach the differential from the case. The differential case and mounting have to able to withstand the weight of the differential itself, the mass of the differential is 8kg.

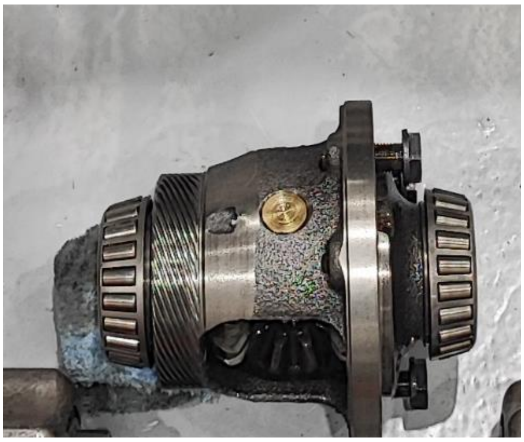


Figure 3.6 Differential Measurement

- Engine dimension measurement

The engine will be mounted from the existing threaded hole under the engine that used to be a footrest mount. It is important to note that the weight of the engine is 20kg and that the engine mounting has to be able to withstand.

Figure 3.7 Engine Mounting Measurement

3.8.1 Frame Measurement

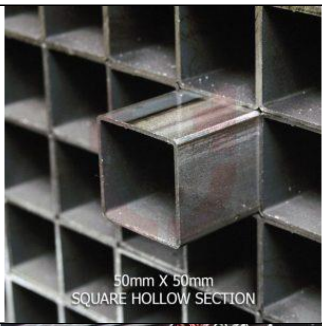
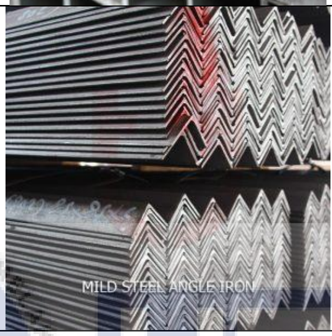
All of the powertrain mounting that will be made must be within the dimensions of the existing frame itself. This consideration is taken to minimize the damage done to the existing frame.

Figure 3.8 Frame Dimension Measurement

3.9 Material Research

The reliability, compatibility, and cost of the material are important aspects that need to be emphasized. Trainer kit material also must be considered to make sure both trainer kit frame and additional material are compatible and can be combined by welding. The material used on the existing trainer kit was square hollow section (SHS) with a dimension of 50mm × 50mm and a thickness of 3.0mm. Mild steel angle iron will be use to fabricate is powertrain mounting with dimension of 38mm × 38mm and a thickness of 2.8mm because a fastener will be used to mount the powertrain to the mounting system so the square hollow section are not suitable for mounting system.

Table 3.2 Material specification

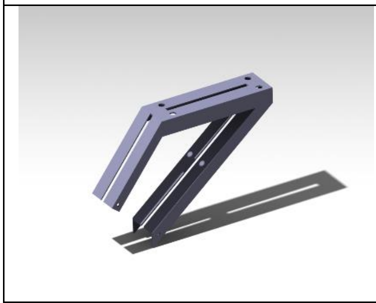
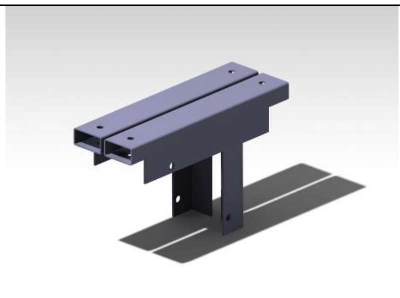
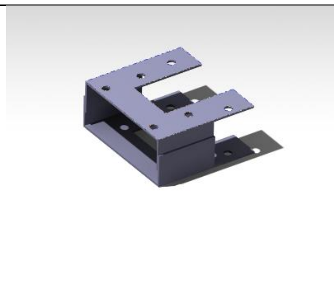
Material name	Geometry	Details
50mm Mild Steel Square Hollow Section		Spec&Gred: J49/M49 BS 50mm×50mm×3mm (square) 6 meters / RM 200.48
Mild Steel Angle Iron		Spec: S235&S275JR 38mm×38mm×2.8mm 6 meters / RM 48.61

3.10 Concept Design Generation

The concept design will be generated based on differential dimensions, engine dimensions and dimensions of existing frame. This concept design will be selected using Pugh Decision Matrix to determine which design is most appropriate for the product fabrication.

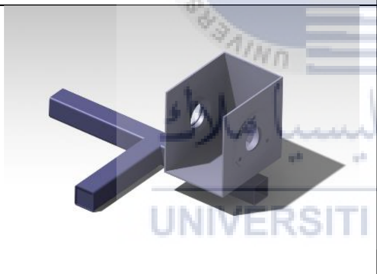
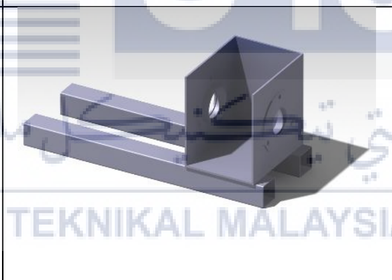
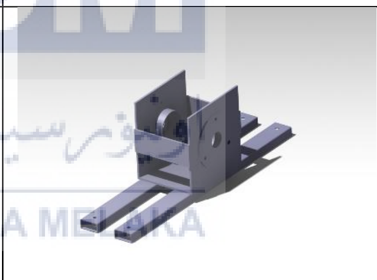
3.10.1 Engine Mounting

Table 3.3 Concept Design of Engine Mounting

Concept 1	Concept 2	Concept 3
		
Less material Top mount engine	Easy to be made Top mount engine	Small product Less material Front mount engine

3.10.2 Differential Case Mounting

Table 3.4 Concept Design of Differential Case Mounting

Concept 1	Concept 2	Concept 3
		
Less material Easy to be made Welded to frame	More support to the differential case Welded to frame	Less use of metal plate Lighter Bolted on Easy maintenance

3.11 Design Selection

From the generated concept design, choosing the suitable design can be achieved using Pugh Decision Matrix to compare all concepts for final product concept. The method of selecting the final design is shown in Table 3.5 and Table **3.6**. Each concept is rated based on its criteria that must be achieved by assigning a plus or minus sign on its performance relative to the concept. Selecting the right concept for the powertrain mounting system is important. The Pugh Matrix, also known as a decision matrix or grid analysis, will be used to determine the suitable design of a powertrain mounting system. It will help decision making to evaluate options by considering various factors and their relative importance. The Pugh Matrix will help to identify the strengths and weakness of each design, and enable us to consider multiple factors simultaneously, such as cost, functionality, aesthetics, and manufacturability. Table 3.5 and Table **3.6** below show design selection using Pugh Matrix.

Table 3.5 Pugh Matrix for Engine Mounting

Criteria	**Importance Weight**	**Concept 1**	**Concept 2**	**Concept 3**
Function	15	+	+	+
Cost	20	+	-	+
Weight	15	+	-	+
Reliable	15	-	+	+
Safety	15	-	+	+
Maintenance	20	+	+	+
	100%			
∑+		70	65	100
∑-		30	35	0
Rank		2	3	1
Approval		NO	NO	YES

Table 3.6 Pugh Matrix for Differential Case Mounting

Criteria	**Importance Weight**	**Concept 1**	**Concept 2**	**Concept 3**
Function	15	-	+	+
Cost	20	+	-	-
Weight	15	+	-	+
Reliable	15	-	+	+
Safety	15	+	+	+
Maintenance	20	-	-	+
	100%			
∑+		50	45	80
∑-		50	55	20
Rank		2	3	1
Approval		NO	NO	YES

As in the result from Table 3.5, concept 3 of Engine Mounting was chosen because it scores all criteria compared to other concepts that do not meet some criteria. For

Differential Case Mounting in Table **3.6**, concept 3 was chosen as its score the highest among the concepts generated that carry out the criteria. Therefore, concept 3 for Engine Mounting and concept 3 for Differential Case Mounting were the final design to be fabricated.

3.12 Powertrain Mounting System Design

The powertrain mounting system will be designed using CATIA software. The reason CATIA software was chosen is because of its user-friendly interface and ease of use compared to other software programs that may be more difficult to familiarize yourself with. Other than that, this software offers an advanced modelling capability such as assembling various parts to build a complete product. This software will help to streamline this project design process and improve overall efficiency. This software selection will to some extent help to reduce the time on designing the 3D model of powertrain mounting system.

Figure 3.9 Dassault CATIA

When the powertrain mounting system design has been designed, the 3D model will go through a load test. To analyze the structure, Altair Inspire will be used because this software has the easiest method to show and understand the minimum and maximum displacement, safety of factor, shear stress, von misses stress, and strain compared to other software that has been used.

Figure 3.10 Altair Inspire

3.12.1 3D Design Procedure

1. Open CATIA V5R21 software.
2. Under the Start tab open Mechanical Design > Part Design to create a new design.
3. Select any plane to create a geometry shape and click Sketch.
4. Draw the shape wanted and constrain all dimensions, make sure all the shape is green color that means the geometry is fully constrain.

Figure 3.11 Sketch the shape needed

5. After done drawing the shape needed, click Exit Workbench.
6. Click Pad to extrude the geometry into 3D model.

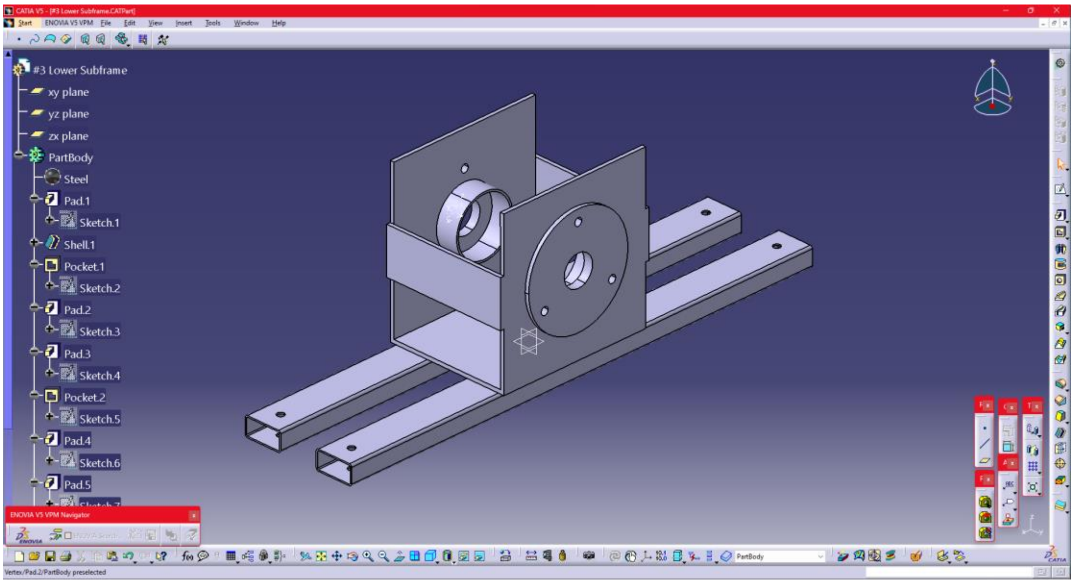


Figure 3.12 Pad the sketches

7. Select the Part Body and click Apply Material to apply Steel material with default properties.
8. To assemble all the part design, click Mechanical Design > Assembly Design.

