POLITEKNIK BANTING SELANGOR

AEROLAND KIT

NAME	MATRIC NO.
MUHAMMAD ALEEF IRFFAN BIN ROSLAN	24DAM21F2009
MUHAMMAD NABIL BIN TAJUL ARIFFLY	24DAM21F2005
MUHAMMAD SHAFIQ IMAN BIN SUFIAN	24DAM21F2013

DEPARTMENT OF AIRCRAFT MAINTENANCE

SESSION 2 2023/2024

POLITEKNIK BANTING SELANGOR

AEROLAND KIT

NAME	MATRRIC NO.
MUHAMMAD ALEEF IRFFAN BIN SUFIAN	**24DAM21F2009**
MUHAMMAD NABIL BIN TAJUL ARIFFLY	**24DAM21F2005**
MUHAMMAD SHAFIQ IMAN BIN SUFIAN	**24DAM21F2013**

A REPORT SUBMITTED TO DEPARTMENT OF AIRCRAFT MAINTENANCE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR A DIPLOMA ENGINEERING IN AIRCRAFT MAINTENANCE

SUPERVISOR:

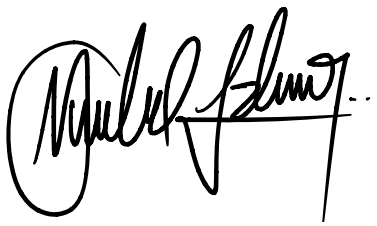
MRS. SHALHAYUNI BINTI SARIPUDEN

REPORT ENDORSEMENT

This report entitled **"AeroLand"** is being submitted, reviewed, and endorsed to fulfill the condition and requirements of report writing as specified.

Checked by:

Supervisor's Signature :



Supervisor's Stamp :

MOHD IZHAN BIN IBRAHIM
Pensyarah
Jabatan Penyenggaraan Pesawat
Politeknik Banting Selangor

Date : 25 Mei 2024

Endorsed by:

Project Coordinator's Signature :

Project Coordinator's Stamp :

MOHD ZULFAZLI B. RAUB KHAN
PENSYARAH
JABATAN PENYENGGARAAN PESAWAT
POLITEKNIK BANTING SELANGOR

Date : 25/5/2024

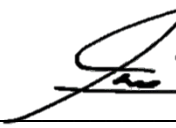
CERTIFICATE OF PROJECT ORIGINALITY & OWNERSHIP

AEROLAND KIT

SESSION: II 2023/2024

NAME	MATRIC NO.
MUHAMMAD ALEEF IRFFAN BIN ROSLAN	**24DAM21F2009**
MUHAMMAD NABIL BIN TAJUL ARIFFLY	**24DAM21F2005**
MUHAMMAD SHAFIQ IMAN BIN SUFIAN	**24DAM21F2013**

"We hereby declare that this report is the result of our own work, except excerpts That we have outlined its sources and this project will be the ownership of polytechnic."



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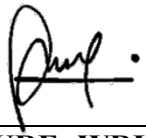

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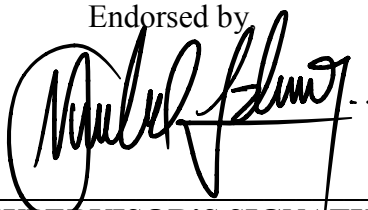
SIGNATURE: WRITER 3

Endorsed by



(SUPERVISOR'S SIGNATURE)

SUPERVISOR'S STAMP

DATE: 25 Mei 2024

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We would like to use this opportunity to express our sincere gratitude to our parents for their sacrifices, full support, and encouragement in helping us complete this end-of-semester project at Politeknik Banting Selangor.

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Once more, a big thank you to the team for their excellent collaboration in putting this into action. They continue to pour money, time, and energy into this cause until it is successful without ever realizing what hopelessness is. In fact, any kind of cooperation, whether direct or indirect, from certain parties is really appreciated by our organization. We extend our sincere gratitude to all those who participated directly, especially Politeknik Banting Selangor.

ABSTRACT

This abstract outlines the design and development of a comprehensive Landing Gear Training Kit (LGTK) aimed at enhancing the understanding and proficiency of aviation maintenance personnel and aspiring engineers. The LGTK is meticulously crafted to simulate real-world scenarios encountered in the maintenance, repair, and operation of aircraft landing gear systems. The existing methods of teaching landing gear system and operations often rely heavily on theoretical knowledge, without having something for students to visualize and interact. Moreover, the lack of access to an actual landing gear further hinders the effectiveness of aviation maintenance education. Therefore, a pressing need for an innovative solution that offers comprehensive training experiences in landing gear maintenance within a cost-effective and accessible framework. As a result, our team developed the AeroLand kit. AeroLand aims to bridge the gap between theoretical knowledge and practical skills in aviation maintenance education. The kit includes a mock-up of an aircraft landing gear system, complete with components such as wheels and indication lights. QR codes equipped with notes to guide users through various maintenance procedures, including inspection, troubleshooting, and repair tasks. Additionally, the kit is designed to be portable. Through the development of this training kit, this thesis seeks to enhance the effectiveness and accessibility of landing gear maintenance education in aviation maintenance programs. The effectiveness of the AeroLand is validated through rigorous testing and feedback loops, ensuring alignment with industry standards and regulatory requirements. In summary, the Landing Gear Training Kit represents a pioneering initiative in aviation education and training, offering a comprehensive learning experience that empowers individuals to excel in the complex domain of aircraft maintenance and engineering.