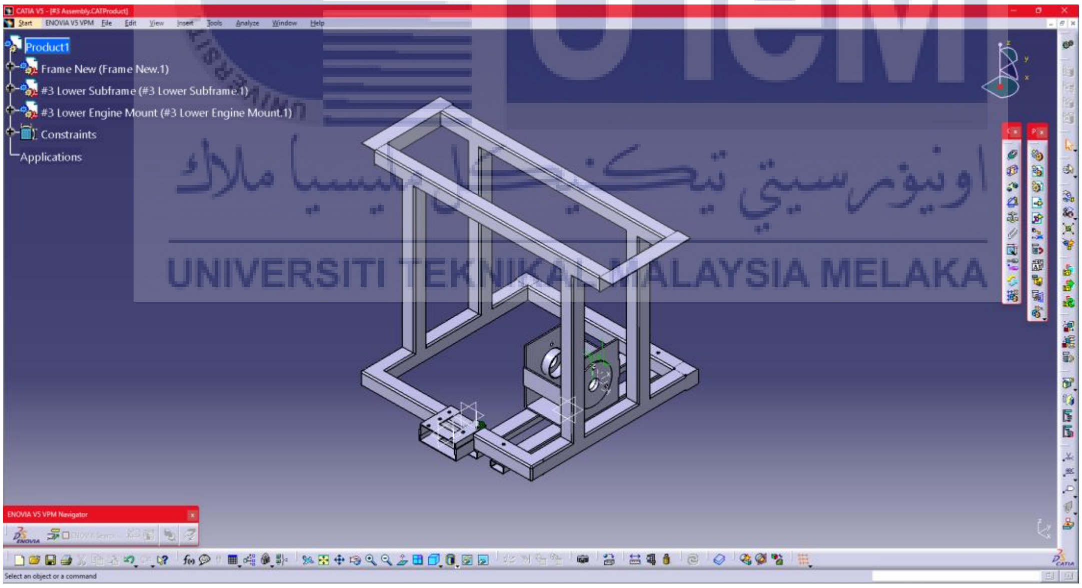


Figure 3.13 Assembly the part together

9. Under File tab, click Save to save the 3D model.
10. Open Altair Inspire software, click File to import the saved file of the model.

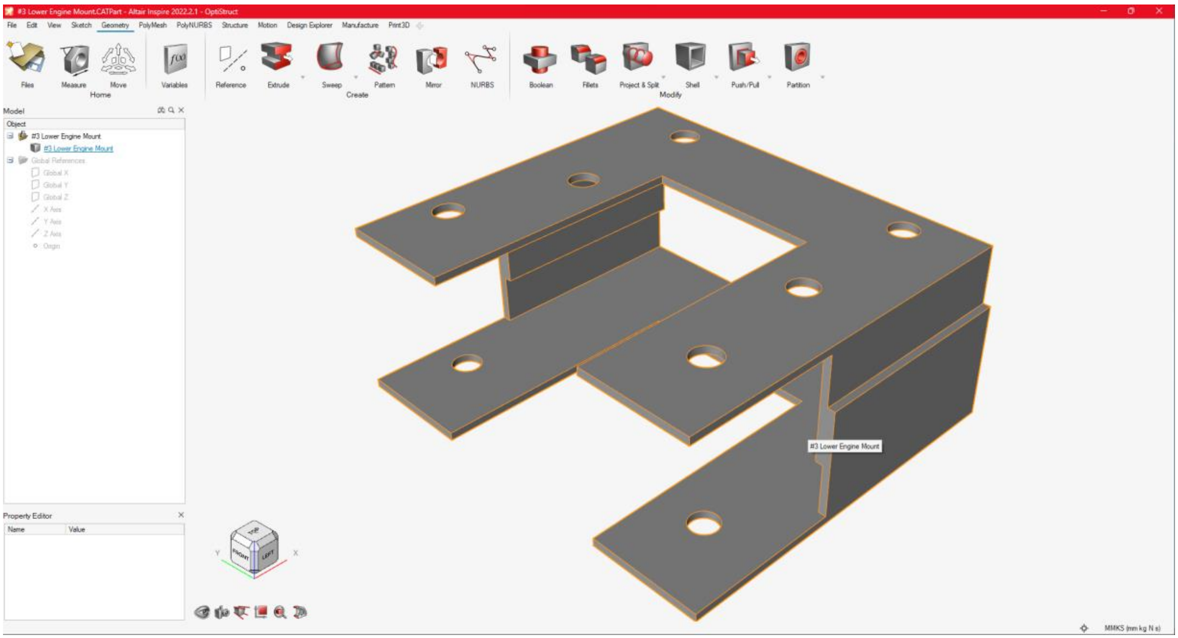


Figure 3.14 Load the model into Altair Inspire

11. Set the support and loads accordingly.

Figure 3.15 Place the load and support

12. Click Run Optistruct Analysis in Analyze tab on the upper ribbon to run the simulation.

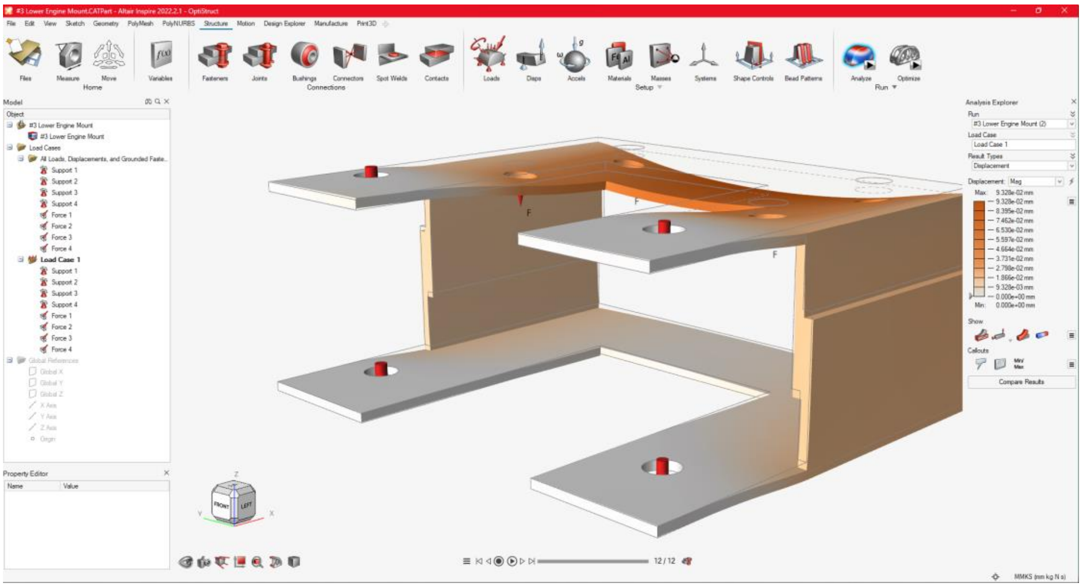


Figure 3.16 Simulation result

13. Observe the analysis data with the animation.
14. Save the simulation file and export the data.

3.13 Tools and Equipment Used in Fabrication

This project fabrication process will mainly involve cutting and welding materials. The cutting process in this project will need to cut down the material to the required length as the raw material form usually comes in various lengths. Besides, some part of the material will be cut at an angle. Drilling the material with bench drill are also required in some part area will have a hole for bolt and nut to fasten the powertrain to the frame. To combine the material pieces together, a welding machine will be used to create a strong and permanent bond allowing it to function as a single unit.

Figure 3.17 Angle Grinder

Figure 3.18 Hand Drill

Figure 3.19 MIG Welding Machine

3.14 Method to Identify Safety Requirements of Structure Design

Safety requirements are those requirements that are defined for risk reduction. With this information any failure of the product can be prevented or made changes to the design. The method used is the factor of safety (FoS) that expresses in unitless value and S-N curve that indicates the total load changes that the material can support before the material is fracture or fails.

3.14.1 Factor of Safety

The factor of safety is defined as the ratio of the ultimate stress of the component material to the working stress. It denotes the additional strength of the component than the required strength. It is a numerical value that quantifies the safety level and reliability of the design. The factor of safety provides a buffer zone to ensure that the product will not fail under certain extreme conditions (Anup Kumar, 2020).

The higher the number of factors of safety (FoS), the safer the product is. A FoS of 1 indicates that a structure will fail immediately when the design load is reached and will not be capable of supporting any extra load. Structure with less than one is not acceptable. If the consequences of failure are severe, such as physical injury, a higher FoS will be required (Loida, 2023).

Table 3.7 Typical Overall Factors of Safety

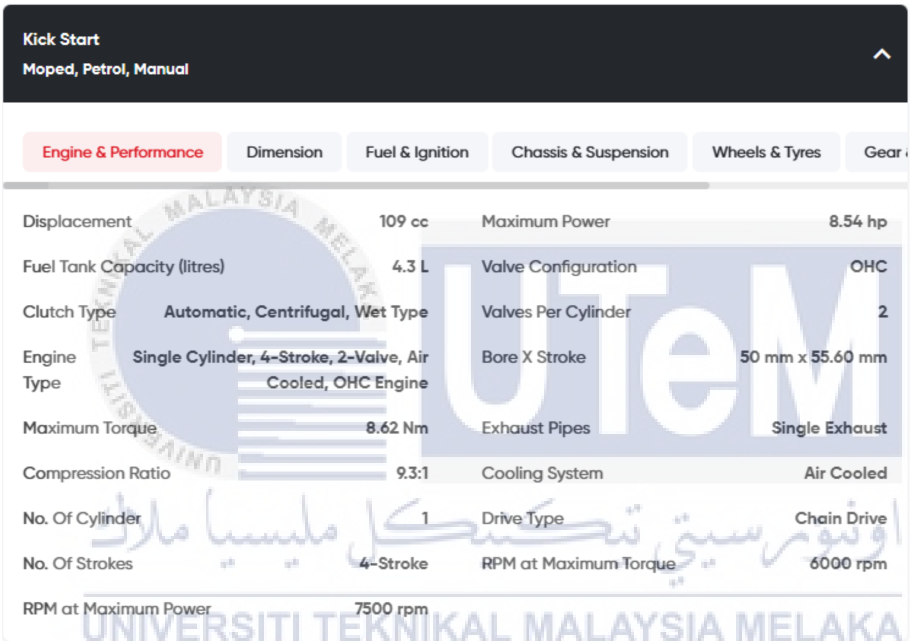
Equipment	**Factor of Safety (FOS)**
Aircraft components	1.5 – 2.5
Boilers	3.5 – 6
Bolts	8.5
Cast-iron wheels	20
Engine components	6 – 8
Highly reliable materials where loading and environmental conditions are not severe	1.3 to 1.5
Lifting equipment – hooks	8 – 9
Pressure vessels	3.5 – 6 (specified in the design code)
Moderately reliable materials where loading and environmental conditions are not severe	1.5 to 2
Turbine components – rotating	2 – 3
Spring, large heavy-duty	4.5
Structural steel work in buildings	4 – 6
Structural steel work in bridges	5 – 7
Wire ropes	8 – 9

Table 3.7 shows typical examples of the factor of safety for some materials depending on application and loading types. However, the typical range is only applicable

to the provided example. An actual value for the factor of safety for this project product is taken from the design standard of the relevant component.

3.14.2 Specific Torque Produce by the Engine

Figure 3.20 shows the technical specifications of Honda EX5 engine. The maximum torque produced is 8.62Nm and rounded off to 9Nm which indicated at the wheel. This torque value will be taken to be use for calculation purpose below.


Kick Start
Moped, Petrol, Manual

Engine & Performance | Dimension | Fuel & Ignition | Chassis & Suspension | Wheels & Tyres | Gear

Displacement	109 cc	Maximum Power	8.54 hp
Fuel Tank Capacity (litres)	4.3 L	Valve Configuration	OHC
Clutch Type	Automatic, Centrifugal, Wet Type	Valves Per Cylinder	2
Engine Type	Single Cylinder, 4-Stroke, 2-Valve, Air Cooled, OHC Engine	Bore X Stroke	50 mm x 55.60 mm
Maximum Torque	8.62 Nm	Exhaust Pipes	Single Exhaust
Compression Ratio	9.3:1	Cooling System	Air Cooled
No. Of Cylinder	1	Drive Type	Chain Drive
No. Of Strokes	4-Stroke	RPM at Maximum Torque	6000 rpm
RPM at Maximum Power	7500 rpm		

Figure 3.20 EX5 Engine Technical Specifications

Torque produced at the sprocket shaft can be calculated by reverse calculation as the rear sprocket and front sprocket information can be obtained. Then the torque produced at front sprocket transfers through the chain to differential sprocket. Therefore, the torque at the differential sprocket can be obtained and applied for simulation purposes. The calculation is shown below.

Torque at front sprocket

Rear sprocket radius, R_{rs}: 0.07m
Front sprocket radius, R_{fs}: 0.03m
Torque at wheel, T_w: 9Nm

Torque at front sprocket, T_{fs}:

$$Tfs = Tw\ x\ \frac{Rfs}{Rrs} \tag{3.1}$$

$$9Nm\ x\ \frac{0.03m}{0.07m} = 3.86Nm$$

Torque at differential sprocket

Torque at front sprocket, T_{fs}: 3.86Nm
Front sprocket teeth, n_{fs}: 14
Differential sprocket teeth, n_{ds}: 45
Torque at differential sprocket, T_{ds}:

$$Tds = Tfs\ x\ \frac{nds}{nfs} \tag{3.2}$$

$$3.86Nm\ x\ \frac{45}{14} = 12.41Nm$$

3.15 Limitation and Problem Faced During Project Implementation

Before concept three of the engine mounting was finalized, concept two was proposed first. Concept two engine mounting idealized to be mount to the top of the frame and mounted in the frame thus save space and the engine is not bulging out of the frame. The problem with the previous design is that the connection of the chain between the engine and the differential is interfered with by steering coupling and brake booster. Therefore, the engine is compelled to be mount at the front and space saving must be sacrificed. Figure below shows how the engine sprocket and steering coupling align.

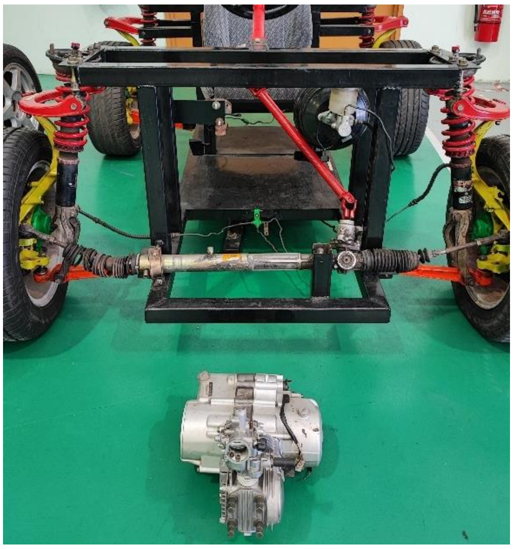


Figure 3.21 Engine and Steering Coupling Allignment

3.16 Summary

In summary, this chapter delineates a strategic and systematic methodology for the development of the supplementary system integrated onto the trainer kit. The initial focus on understanding the existing product's structure serves as a foundation for subsequent design endeavors. Through meticulous planning and consideration of material properties, the design process unfolds with the utilization of advanced tools such as CATIA and Altair Inspire. The ultimate goal is to ensure a harmonious integration of the proposed system with the trainer kit frame. Notably, the incorporation of the Pugh Matrix in the design selection phase adds a quantitative dimension to the decision-making process, aiding in the identification of the most suitable design based on weighted ratings. This methodological approach contributes to the efficiency of the development process, fostering a seamless transition from concept to a well-integrated and optimized additional system.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

The previous sections of this thesis have covered the vehicle trainer kit's creation and analysis, in addition to the BMMA students' demographic survey. The findings from the structural analysis of the engine mounting and differential case mounting under various conditions are presented in this chapter. Furthermore, the results of the survey concerning the demographics, educational backgrounds, and automotive expertise of the pupils are examined.

4.2 Survey Demographics

Table 4.1 Table of Survey Demographics

Description	**Details**	**Number of People**	**Percentage**
Gender	Male	26	93%
	Female	2	7%
Age	<20 Year old	0	0%
	20-22 Year old	4	14%
	23-25 Year old	20	71%
	>26 Year old	4	14%
Previous Qualification Prior to UTeM	Matriculation	9	32%
	Polytechnic	14	50%
	UTeM Diploma	0	0%
	STPM	2	7%
	Others	3	11%
Previous Education Background	Automotive	9	32%
	Non-Automotive	19	68%
Drive a car	Yes	26	93%
	No	2	7%
Own a car	Yes	11	39%
	No	17	61%

Ever taken car to service centre	Yes	24	86%
	No	4	14%
Ever look under the car	Yes	24	86%
	No	4	14%
Ever work on a car	Yes	21	75%
	No	7	25%
Naming drive axle	Knuckle assembly	2	7%
	Differential	0	0%
	Drive axle	25	89%
	Transfer case	1	4%
Function of drive axle	Supporting the skeleton for wheel assembly	1	4%
	Engaging power from the engine to transmission	0	0%
	Allowing wheels to rotate at different speeds on turns	10	36%
	Transfers the power from the transmission to the front wheels and rear wheels	14	50%
	Others	2	7%
Naming differential	Knuckle assembly	2	7%
	Differential	19	68%
	Drive axle	4	14%
	Transfer case	1	4%
Function of differential	Supporting the skeleton for wheel assembly	2	7%
	Engaging power from the engine to transmission	2	7%
	Allowing wheels to rotate at different speeds on turns	16	57%
	Transfers the power from the transmission to the front wheels and rear wheels	3	11%
	Others	3	11%

Based on the demographic survey, we found that the proportion of male is in the majority and females is in minority of the respondent with a total of 28 respondents. The proportion of male is 26, 93%, and the proportion of female is 2, 7%. This is because the survey distributes mainly to automotive students. After all, automotive course is dominated by male.

The age distribution reveals that people in the 23–25 age bracket makes up the majority of the population (71%). The age categories of 20–22 (14%) and over-26 (14%), on the other hand, have smaller percentages. There aren't any responders younger than twenty.

Polytechnic degrees account for 50% of qualifications, with matriculation coming in second (32%). Only 7% of responses are from STPM, and none of them have a UTeM diploma.

While 32% of respondents have automotive education, a sizable number (68%) have no prior automotive experience.

The majority of respondents (39%) own a car, and 93% of them drive one.

Most have worked on cars (75%), examined beneath cars (86%), and taken their cars to a service center (86%).

The driveshaft is accurately named “drive axle” by the majority of responders (89%). Fewer responders mistakenly identify it as “Transfer case” (4%), or as “Knuckle assembly” (7%) instead. Regarding the function of the drive axle, the majority correctly link it with delivering power from the transmission to the front and rear wheels (50%). Some respondents accurately note other functionalities, such as permitting wheels to rotate at varying rates on turns (36%).

The differential is accurately named by 68% of respondents, however some respondents mistakenly identify it as “Transfer case” (4%), “Drive axle” (14%), or “Knuckle assembly” (7%). Most people correctly identify the differential's functions as transmitting power from the gearbox to the front and rear wheels (11%) and allowing wheels to rotate at different speeds during turns (57%).

4.3 Survey Data

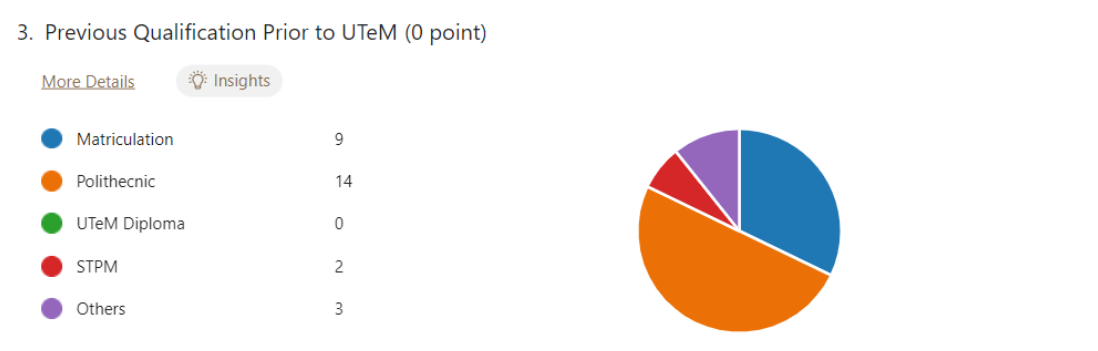


Figure 4.1 Previous qualification of respondent

Figure 4.1shows the respondents' previous qualification before continuing their study in UTeM. Half of the respondents are from polytechnic. 32% of respondents are from matriculation, 7% are from STPM and 11% are from other institutions. Half of respondents that come from polytechnic are already familiar with hands on learning and have a lot of experience.

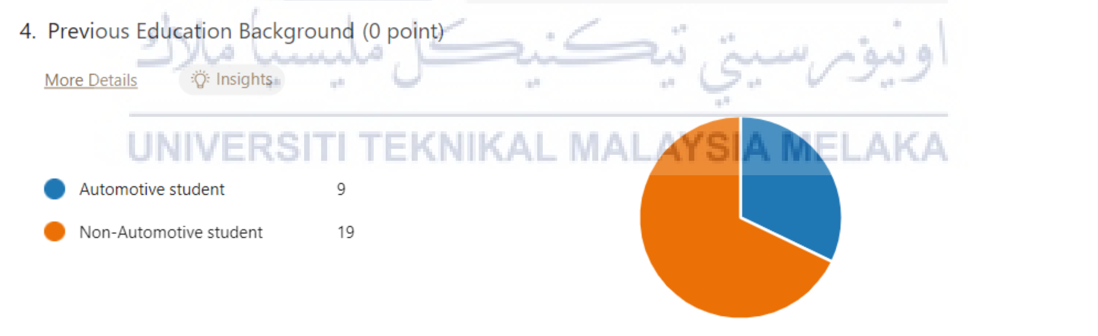


Figure 4.2 Respondent previous education background

Figure 4.2shows respondents' previous education background. 68% of the respondents are non-automotive students and only 32% of the respondents are automotive students. This shows that the majority of respondents that take automotive courses in UTeM doesn't have basic knowledge in automotive.

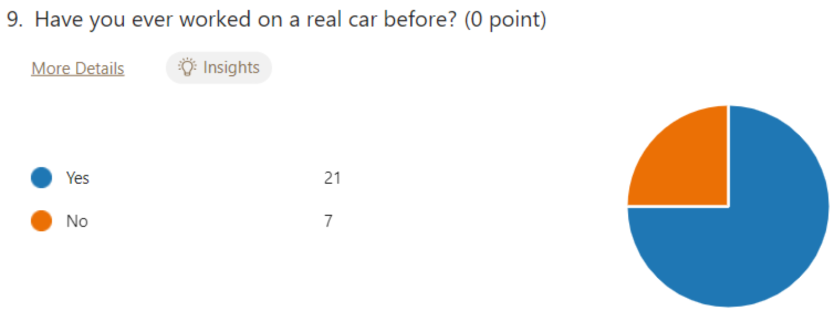


Figure 4.3 Respondent experience on working on a car

As seen in Figure 4.3, 25% of respondents had never worked on a real car before, and 75% of respondents had worked on one in the past. By the time they reach their final year of study in an automotive course, they ought to have worked on cars before, or perhaps they already have, but they forgot.