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LIST OF ABBREVIATION

AI	Artificial Intelligence
AR	Augmented Reality
IDE	Integrated Development Environment
LED	Light Emitting Diode
LGTK	Landing Gear Training Kit
MIG	Metal Inert Gas
USB	Universal Serial Bus
VR	Virtual Reality

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Aircraft landing gear plays a pivotal role in the safe and efficient operation of aircraft during takeoff and landing phases. The design, performance, and maintenance of landing gear are critical factors that directly influence the overall safety, reliability, and operational cost of an aircraft. As aviation technology continues to advance, there is a growing need to enhance the understanding and capabilities of landing gear systems to meet the demands of modern aircraft.

The aerospace industry is witnessing a paradigm shift with the development of new-generation aircraft, including those with unconventional configurations such as blended-wing bodies and electric propulsion systems. These innovations pose unique challenges for landing gear design, demanding a reevaluation of traditional approaches. Furthermore, the increasing focus on fuel efficiency, environmental sustainability, and passenger comfort necessitates continuous improvement in landing gear technology.

The operational environment for landing gear is diverse, ranging from routine landings on well-maintained runways to challenging conditions such as rough terrain, adverse weather, and emergency situations. As a result, there is a need to investigate and optimize landing gear configurations, materials, and systems to ensure optimal performance across a wide range of operating conditions.

Moreover, the impact of landing gear on overall aircraft weight, fuel efficiency, and maintenance costs cannot be overstated. Researchers and engineers are actively exploring lightweight materials, advanced manufacturing techniques, and innovative design concepts to achieve a balance between structural integrity and weight reduction. These efforts are crucial for the development of next-generation aircraft that meet stringent performance and sustainability goals.

"The landing gear is a complex system consisting of structural members, hydraulics, energy absorption components, brakes, wheels, and tires. Additional components attached to and functioning with the landing gear may include steering devices and retracting mechanisms. Of the many components, it is the structural members that support the heavy landing loads and stop the landing gear from collapsing under the aircraft weight. The materials must be strong enough to support heavy takeoff weight when an aircraft has a full load of fuel and the high impact loads on landing. Landing gear materials must therefore have high static strength, good fracture toughness, and fatigue strength, and the most commonly used materials are high-strength steel and Ti-alloy. It is possible to design a landing gear with still better energy absorption, but somewhere a compromise must be found, if the pilot can walk away without a painful back from an unintended very hard landing." (*Ajit Behera. et al, 2020)*

Based on the statement above, the landing gear system is a crucial, filled with many intricates system and components such as the energy absorption components, hydraulic system, steering devices and so on. So, in order to produce a competent aircraft technician, it is required for the education sector to implements not only about the systems but also the materials used for the landing gear.

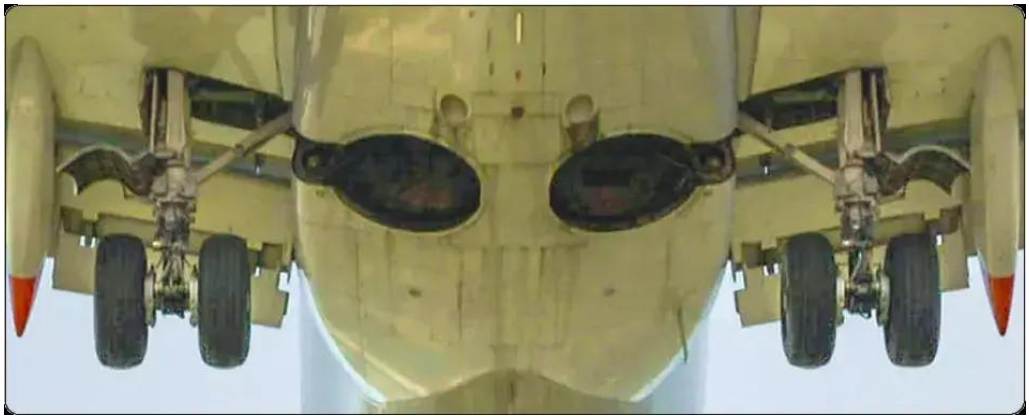


Figure 1.1: Aircraft Retractable Landing Gear (Aircraft System Tech, 2012)

Figure 1.1 shows one of many aircraft landing gear type, retractable landing gear, which most retractable gear have a close-fitting panel attached to them that fairs with the aircraft skin when the gear is fully retracted. Other aircraft have separate doors that open, allowing the gear to enter or leave, and then close again for this type of landing gear

This study aims to contribute to the existing body of knowledge by conducting a comprehensive analysis of landing gear systems, encompassing design considerations, material advancements, structural integrity, and operational performance. By addressing these critical aspects, the research endeavors to provide valuable insights for the enhancement of landing gear technology, ultimately contributing to the safety, efficiency, and sustainability of future aircraft operations.