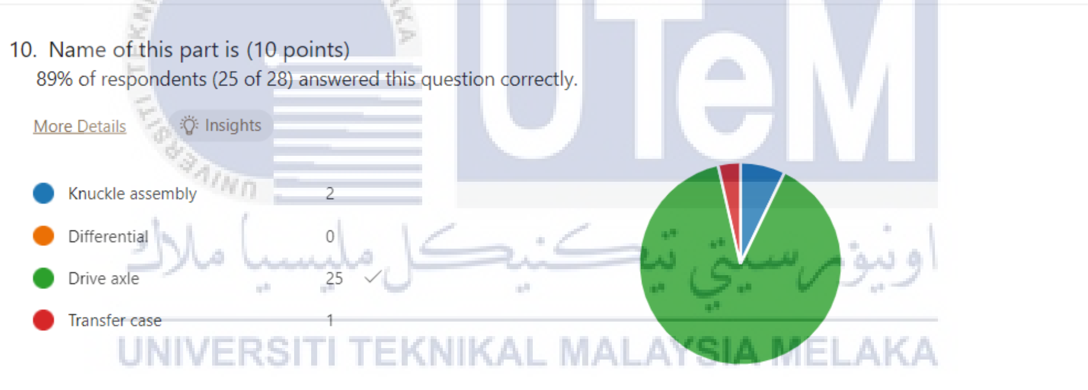


Figure 4.4 Name of the drive axle

As seen in Figure 4.4 shows the answer selected by respondents on a picture of the drive axle. 89% of them get the answer right and other 11% get the answer wrong. Even though the driveshaft is a fairly hidden component, nearly all of the respondents name it correctly.

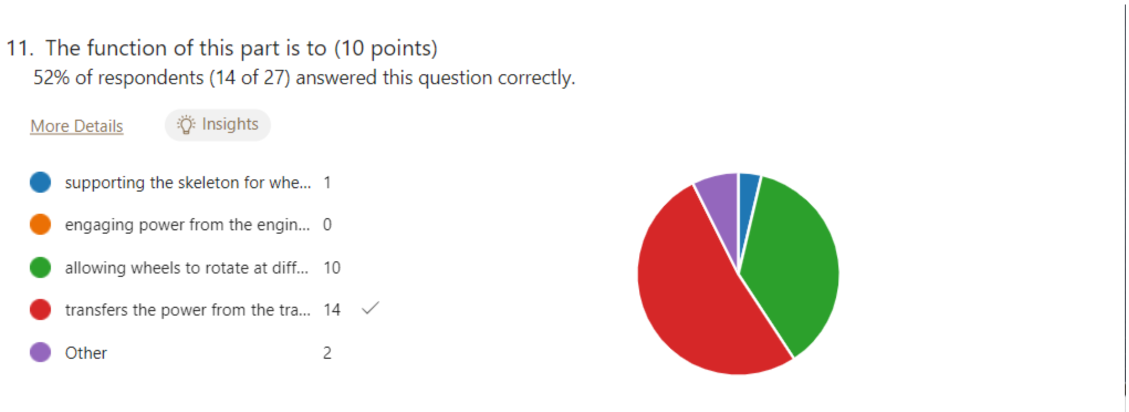


Figure 4.5 Function of the drive axle

Figure 4.5 shows the answer selected by respondent on the function of a drive axle. Just 50% of responders correctly identify the response. Half of the respondents were unaware of the purpose of a drive axle, despite the fact that nearly all of them knew the name of the component.

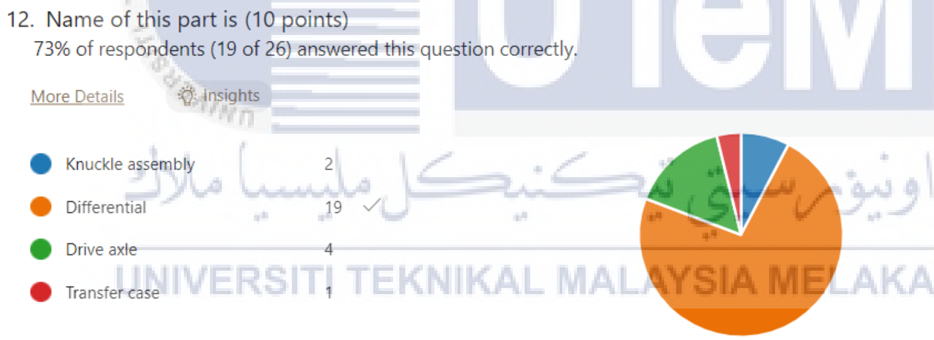


Figure 4.6 Name of the differential

Figure 4.6 shows that 73% of respondent get the answer right on the name of differential. 15% of them answer drive axle, 8% of them answer knuckle assembly, and 4% answer transfer case. The differential is a part of the gearbox that students hardly ever see, but three quarters of respondents correctly answered it.

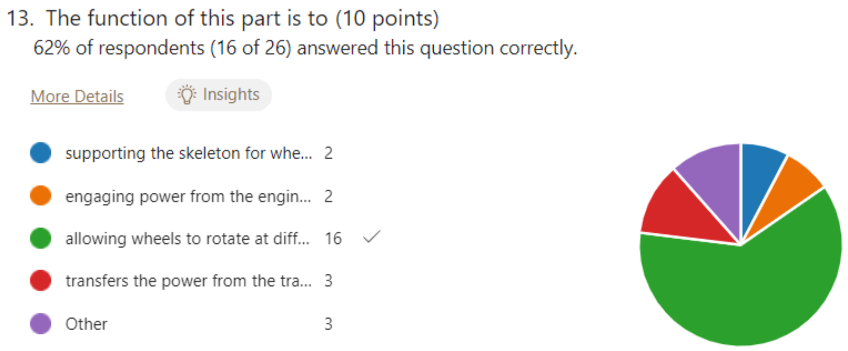


Figure 4.7 Function of the differential

Figure 4.7 shows that 62% of the respondents get the answer right to the function of the differential part. The other 38% didn’t get the answer right. Eventhough most of the BMKA student are not an automotive student, more than half of them answer the question on part name and part function correctly.

4.4 Result and Analysis of the Final Design

In this case study, mild steel will be used to create the final product. Because different kinds of metal are used, the result may be different as expected in the structure analysis in Altair Inspire. The drawing procedure of the model is shown in 3D Design Procedure. In the software, the model was created in one piece. Take the example of differential case mounting, the differential case has been sketched directly on top of the hollow steel. In reality is the differential case welded on top of the hollow steel. Same goes for the engine mounting, the angle iron bar is welded together at its seams. Therefore, the analysis result may be different if compared but the result can be taken as a reference.

The simulation is mainly to analyze the deformation and Von Mises Stress. The data collected can determine the Factor of Safety (FoS) of the product. In the case of differential case mounting and the engine mounting, the FoS of the product will be assumed to be higher than 2 because it is considered an ordinary material where loading and environmental conditions are not severe. Thus, it can be assumed that the structure will be able to withstand twice its original weight.

4.4.1 Engine Mounting Analysis

According to the scenario "On its own weight," the engine mounting is experiencing a downward force of 196.2N, which can be attributed to the gravitational force of the engine's actual mass of 20 kg. A failure is defined as having a factor of safety (FoS) of 1, and the assessment of FoS is based on strict criteria. Consequently, a FoS value of two or higher is considered satisfactory in this study, indicating the engine mounting's ability to withstand applied loads.

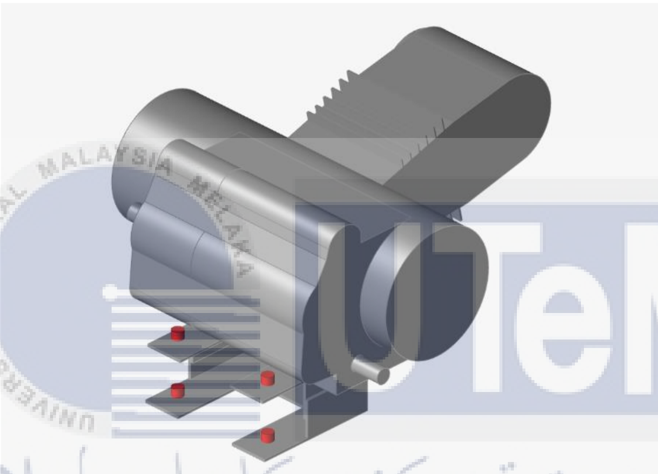


Figure 4.8 Engine and Engine Mount

A force of 392.4N is applied to the lever in the "Kick start" scenario, and the distance perpendicular to the lever is 0.15m. Taking into account half of the student's body weight, the force applied to the lever comes to 40 kg. At the kick start shaft, this arrangement produces a counterclockwise torque of 58.8 Nm, which is rounded to 60 Nm for practical reasons.

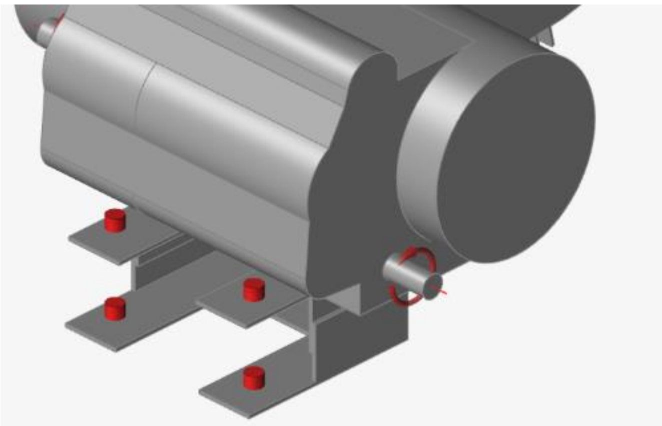


Figure 4.9 Torque Applied at Kick Start Shaft

According to the calculations in equation (**3.1**, a torque of 3.86 Nm is applied at the sprocket shaft in the "In Gear" scenario as shown in Figure 4.10. This situation simulates what happens when the engine is in gear 1 and starts moving forward. To facilitate simulations, the torque is rounded to 4Nm.

Figure 4.10 Torque Applied at Sprocket Shaft

The Table 4.2 below provides a condition overview of various structural parameter associated with engine mounting under different condition.

Table 4.2 Engine Mount Analysis Data

Condition	**Maximum Displacement (m)**	**Minimum Factor of Safety**	**Maximum Percent of Yield (%)**	**Maximum Shear Stress (Pa)**	**Maximum Von Mises Stress (Pa)**
On its own weight	1.788×10^{-5} (0.01788mm)	5.4	18.52	2.998×10^{7}	5.277×10^{7}
Kick start	1.294×10^{-5}	5.0	19.94	2.961×10^{7}	5.683×10^{7}
In gear	1.712×10^{-5}	5.5	18.27	2.961×10^{7}	5.208×10^{7}

The table presents an organized study of engine mounting and divides it into three categories: “On its own weight,” “Kick start,” and “In gear.” The engine mount exhibits a subtle displacement in each circumstance, ranging from 1.294×10^{-5} to 1.788×10^{-5} meters. Interestingly, all of the scenarios have minimal factors of safety that are between 5.0 and 5.5, which indicates a significant safety buffer above the critical load.

In addition, the engine mount shows a yield percentage between 18.27% and 19.94%, which indicates how much deformation it can withstand before suffering irreversible damage. The engine mount experiences forces ranging from 2.961×10^{7} to 2.998×10^{7} Pascals, which are the maximum shear stress values working within the material. Furthermore, the total measurement of the primary stresses that the engine mount experiences fall between 5.208×10^{7} and 5.683×10^{7} Pascals. This in-depth examination advances our knowledge of the engine mount's structural performance in a variety of operating scenarios.

In comparison to the other scenarios, the “Kick start” scenario shows a slightly smaller maximum displacement but a greater factor of safety, suggesting improved structural stability under these circumstances. Every scenario falls within a fairly similar spectrum with regard to material yield.