1.2 PROBLEM STATEMENT

In the aviation industry, there exists a substantial gap between theoretical knowledge and practical experience when it comes to landing gear systems. Classroom instruction and theoretical coursework often fall short in providing students and aviation enthusiasts with

the hands-on training required to comprehend the nuances of landing gear maintenance and operation.

The problem at hand is the absence of a comprehensive and accessible training solution for landing gear systems, which results in a lack of exposure to landing gear, safety concerns, and inefficiencies in maintenance practices. There is a need for a robust and educational training kit that addresses these issues.

Also in every aircraft maintenance institution, they do not have an appropriate landing gear instrument kit as their important need to know how aircraft landing gear operate during aircraft operation. Even if they have also, the landing gear instrument will have different size. For example, the landing gear is too big and heavy. This could make troublesome for student if they want to do their practical task on the landing gear at different area. It is because the size makes it difficult for students to carry it.

Therefore, to solve this, the product is improvised from the big aircraft landing gear instrument kit to a compact aircraft landing gear instrument kit, also to improve the product weight. Therefore, it is easier for student to do their practical task on landing gear.

"The persistent hydraulic system failures exhibited by the landing gear training kit present a significant safety hazard to pilot trainees and instructors alike. Beyond disrupting training sessions, these failures raise concerns about the potential for similar malfunctions during actual flight operations, where the consequences could be catastrophic. Urgent attention to rectifying these issues and implementing stringent maintenance protocols is imperative to mitigate risks and uphold safety standards in aviation training." (*Snorri Gudmundsson, 2012)*

Most training kit in the market uses a heavier landing mechanism thus the usage of hydraulics actuators to cope with the load. This will increase the risk of hazard for the people in the vicinity of the landing gear training kit where the mechanism would malfunction and high chance for the exposed and protruding parts of the landing gear training kit would pose a threat and injured the surrounding people.

Besides, there some aircraft maintenance institution that do not have their own aircraft landing gear instrument kit at all, they will need to rent another institution landing gear instrument kit for their practical work.

In order to solve this lack of equipment, the product is designed to be aim affordable for all aircraft maintenance institution, so all the institute can give the student their own landing gear instrument kit without thinking cost for rent another instrument kit for other institute.

1.3 OBJECTIVES

1.3.1 General Project Objectives

- To design an Aeroland kit that portable as for aids of teaching.
- To develop an aircraft landing gear instrument kit as a Aeroland kit.
- To demonstrate Aeroland kit as aids of teaching.

1.3.2 Specific Individual Project Objectives

1.3.2.1 Project Structure

This project aimed:

- To design a better equipment for learning.

- To develop, and deliver an Aircraft Landing Gear Training Kit that offers a practical, aids of teaching and in general of landing gear construction.
- To bridge the gap between theoretical knowledge and practical skills.

1.3.2.2 Product Mechanism

This project aimed:

- To design a switch button for product to operate.
- To develop a mechanism of transportation by using lever actuator that connected by hydraulic actuator outside the device as for operating switch.
- To demonstrate a functional mechanism of transportation without being exposed to hazardous of over load.

1.3.2.3 Product Software/Electronic

This project aimed:

- To design a program that can help in reading situation for AeroLand Kit.
- To develop a software that using completely coding on Arduino.
- To demonstrate system that can decrease human intervention as much as possible.

1.3.2.4 Accessories & Finishing

This project aimed:

- To furnish Aeroland kit with appropriate and beneficial accessories to increase and improve its functionality.
- To finish Aeroland kit with materials or coatings that are affordable to all aircraft maintenance institute.
- To design Aeroland kit with aesthetic looks and finishing without affecting the functionality of the product.

1.4 PURPOSE OF PRODUCT

The Landing Gear Training Kit serves as an indispensable tool for aviation enthusiasts, aspiring pilots, and seasoned professionals alike. Designed to provide comprehensive training in the intricate mechanics and operations of aircraft landing gear systems, this product offers hands-on learning experiences that are both educational and engaging. With its meticulously crafted components and detailed instructional materials, the kit enables users to delve into the complexities of landing gear functionality, from understanding the principles of retraction and extension to mastering troubleshooting techniques. Whether used in classroom settings, flight training programs, or personal workshops, this versatile kit empowers individuals to develop proficiency in handling one of the most critical aspects of aviation, ultimately enhancing safety, confidence, and expertise in the skies.

1.5 PROJECT SCOPES

1.5.1 General Project Scopes

This product is specifically targets for the aircraft maintenance students who studies at aircraft maintenance institution. This product can be used in class while doing the practical task or manual work such as assembly and disassembling.

The limitation of this product is Aeroland kit only show a simple way of how aircraft landing gear operate. For example, this product only shows the way of landing gear retract and extend operation. Besides, the product also lacks of detailed diagnostic capabilities, limiting the kit's ability to identify specific issues or malfunctions within the landing gear system.

1.5.2 Specific Individual Scopes

1.5.2.1 Product Structure

Aeroland kit is simple landing gear instrument kit that encompasses a well-defined product structure designed to ensure the comprehensive functionality and reliability of the aircraft's landing gear system.

The product structure is engineered to meet stringent aviation standards, emphasizing durability, accuracy, and seamless integration with the broader avionics system for students. Through this simple but well-defined structure, the landing gear instrument kit plays a pivotal role in enhancing the overall safety, efficiency, and operational capabilities of the aircraft.

1.5.2.2 Product Mechanism

The Aeroland kit comprises a streamlined product mechanism tailored for efficient and reliable functionality within the aircraft's landing gear system. This compact system is designed with a focus on essential components, featuring sensors to detect critical parameters like altitude, ground proximity, and wheel status. These sensors feed data to a central processing unit, which interprets and communicates information to the cockpit display.

The kit's mechanism also includes a basic actuation system responsible for executing manual or automated adjustments during takeoff and landing. The simplicity of the product mechanism ensures ease of installation, operation, and maintenance, making it an ideal solution for light aircraft or general aviation applications. Despite its minimalist design, the product mechanism upholds safety standards, contributing to a dependable landing gear system that meets the fundamental needs of smaller aircraft with efficiency and effectiveness.

1.5.2.3 Product Software/Electronic

This Aeroland kit us a simple and easy software for designed to interface seamlessly with the aircraft's avionics system, translating sensor data into actionable insights for the lever actuator function. The software is programmed to monitor critical parameters such as altitude, descent rate, and wheel status, providing real-time information that aids in precise decision-making during takeoff and landing. The software's algorithmic capabilities contribute to automated adjustments, enhancing the overall efficiency of the landing gear operation.

Moreover, the simplicity of the electronic system ensures user-friendly interactions, making it an accessible solution for a wide range of pilots. As aviation technology

continues to evolve, the role of electronic software in landing gear instrument kits remains indispensable for ensuring safe, reliable, and efficient aircraft operations.

1.5.2.4 Accessories & Finishing

Since there's a lot of type landing gear regarding the type of aircraft, Aeroland kit is designed to be able to show how aircraft landing gear operate in general without focusing on one type of landing gear only.

Other than that, the project is to be finished with coatings and materials that are able to bring down the exposure of the personnel to hazardous if it is overweight.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL LITERATURE REVIEW

2.1.1 Aviation Industry in Malaysia

The aviation industry's relationship with landing gear training kits is integral to the development and sustainability of a skilled workforce capable of ensuring the safety and reliability of aircraft operations. Landing gear, being a critical component of an aircraft, demands specialized knowledge and hands-on expertise from aviation professionals, especially maintenance technicians. As aviation technology evolves, aircraft manufacturers introduce increasingly sophisticated landing gear systems. In response to these advancements, the aviation industry seeks training solutions that go beyond theoretical knowledge, and landing gear training kits become invaluable tools for providing practical, real-world experience to professionals in the field. *(Malaysian Aviation Commission, 2018)*

One of the primary drivers for the adoption of landing gear training kits in the aviation industry is the emphasis on safety and regulatory compliance. Aviation authorities worldwide, including the Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA), set stringent standards for aircraft maintenance and safety. Training programs incorporating landing gear kits enable technicians to familiarize themselves with maintenance procedures, troubleshooting techniques, and emergency protocols specific to landing gear systems. This hands-on training is crucial for ensuring that aviation professionals are well-prepared to meet regulatory requirements and contribute to the overall safety of air travel.

Furthermore, the aviation industry's reliance on landing gear training kits is closely tied to the ongoing need for skills development and workforce readiness. As the industry faces a shortage of skilled aviation maintenance technicians, these training kits play a pivotal role in training the next generation of professionals. They offer a practical and interactive learning environment, allowing technicians to gain confidence in handling complex landing gear systems before they encounter them in actual operational scenarios. This proactive approach not only enhances the competency of aviation professionals but also contributes to reducing maintenance errors and improving overall operational efficiency in the aviation sector.

Lastly, the aviation industry's engagement with landing gear training kits aligns with broader trends in technological innovation. The integration of advanced features such as augmented reality, virtual reality, and interactive simulations in these kits reflects the industry's commitment to embracing cutting-edge tools for training and education. By incorporating modern technologies, aviation training programs ensure that professionals are well-versed in the latest advancements in landing gear systems, preparing them to adapt to the evolving landscape of aviation and contribute to the industry's growth and resilience in the long term. (*J M Peterson, 2014)*

2.1.2 Demand for Aircraft Landing Gear Training Kit

The demand for aircraft landing gear training kits in the aviation industry is driven by the industry's constant need for well-trained and highly skilled aviation maintenance professionals. As aircraft technology advances, there is a growing emphasis on ensuring that maintenance technicians are equipped with the practical knowledge and hands-on skills required to address the complexities of landing gear systems. The intricate nature of landing gear components, including struts, wheels, brakes, and retraction mechanisms, necessitates specialized training to ensure the safety, reliability, and efficiency of aircraft operations. Consequently, the aviation industry is increasingly recognizing the value of training kits that provide a realistic and immersive learning experience, allowing maintenance personnel to practice procedures, conduct troubleshooting, and familiarize themselves with the intricacies of landing gear systems.