4.4.2 Differential Case Mounting Analysis

The differential's 8 kg mass acts as a gravitational force, causing a downward force of 78.48N on the bearing mating surface. Four kilograms of additional mass are attached to each bearing surface in order to replicate the gravitational force operating on the structure as shown in Figure 4.11.

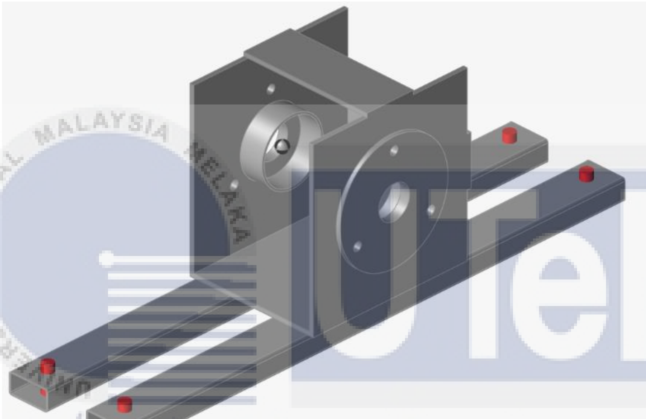


Figure 4.11 Mass Applied to the Bearing Surface

Based on the computation using equation (3.2, the structure experiences a torque of 12 Nm, as shown in Figure 4.12. When the engine is running in gear 1 and going forward, it produces this torque. A force of 12 Nm is imparted to each axis of the bearing mating surface on the case when the bearing is in the geared condition.

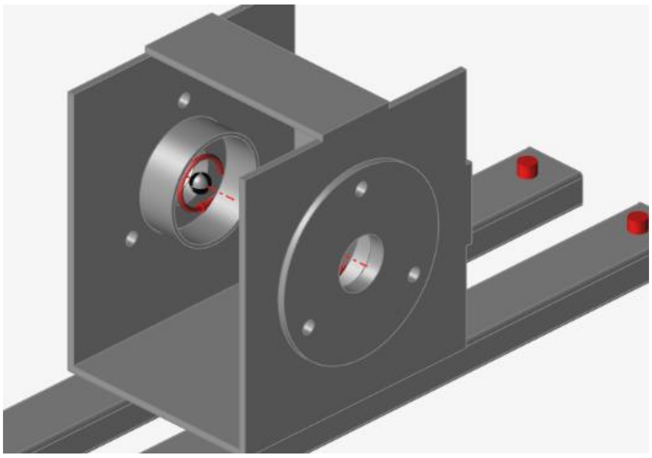


Figure 4.12 Torque Acting at Bearing Surface

Table 4.3 Differential Case Mount Analysis Data

Condition	**Maximum Displacement (m)**	**Minimum Factor of Safety**	**Maximum Percent of Yield (%)**	**Maximum Shear Stress (Pa)**	**Maximum Von Mises Stress (Pa)**
On its own weight	1.583×10^{-5} (0.01583mm)	23.4	4.27	6.895×10^{6}	1.217×10^{7}
In gear	2.758×10^{-5} (0.02758mm)	16.0	6.25	9.981×10^{6}	1.780×10^{7}

When operating “On its own weight,” the greatest displacement is 1.583×10^{-5} meters (0.01583 mm), and when operating “In gear,” it rises to 2.758×10^{-5} meters (0.02758 mm). Interestingly, the shift is so tiny that the unaided eye cannot detect it. The minimum factor of safety for the “On its own weight” scenario is an astounding 23.4. Similar to this, the factor of safety in the “In gear” situation is recorded at 16.0, exceeding the desired value and demonstrating the safety of the structural design. The “On its own weight” scenario, which analyzes the structural deformation capacities, permits a maximum percentage of distortion up to 4.27% before irreversible deformation takes place. When in the “In gear” state, this figure rises to 6.25%. Shear stress analysis shows that the maximum shear stress in the “On its own weight" scenario is 6.895×10^6 Pascals, and in the "In gear" situation it is raised to 9.981×10^6 Pascals. Examining Von Mises stress in more detail, the "On its own weight" case shows a maximum stress of 1.217×10^7 Pascals. This stress value climbs to 1.780×10^7 Pascals in the "In gear" scenario. These results validate the design's deformation and safety features by offering a thorough understanding of the structure's behavior under various circumstances.

The data suggests that there is more movement of the engine mounting during gear engagement since the "In gear" condition produces a higher maximum displacement than the "On its own weight" condition. When the engine is not running, the "On its own weight" state demonstrates a much greater factor of safety, suggesting a more robust construction. There is a finite amount of material deformation before irreversible damage occurs, as indicated by the maximum percentage of yield for both situations, which is within a reasonable range. The engine mounting may be under more stress while the engine is "in gear" as opposed to when it is on its own weight, according to higher shear stress and Von Mises stress values.

4.5 Mounting Failure Point

Figure 4.13 shows the highest von mises stress value at the engine mount, the area around the bolt hole is experiencing the most stress. This is the hole that bolt is fastened to the frame, therefore at this point may be the first area to fail caused in the worst case scenario.

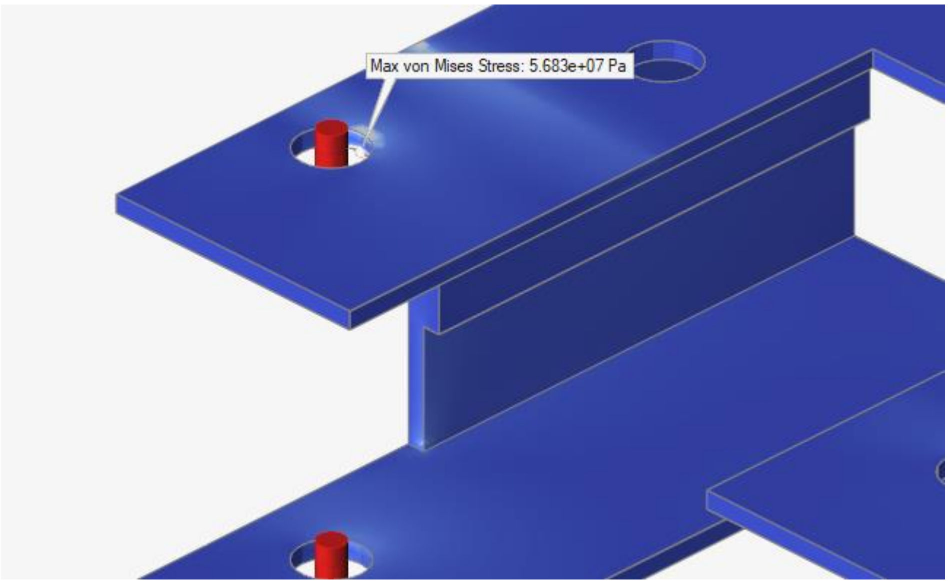


Figure 4.13 Engine Mount Failure Point

Figure 4.14 shows the maximum von mises stress at the most critical point when the structure in condition of "In gear". In both of the condition undergo by the differential case mounting, under condition of "In gear" suffer the most at the bolt hole. Also, to be noted that the hole on the differential case mount aligns with the hole on engine mount that is mounted to the frame using one bolt.

Figure 4.14 Differential Case Mount Failure Point

4.6 Final Product Overview

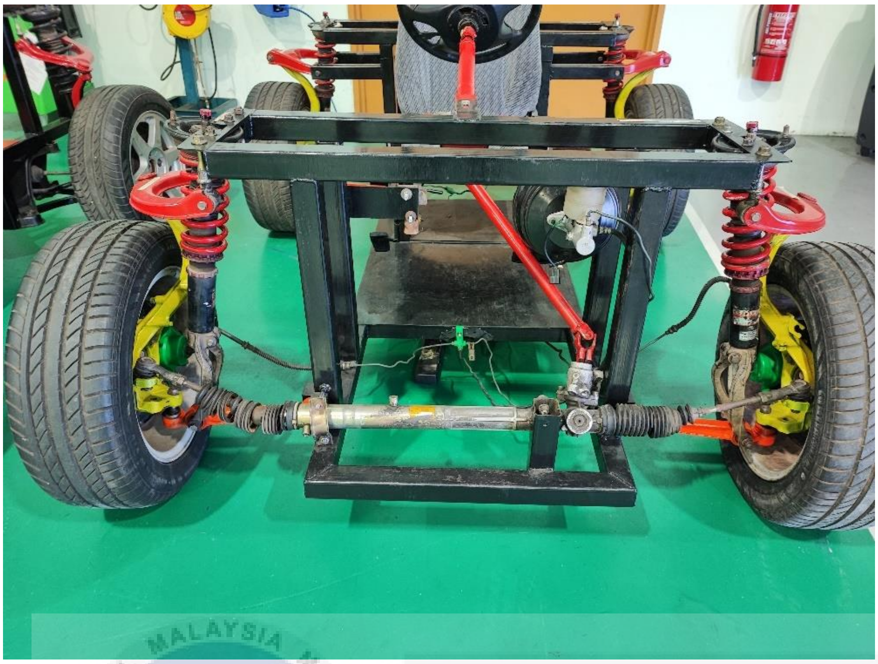


Figure 4.15 Trainer kit before upgrade

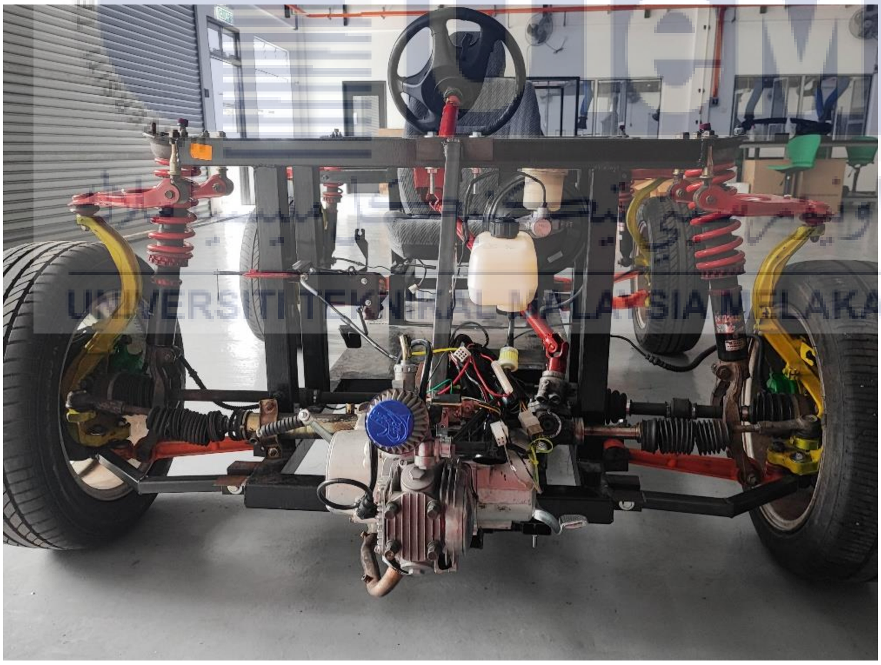


Figure 4.16 Trainer kit after upgrade

Figure 4.17 Engine mounting

Figure 4.18 Differential case mounting

4.7 Bill of Materials

Table 4.4 Bill of material used to fabricate mounting

No	Material	Size (mm)	Unit	Cost (RM)	Total (RM)	Supplier
1	Mild Steel Rectangle Hollow Section	50×25×1.8 (1m)	2	0.00	0.00	UTeM
2	Mild Steel Square Hollow Section	25×25×1.6 (1m)	3	5.83	17.49	Syarikat Kiat Huat
3	Mild Steel Angle Iron	38×38×1.6 (1m)	3	5.00	15.00	Khee Steel Trading
4	Hex Bolt	M10×25	6	0.50	3.00	AT Fasteners
5	Spring Washer	M10	6	0.15	0.90	AT Fasteners
6	Hex Nut	M10	6	0.30	1.80	AT Fasteners
7	Mild Steel Plate	200×200×5	2	19.00	38.00	MMC Steel
8	Mild Steel Plate	200×160×5	2	17.00	34.00	MMC Steel
9	Mild Steel Round Plate	Ø140×5	2	13.00	26.00	MMC Steel
10	Steel Round Bar	Ø80×100	1	66.00	66.00	Steel Grocery
11	Galvanized Bolt, Washer & Nut	M9	7	1.80	12.60	Chin Tek Hardware
12	Differential Bearing		1	35.00	35.00	Holly Auto Parts
				Total	**249.79**	

4.8 Discussion

The BMMA students' survey provided insightful information about their demographics, educational backgrounds, and level of automotive knowledge. The preponderance of male students in automotive courses is reflected in the 93% male response rate. The age distribution showed that a large percentage had prior polytechnic qualifications (50%) and that the concentration was in the 23–25 age group (71%). It's interesting to note that 68% of respondents had no prior automotive education, despite taking automotive courses.