Moreover, the demand for landing gear training kits is fueled by the regulatory requirements and certification standards set by aviation authorities. Organizations such as the Civil Aviation Authority Malaysia (CAAM) emphasize the importance of practical training and hands-on experience in addition to theoretical knowledge. Landing gear is a critical component of an aircraft's structure, and thorough training is essential to meet the stringent safety and maintenance standards enforced by regulatory bodies. As a result, aviation maintenance training programs seek comprehensive solutions like training kits to meet these requirements and produce graduates who are well-prepared to contribute to the industry.

Furthermore, the demand for landing gear training kits is heightened by the increasing complexity of modern aircraft. With advancements in materials, technology, and design, landing gear systems have become more sophisticated. Training kits that incorporate features such as 3D models, augmented reality, and virtual reality not only meet the industry's demand for practical training but also align with the industry's trajectory towards embracing cutting-edge technologies. As airlines and aircraft manufacturers continue to

invest in state-of-the-art equipment, the demand for training solutions that keep pace with these advancements remains robust. In summary, the demand for aircraft landing gear training kits is driven by the industry's commitment to safety, regulatory requirements, and the necessity to prepare maintenance professionals for the evolving landscape of modern aviation.

2.1.3 Types of Aircraft Landing Gear Training Kit in Market

Landing gear training kits are instrumental in providing comprehensive education about aircraft landing gear systems, catering to the needs of aspiring pilots and maintenance personnel. These kits are diverse in their approaches, offering various types to address distinct facets of training and knowledge acquisition. (*Pilot Institute, 2022)*

Static training kits serve as an initial point of engagement, featuring non-moving, static models of landing gear components. This foundational level aids students in becoming acquainted with the intricate parts that constitute a landing gear system. Moving beyond static models, functional training kits introduce an interactive element, with manipulable landing gear components simulating real-world scenarios. This allows students to grasp the dynamic aspects of landing gear operation without requiring physical interaction.

For a more immersive experience, computer-based simulators have become increasingly popular. These virtual environments enable students to practice landing gear-related procedures and troubleshooting in simulated scenarios, providing a realistic and risk-free learning experience. Hydraulic systems training kits are designed to specifically focus on the hydraulic components associated with landing gear operation, helping students understand the principles and maintenance procedures related to hydraulic systems, a critical aspect of many landing gear configurations.

2.1.3.1 Model Kits

Physical model landing gear training kits are tangible, three-dimensional replicas of actual landing gear components, such as struts, wheels, and brakes. These kits provide hands-on learning experiences, allowing users to touch, feel, and visually inspect the various parts of the landing gear system. Physical model kits are particularly useful for basic familiarization and understanding of the physical structure of landing gear components. They are valuable in introducing students or aviation maintenance technicians to the tactile aspects of the landing gear, enhancing their ability to identify and recognize components in real-world scenarios.

Figure 2.1: Avotek Landing Gear Training Kit *(Google, n.d.)*

2.1.3.2 Cutaway Models

Cutaway landing gear training kits offer a unique perspective by providing cross-sectional views of landing gear components. These kits allow users to see the internal workings of the landing gear, revealing the mechanisms and structures that are otherwise hidden. Cutaway models are especially beneficial for illustrating the intricate internal systems of

landing gear, aiding in the comprehension of how different components function together during various phases of operation. This type of kit enhances the user's understanding of the internal complexities of landing gear systems, making it a valuable tool for advanced training.

2.1.3.3 Virtual Reality (VR) Kits

Virtual reality landing gear training kits leverage VR technology to create immersive and interactive learning environments. Users wear VR headsets to enter a simulated world where they can explore and interact with virtual landing gear components. *(Ali Gunawan, Nivendy Wiranto & Daldwin wu, 2022)*.

VR kits offer a high degree of realism, allowing users to visualize and manipulate virtual components in three dimensions. These kits are particularly effective in providing a dynamic and engaging learning experience, enabling users to practice procedures, troubleshoot issues, and gain a deeper understanding of landing gear operations within a virtual setting.

2.1.3.4 Augmented Reality (AR) Kits

Augmented reality landing gear training kits blend digital information with the real-world environment. Users typically use tablets or smart glasses to view digital overlays and annotations on physical landing gear components. (*Mehmet Kesim & Yasin Ozarslan, 2012)*.

AR kits enhance the user's real-world view with additional information, making it easier to understand complex systems while still interacting with physical components. This type of kit is versatile, offering a balance between the tangible elements of physical models and the digital enhancements of virtual environments, providing an enriched learning experience.