According to the survey, 75% of students had worked on automobiles, and 86% had either looked under cars or driven them to service centers, providing insight into their practical experience. Even though most respondents identified parts like the driveshaft and differential accurately, a significant percentage showed gaps in their knowledge of how they work. Significantly, half of the participants were not familiar with the purpose of a drive axle, suggesting possible avenues for focused instruction.

Comprehensive structural insights were obtained from the analysis of the engine mounting and differential case mounting under various situations. The designs demonstrated minimum displacements, factors of safety within the range of 5.0 to 5.5, and satisfactory percentages of yield prior to permanent deformation in both cases. The "Kick start" scenario showed better stability, and the simulation results showed that the structures could support imposed loads.

By comparing the two cases, it was possible to see that the "In gear" state caused somewhat larger displacements, indicating more movement during gear engagement. The von Mises stress analysis highlighted possible failure locations and identified crucial points. The investigation found that, with only slight differences in how well they performed in various scenarios, both designs successfully complied with safety requirements.

4.9 Summary

Students at BMMA participated in a survey that gave an overview of their educational backgrounds, understanding of cars, and demographics. Most were male, between the ages of 23 and 25, with polytechnic credentials. Even though they took automotive classes, a significant percentage had no prior automotive education. Although there were some gaps in the respondents' functional comprehension, most of them had practical experience.

The resilience of the engine mounting and differential case mounting was demonstrated by the structural study conducted under various conditions. The structural integrity of the designs was confirmed by minimal displacements, factors of safety greater than 5.0, and acceptable percentages of yield. Slightly larger displacements were seen in the "In gear" scenario, indicating more movement during gear engagement. Von Mises' stress analysis brought attention to important details and possible points of failure.

All things considered, both designs demonstrated their ability to withstand applied loads, adhere to safety standards, and offer insightful information for upcoming improvements. The study advances knowledge about the structural performance of automotive components and adds to a comprehensive understanding of the profiles of BMMA students.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Finally, the vehicle trainer kit is a brilliant invention by former BMKA students, and it is a great resource for teaching students the nuances of checking and changing a car's brake pads. The hands-on experience it gives, including the option to repair the entire brake system, helps students' understanding of real-world automobile issues. The good influence this kit has on present students, increasing their learning experience, is a testament to the dedication of prior BMKA students who built it.

But the trainer kit's main drawback is that it doesn't have a powertrain, thus moving about requires manual labor. Having identified this weakness, the goal of our project is to create a powertrain mounting system by developing and manufacturing it. This upgrade not only improves the kit's functionality by enabling realistic brake tests on all wheels, but it also fixes the practical nuisance of manual movement. The addition of a powerplant not only increases the trainer kit's versatility but also functions as a teaching tool for comprehending engine procedures, which are sometimes hidden in actual cars.

The goals of the project are very clear: to build a powertrain mounting system that will support instructors and students during lab and lecture sessions. Structural endurance is ensured by the use of sophisticated design and analysis tools like Altair Inspire and CATIA. The project's focus is restricted to UTeM students studying automotive technology, and it emphasizes the significance of the mounting structure's robustness through careful construction. The project's scope is further defined by the usage of a motorcycle engine and the end product's non-road application.

To put it briefly, this effort helps improve the instructional resources in the automotive curriculum while simultaneously addressing a real-world problem. In addition to helping the current UTeM students, the accomplishment of these goals will serve as evidence of the industry's ongoing innovation and progress in the field of automotive education.

5.2 Recomendation

Although the project's primary goal is to develop and build a powertrain mounting system for the vehicle trainer kit, it might benefit from a few more features to improve both its usability and educational value. We suggest the following changes for future development:

i. Include Reverse Gear Mechanism: The trainer kit's realism would be greatly increased by including a reverse gear mechanism in the powertrain system. This feature would provide students a more thorough learning experience by enabling them to comprehend and practice the nuances of operating a car in reverse.

ii. Incorporate Gear Lever Mechanism: By incorporating a gear lever mechanism into the engine design, pupils will be able to manually shift between different gears. This improvement might imitate shifting gears, offering a useful comprehension of how transmission systems function. Additionally, the idea of gear ratios and how they affect a vehicle's performance would be introduced to the students.

iii. Install Braking Light System: There are several reasons to include a braking light system in the training kit. In the first place, it would mimic actual braking situations so that students could see how braking affects the system. Second, by making the braking process visibly evident, it improves safety and offers a useful visual signal for training.

REFERENCES

O. Ekwueme, C., E. Ekon, E., & C. Ezenwa-Nebife, D. (2015). The Impact of Hands-On-Approach on Student Academic Performance in Basic Science and Mathematics. Higher Education Studies, 5(6), 47. https://doi.org/10.5539/hes.v5n6p47

Dhanapal, Saroja & Wan, Evelyn. (2014). A STUDY ON THE EFFECTIVENESS OF HANDS-ON EXPERIMENTS IN LEARNING SCIENCE AMONG YEAR 4 STUDENTS. 3. 29-40.

JPK Malaysia, 2022. TVET in Malaysia – 5 essential things you must know. [online] (4 May 2022) Available at: https://jpkmalaysia.com/tvet-program/ [Accessed on 31 May 2023]

StudyMalaysia.com, 2016. Technical and vocational education and training (TVET) in Malaysia. [online] (12 October 2016) Available at: https://studymalaysia.com/education/top-stories/technical-and-vocational-education-and-training-in-malaysia [Accessed on 30 May 2023].

Usama, Mohd & Singhal, Gagan. (2018). Design and Analysis of Braking System for FSAE. 10.13140/RG.2.2.26149.65760.

Hayes. A., 2022. Investopedia. [online] (December 04, 2022) Available at: https://www.investopedia.com/terms/s/skilled-labor.asp [Accessed on 5 June 2023].

HR Asia, 2019. Automotive Sector to Drive Malaysia's Workforce Development. [online] (29 August 2019) Available at: https://hr.asia/top-news/automotive-sector-to-drive-malaysias-workforce-development/ [Accessed on 5 June 2023].

BERNAMA, 2022. Automotive industry faces acute shortages of manpower, needs immediate solution. [online] (3 April 2022) Available at: https://www.nst.com.my/news/nation/2022/04/785574/automotive-industry-faces-acute-shortage-manpower-needs-immediate#:~:text=Automotive%20industry%20faces%20acute%20shortage%20of%20ma npower%2C%20needs,if%20not%20resolved%20immediately.%20-%20NSTP%20file%20pic [Accessed on 6 June 2023].

Du H. J,. 2021. Teaching Connections. [online] (2021, Aug 26) Available at: https://blog.nus.edu.sg/teachingconnections/2021/08/26/online-lecture-and-hands-on-practice-a-complementary-approach-for-learning/ [Accessed on 28 May 2023].

Malaysia Investment Development Authority, 2022. Automotive sector to remain Positive in 2022 says analyst. [online] (23 Feb 2022) Available at: https://www.mida.gov.my/mida-news/automotive-sector-to-remain-positive-in-2022-says-analysts/ [Accessed on 6 June 2023].

Charles. C., 2021. Malaysia needs more highly skilled workers for competitive edge. [online] (14 September 2021) Available at: https://hrmasia.com/malaysia-needs-more-highly-skilled-workers-for-competitive-edge/ [Accessed on 6 June 2023].

HRDF, 2019. HRDF Human Capital Report. [online] Available at: https://hrdcorp.gov.my/wp-content/uploads/2021/03/12.-issue_Sept02_2019-Human-Capital-Report-Skills-Shortages.pdf [Accessed on 6 June 2023].

Lim. I., 2021. Malaysia faces manpower shortage in critical sector even as economy opens up. [online] (31 October 2021) Available at: https://www.malaymail.com/news/malaysia/2021/10/31/report-malaysia-faces-manpower-shortage-in-critical-sectors-even-as-economy/2017327 [Accessed on 6 June 2023].

Matthew. H., 2014. Learning by Doing: Ways to Study as a Kinestetic Learner. [blog] Available at: https://takelessons.com/blog/kinesthetic-learning-strategies?utm_source=bing&utm_medium=richqna_answer&utm_campaign=richqna&utm_trigger=richqna&utm_query=kinesthetic%20learner&utm_content=blogsqna+title&muid=2CE5836DC44161FE3D5491BDC50460AE&utm_region=MY&utm_position=Default [Accessed on 6 June 2023].

Validyne Engineering, n.d.. Vehicle Hydraulic Brake System Testing. [online] Available at: https://www.validyne.com/blog/vehicle-hydraulic-brake-system-testing/ [Accessed on 7 June 2023].

Iyas, M. (2022). Powertrain vs Drivetrain: What's The Difference? [Explained]. *The Engineers Post*. [online] (29 April 2022) Available at: https://www.theengineerspost.com/powertrain-vs-drivetrain/#more-16247 [Accessed on 16 June 2023].

M. Transmission, n,d. What is a Drivetrain [blog] Available at: https://www.mistertransmission.com/what-is-a-drivetrain/ [Accessed on 19 June 2023]

Unrau, J. (2016). I'm Always Hearing About Powertrain – What Does it Mean? [online] Available at: https://www.jaywolfeacura.com/im-always-hearing-powertrain-mean/ [Accessed on 16 June 2023].

Tec-Science. (2021, March 11). *How does a differential gear work? - tec-science*. Tec-science. https://www.tec-science.com/mechanical-power-transmission/planetary-gear/how-does-a-differential-gear-work/ [Accessed on 20 June 2023].

Godwin. (2020). Types of differential and their functions. *Student Lesson*. https://studentlesson.com/types-of-differential-and-their-functions/ [Accessed on 20 June 2023].

Anup. K, (2020). Factor of Safety: Definition, Equation, Examples, Calculator. [online] Available at: https://whatispiping.com/factor-of-safety/ [Accessed on 2 January 2024].

Loida. B, (2023). Factor of Safety: Ratio for Safety in Design Use. [online] Available at: https://safetyculture.com/topics/factor-of-safety/ [Accessed on 3 January 2024].

APPENDICES

APPENDIX A Questionaire Survey Form

Vehicle Trainer Kit Upgrade

As a BMMA student, your knowledge about automotive parts, their location, and function is essential to your success in this course. This survey is designed to assess your understanding of these components.

Thank you for your participation in this survey. Your responses will help us identify areas where we can improve the existing training kit and ensure that students are well-equipped to succeed in the automotive industry.