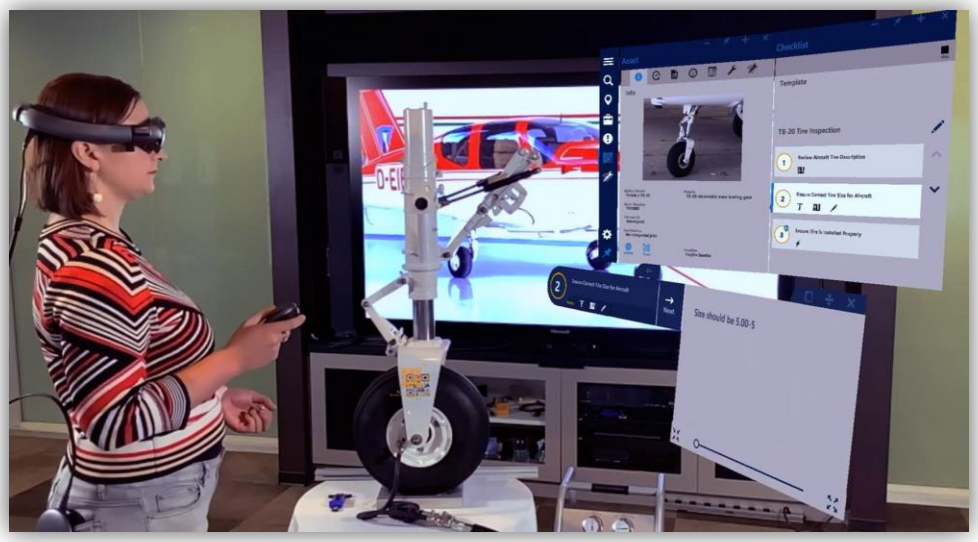


Figure 2.2: AR Landing Gear Training Kit *(Google, n.d.)*

2.1.3.5 Computer-Based Simulators

Computer-based landing gear training simulators run on desktop computers or laptops and offer software-based training modules. These simulations can range from basic animations to more complex scenarios, allowing users to interact with landing gear systems in a virtual environment. Simulators provide a flexible and cost-effective solution for training, often including features such as interactive quizzes, assessments, and varying levels of difficulty. They are suitable for both introductory training and advanced scenarios, catering to a wide range of users with diverse learning objectives.

2.1.3.6 Integrated Training Systems

Integrated landing gear training systems encompass a combination of physical components, virtual elements (VR or AR), and computer-based simulations. These comprehensive kits aim to provide a holistic and immersive training experience. Users can interact with physical models, explore virtual environments, and engage in simulated

scenarios, creating a well-rounded approach to landing gear training. Integrated systems offer versatility, accommodating different learning styles and providing a comprehensive educational solution for aviation maintenance professionals, students, and enthusiasts seeking a thorough understanding of landing gear operations.

2.2 SPECIFIC LITERATURE REVIEW

2.2.1 Product Structure

2.2.1.1 Basic design of main structure

A landing gear training kit with a rectangular structure is a thoughtfully designed educational tool, featuring a systematic product structure that enhances accessibility, organization, and practicality for learners studying aircraft landing gear systems. The rectangular shape of the kit allows for easy handling, storage, and transport, making it a convenient and versatile resource.

In response to the demand for user-friendly technology, the rectangular training kit integrates a section for computer-based components. This compartment includes a user-friendly interface and intuitive software that allows learners to navigate through virtual landing gear simulations easily. The design focuses on simplicity, ensuring that users can operate the digital aspects of the kit without unnecessary complexity.

In conclusion, the product structure of this rectangular training kit emphasizes portability, effectiveness, and ease of operation. Its compact design, intuitive organization of instructional materials, static and functional models, and user-friendly digital components

contribute to a well-rounded and accessible learning experience for individuals studying aircraft landing gear systems. (*Plabita Sonowal, K.M. Pandey & K.K. Sharma, 2021)*

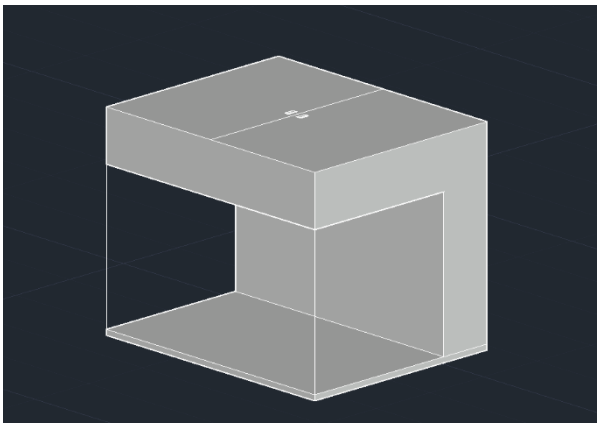


Figure 2.3: 3D model of Aeroland kit in AutoCAD

2.2.1.2 Type of material used for product structure

1. Metal pole

Utilizing metal poles as a structural framework for a landing gear training kit brings several advantages that contribute to the overall effectiveness and longevity of the educational tool. Firstly, the inherent strength and durability of metal, particularly steel or aluminum alloys, provide a robust foundation for the training kit. This durability ensures that the structure can withstand frequent handling, manipulation, and potential impacts, making it well-suited for the interactive nature of landing gear training. The resilience of metal poles translates to a longer lifespan for the training kit, minimizing the need for frequent replacements and enhancing cost-effectiveness.