Muhammad Hanif Asyraf Bin Amir
BMMA Kohort 6 PSM Student
Universiti Teknikal Malaysia Melaka

* Required

1
Gender *
- Male
- Female

2
Age *
- 19 and below
- 20 - 22
- 23 - 25
- 26 and above

3
Previous Qualification Prior to UTeM *
- Matriculation
- Polithecnic
- UTeM Diploma
- STPM
- Others

4
Previous Education Background *
- Automotive student
- Non-Automotive student

5
Do you drive a car? *
- Yes
- No

6
Do you own a car? *
- Yes
- No

10
Name of this part is (10 Points)

- Knuckle assembly
- Differential
- Drive axle
- Transfer case

11
The function of this part is to (10 Points)

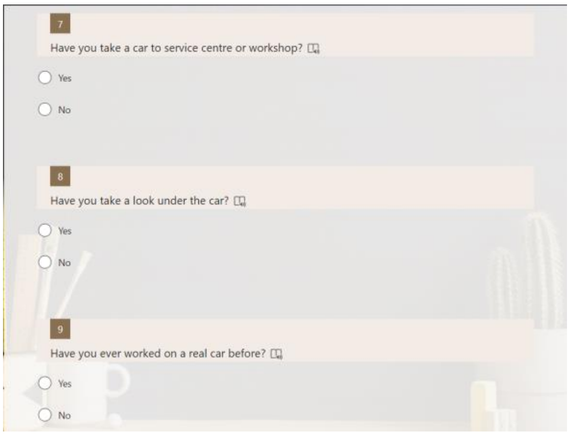
- supporting the skeleton for wheel assembly.
- engaging power from the engine to transmission.
- allowing wheels to rotate at different speeds on turns.
- transfers the power from the transmission to the front wheels and rear wheels.

12
Name of this part is (10 Points)

- Knuckle assembly
- Differential
- Drive axle
- Transfer case

13
The function of this part is to (10 Points)

- supporting the skeleton for wheel assembly.
- engaging power from the engine to transmission.
- allowing wheels to rotate at different speeds on turns.
- transfers the power from the transmission to the front wheels and rear wheels.



7

Have you take a car to service centre or workshop?

Yes

No

8

Have you take a look under the car?

Yes

No

9

Have you ever worked on a real car before?

Yes

No

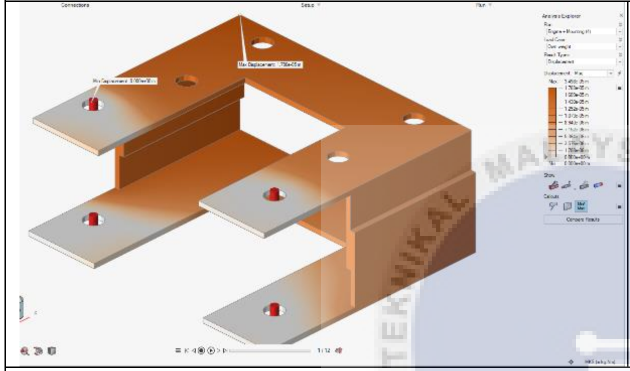
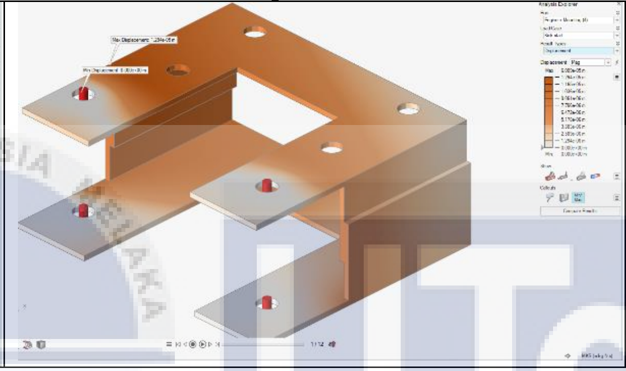
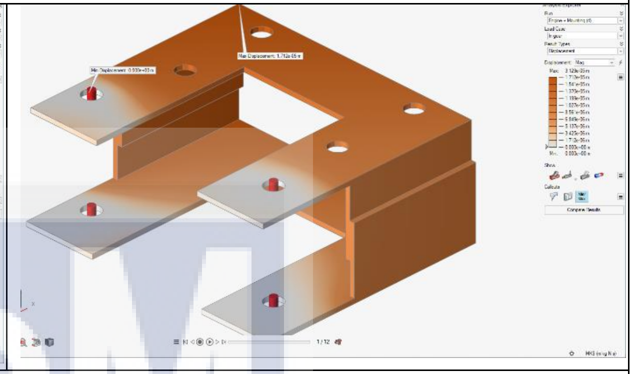
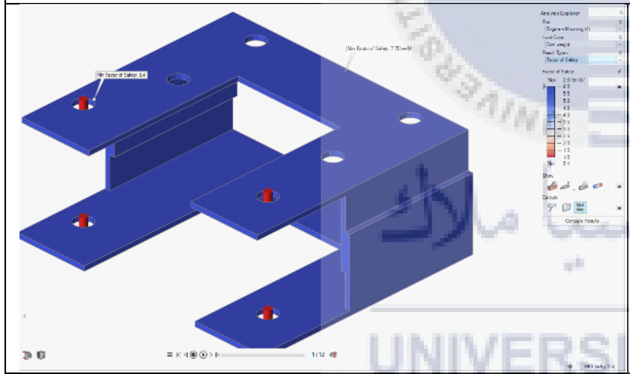
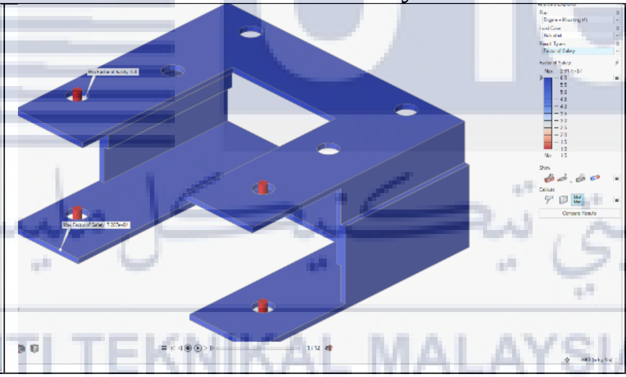
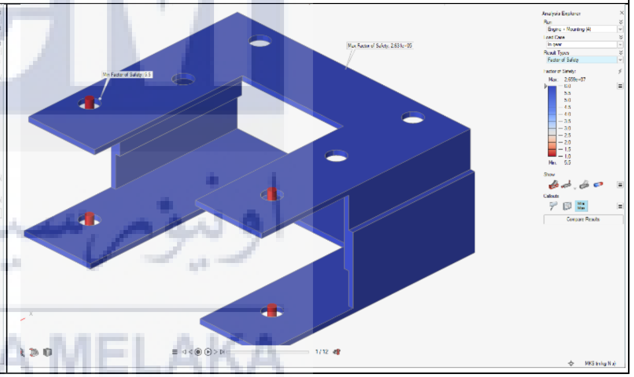
APPENDIX B Gantt Chart BDP I

	Week													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Final Year Project briefing														
Title selection														
Chapter 1, Introduction (Background, Problem Statement, Project Objective, Scope of Project)														
Chapter 2, Literature Review														
Survey qeuestion construction														
Survey conduct														
Chapter 3, Methodology														
Survey review														
Chapter 4, Result														
Presentation, Complete Final Year Project 1														

APPENDIX C Gantt Chart BDP II

	Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PSM 2 briefing														
Brainstorming ideas														
3D model drawing														
Start to update on Chapter 3														
Complete chapter 3, start to update on Chapter 4														
Simulate the strength analysis in Altair Inspire														
Update on Chapter 4														
Fabricate the product														
Find solution on problem face in fabrication														
Finish product, test the product, update Chapter 4														
Completing Chapter 5														
Complete BDP II														