Secondly, metal poles offer exceptional stability and rigidity to the structure. This stability is crucial for maintaining the integrity of the training kit, especially when it involves dynamic components or simulations. Learners can confidently interact with the kit, knowing that the structure remains stable and secure. This advantage is particularly

relevant in creating a safe and conducive learning environment where trainees can focus on understanding landing gear systems without concerns about the structural stability of the training apparatus.

Lastly, the versatility of metal poles allows for a customized and optimized design of the landing gear training kit. These poles can be easily shaped and configured to meet specific requirements, accommodating the diverse components and features of the training kit. Whether supporting static models, providing a framework for moving components, or integrating electronic elements, the adaptability of metal poles facilitates a tailored design that aligns with the educational objectives of the landing gear training program.

Figure 2.4: Hollow Metal Square Pole *(Google, n.d.)*

2. Perspex panel

Opting for Perspex panels as a structural material for a landing gear training kit introduces several advantages, primarily centered around transparency, lightweight construction, and ease of customization. Perspex, a brand name for acrylic glass, is known for its clarity, allowing for transparent panels that offer a clear view of the internal components. This

transparency is particularly advantageous in a training context, enabling learners to observe the intricate details of landing gear systems in action. The see-through nature of Perspex panels enhances the educational experience, allowing for visual comprehension and aiding in the explanation of complex concepts.

In addition to transparency, Perspex panels contribute to the lightweight construction of the training kit. Acrylic glass is significantly lighter than traditional materials like metal, making the kit more portable and user-friendly. This characteristic is especially beneficial in training environments where mobility and flexibility are essential. The lightweight nature of Perspex panels simplifies the assembly and disassembly process, enabling easy transport and setup in various locations, promoting adaptability and convenience for training sessions.

Furthermore, Perspex panels are easily customizable, allowing for flexibility in design and layout. We can shape, cut, and mold the panels to create a tailored structure for the landing gear training kit. This adaptability facilitates the integration of various components, accommodating the specific needs and educational objectives of the training program. The ease of customization enables the creation of engaging and interactive training scenarios, enhancing the overall effectiveness of the learning experience for individuals studying aircraft landing gear systems.

Figure 2.5: Perspex Transparent Clear Panel *(Desertcart, n.d.)*

2.2.2 Product Mechanism

A simple landing gear mechanism for a training kit typically consists of the main landing gear, nose landing gear, and associated components to mimic the fundamental features of an aircraft's landing gear system. The main landing gear, positioned beneath the wings, supports the aircraft during landing and taxiing. In the training kit, this can be represented by a set of fixed or retractable wheels. Similarly, the nose landing gear, located at the front of the aircraft, provides support for the nose section. Its representation in the training kit may involve a wheel or set of wheels, and depending on the level of simulation, it can be designed as either fixed or retractable. (*Hong-Tu Luo, 2018)*

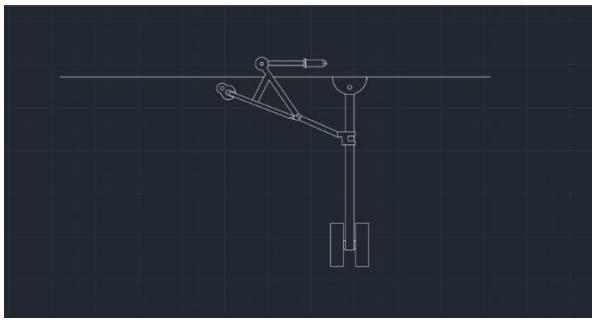


Figure 2.6: Simplified Landing Gear Extend and Retract Mechanism

2.2.2.1 Actuator

Linear Actuator

Linear actuators offer a range of advantages across various applications, thanks to their simplicity, precision, and versatility. One key advantage is their straightforward design, which translates into ease of use and maintenance. Linear actuators typically consist of a motor, a lead screw, and a nut, providing a linear motion output. This simplicity not only makes them easy to install but also reduces the likelihood of mechanical failures,

contributing to their overall reliability. The uncomplicated structure of linear actuators makes them a cost-effective and practical choice for applications where a straightforward linear motion is required.

Precision is another significant advantage of linear actuators. These devices are capable of providing accurate and repeatable positioning, making them suitable for applications demanding precise control over motion. This precision is crucial in various industries, including manufacturing, robotics, and automation, where controlled and predictable movements are essential. Linear actuators can be easily integrated into systems requiring intricate positional adjustments, ensuring that the desired outcomes are achieved consistently and with a high degree of accuracy.

Versatility is a key aspect that sets linear actuators apart. They come in various sizes and load capacities, making them adaptable to a wide range of applications. Linear actuators find utility in scenarios where controlled and programmable linear motion is needed, such as in opening and closing doors, adjusting solar panels, or positioning medical equipment. The ability to customize linear actuators based on specific requirements enhances their versatility, making them suitable for diverse industries and applications

Figure 2.7: Linear Actuator with 12V 2.6 Ah *(Google, n.d.)*

2.2.2.2 Battery

Rechargeable Battery

Rechargeable batteries offer several advantages that contribute to their widespread use in various electronic devices and applications. One significant benefit is cost-effectiveness. While rechargeable batteries may have a higher upfront cost compared to disposable batteries, their ability to be recharged and reused multiple times results in long-term savings. Users can recharge the batteries hundreds or even thousands of times, reducing the need for frequent replacements and minimizing the environmental impact associated with disposable batteries.