APPENDIX D Simulation Result Engine Mounting

<table>
<tr><td>On its own weight</td><td>Kick start</td><td>In gear</td></tr>
<tr><td colspan="3">Displacement</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Factor of Safety</td></tr>
<tr><td></td><td></td><td></td></tr>
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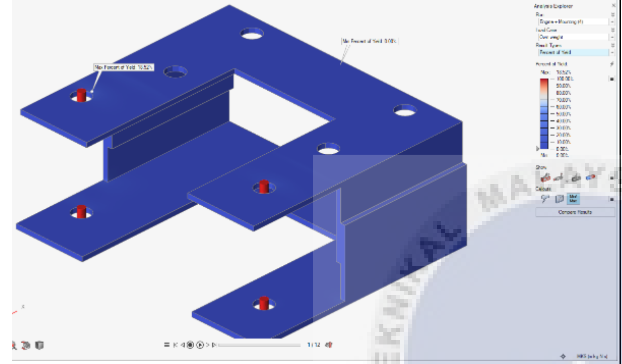
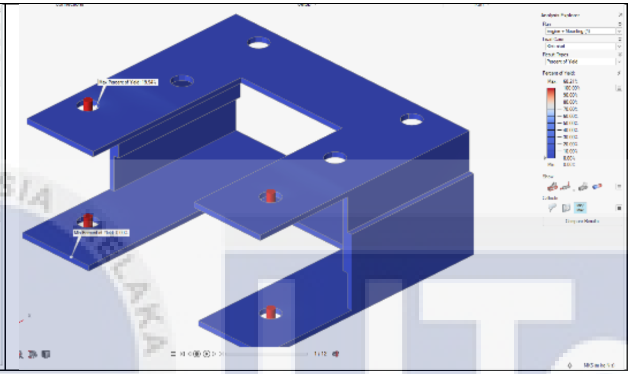
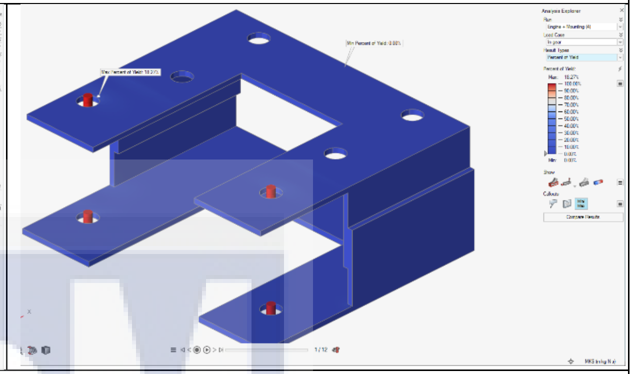
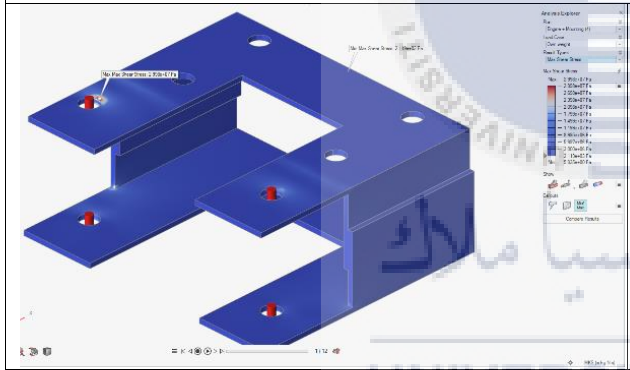
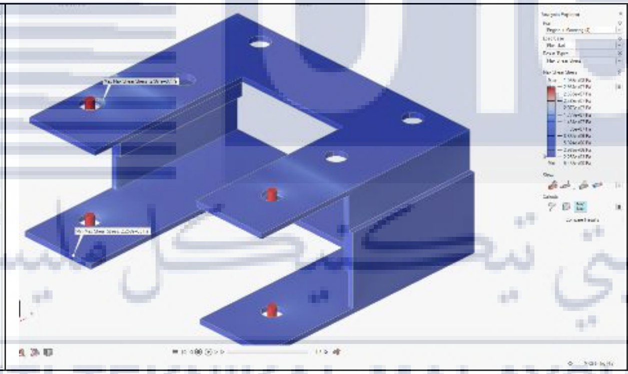
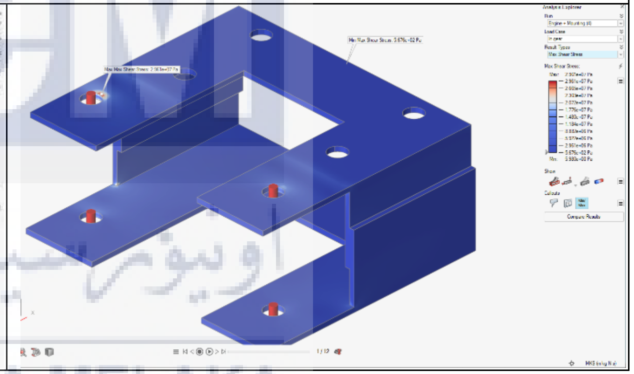
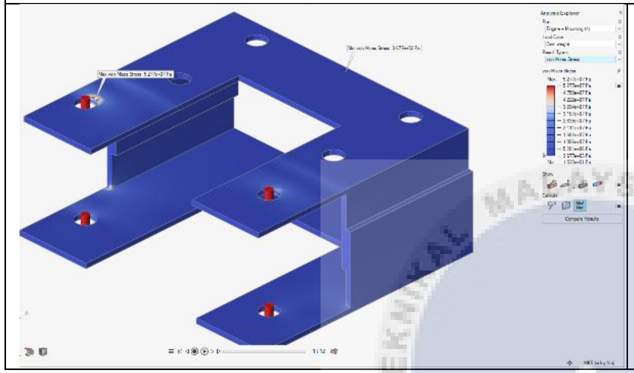
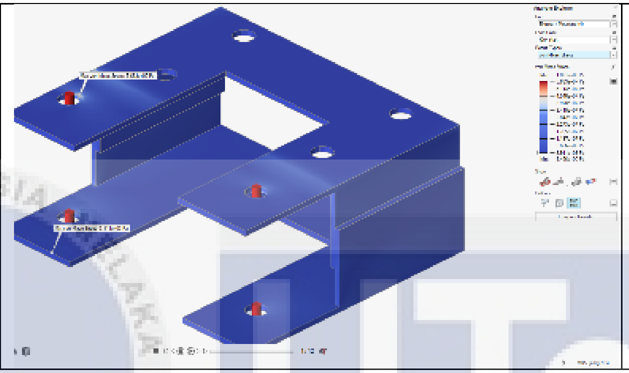
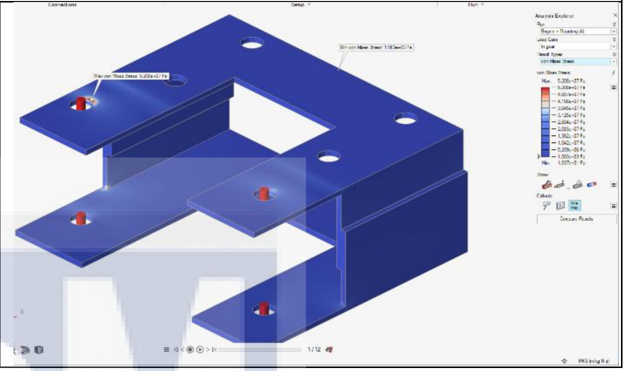
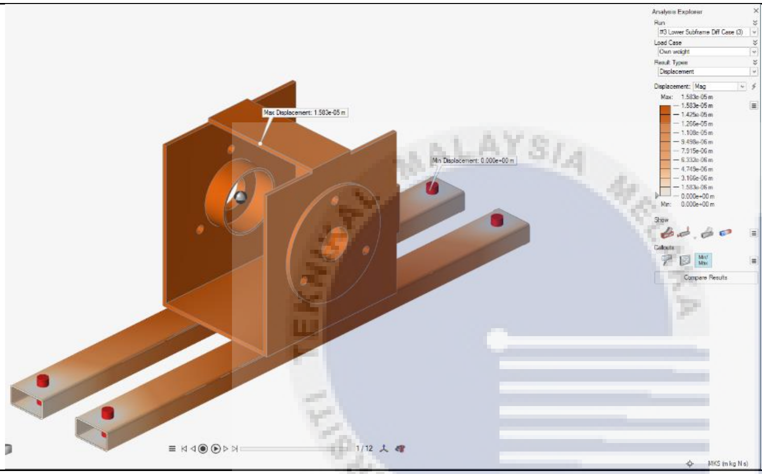
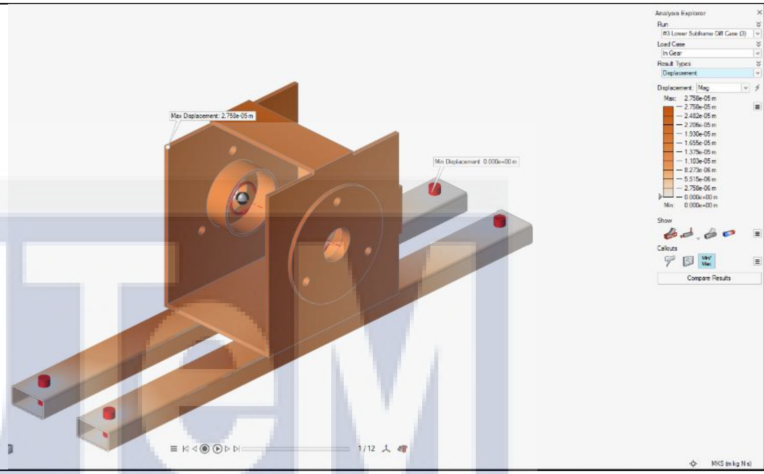
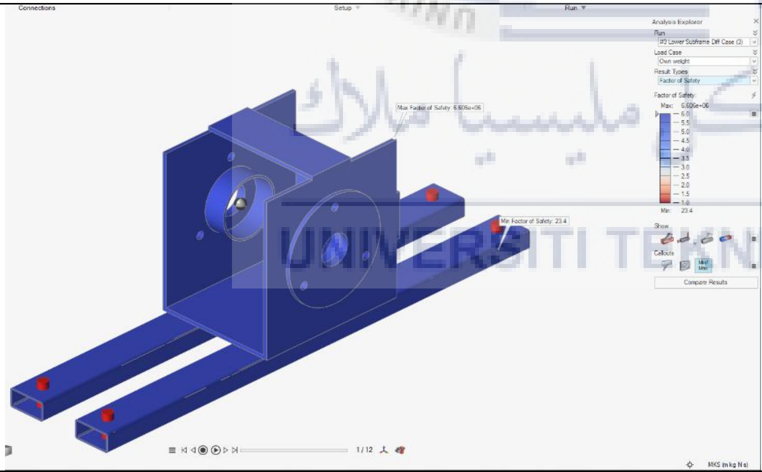
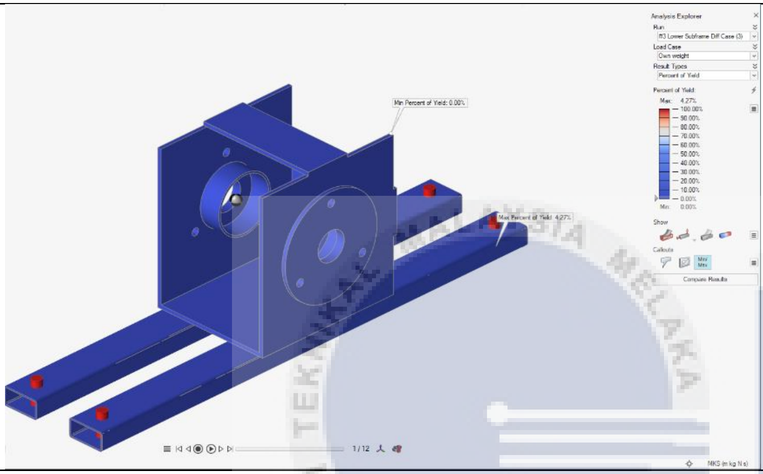
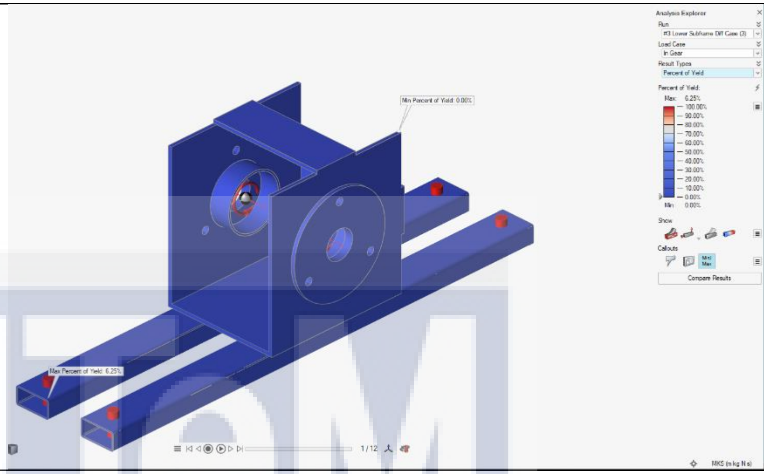
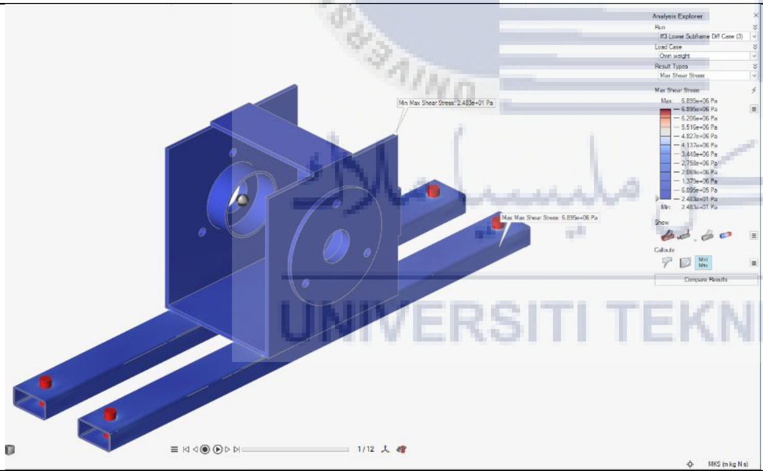
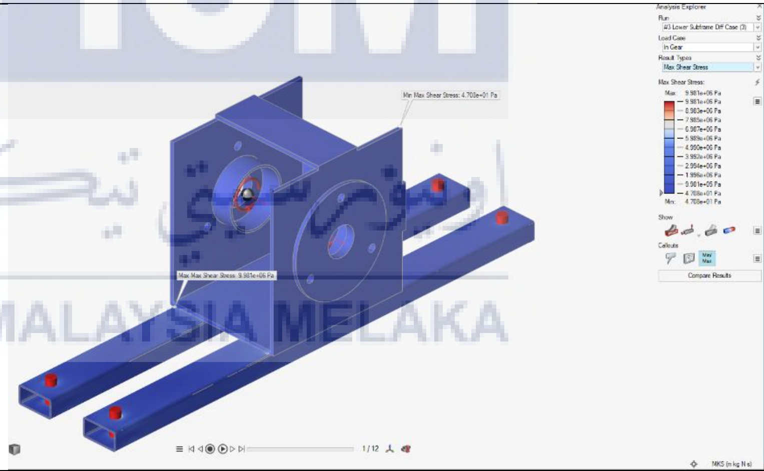
On its own weight	Kick start	In gear
Percent of Yield		
		
Maximum Shear Stress		
		

On its own weight	Kick start	In gear
Von Mises Stress		
		

APPENDIX E Simulation Result Differential Case Mounting

On its own weight	In Gear
Displacement	
	
Factor of Safety	
	

On its own weight	In Gear
Percent of Yield	
	
Maximum Shear Stress	
	

On its own weight	In Gear
Von Mises Stress