Environmental sustainability is another crucial advantage of rechargeable batteries. By reducing the number of batteries disposed of in landfills, rechargeable batteries help minimize the environmental footprint associated with battery waste. The materials used in rechargeable batteries, such as nickel-metal hydride (NiMH) or lithium-ion, are generally less harmful to the environment compared to the toxic components found in disposable batteries. This makes rechargeable batteries an eco-friendlier choice, aligning with global efforts to promote sustainable practices and reduce electronic waste.

Convenience is a key factor that makes rechargeable batteries advantageous for many users. The ability to recharge batteries at home or on the go provides a continuous and reliable power source for electronic devices. This is particularly beneficial for devices with high energy consumption and also great for confined space as it was small in size.

Figure 2.8: Rechargeable Battery with 12V 2.6Ah *(Tokkoyo, n.d.)*

2.2.3 Software / Programming

2.2.3.1 Autodesk AutoCAD 2023

AutoCAD, developed by Autodesk, is a widely-used computer-aided design (CAD) software that serves as a powerful tool for professionals in architecture, engineering, and design. Offering a versatile platform, AutoCAD enables users to create precise and detailed 2D drawings as well as complex 3D models. Its intuitive interface, featuring a command line and graphical user interface, facilitates efficient navigation and execution of commands. AutoCAD's extensive set of drawing and drafting tools, coupled with customization options, allows users to create, edit, and annotate designs with ease. As an industry standard, AutoCAD continues to evolve, incorporating new features to meet the evolving needs of designers and architects, making it an indispensable software for digital design and drafting across various disciplines.

Figure 2.9: Autodesk AutoCAD

2.2.3.2 Arduino

Arduino is an open-source electronics platform designed for hobbyists, students, and professionals to create and prototype interactive electronic projects. It consists of a physical programmable circuit board (often referred to as the Arduino board) and a user-friendly Integrated Development Environment (IDE). The Arduino board is equipped with input and output pins that can be easily connected to sensors, actuators, and other electronic components. Users can write code in the Arduino IDE, which is based on the C++ programming language, to define the behavior of their projects. With its simplicity and accessibility, Arduino has become a popular choice for individuals interested in learning and experimenting with electronics, coding, and creating a wide range of projects, from simple LED displays to complex robotics and automation systems. There are two types of Arduinos.

A. Arduino Uno

The Arduino Uno is a widely used open-source microcontroller board that serves as a versatile platform for electronics enthusiasts and makers. It features the Atmega328P microcontroller, providing 14 digital input/output pins, six of which support PWM, and six analog input pins. The board's USB interface allows for easy programming and power supply, making it accessible for both beginners and experienced users. With a clock speed of 16MHz, compatibility with various sensors and shields, and a robust community, the Arduino Uno is an ideal choice for prototyping and developing a diverse range of projects, from simple LED displays to complex robotics applications.

Figure 2.10: Arduino Uno *(Google, n.d.)*

B. Arduino nano

The Arduino Nano is a compact and versatile microcontroller board that shares many features with its larger counterpart, the Arduino Uno. It is equipped with the ATmega328P microcontroller, providing 22 digital input/output pins, eight of which support PWM, and 14 analog input pins. Despite its small form factor, the Nano retains the USB interface for

programming and power supply, making it suitable for projects with space constraints. With a clock speed of 16MHz and compatibility with a wide range of sensors and shields, the Arduino Nano is well-suited for prototyping and developing various electronic projects, offering a balance between size, functionality, and flexibility.

Figure 2.11: Arduino Nano *(Google, n.d.)*

2.2.3.3 ChatGPT

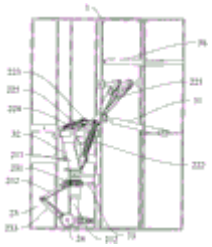
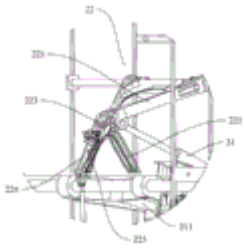
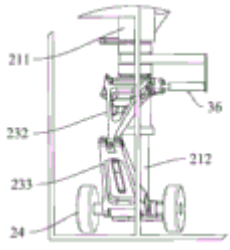
ChatGPT is a state-of-the-art language model developed by OpenAI, based on the GPT-3 architecture, designed to understand and generate human-like text. While it excels in natural language understanding and generation, it is not specifically tailored for coding tasks. It can assist with discussing coding concepts, providing explanations, and offering general programming advice. However, for hands-on coding tasks, dedicated programming environments and tools, such as integrated development environments (IDEs) and code editors, are more suitable. ChatGPT's proficiency lies in its ability to generate coherent and contextually relevant responses across a broad spectrum of topics, including coding and programming, making it a valuable resource for engaging in discussions and gaining insights in the field. (*Kayla DePalma & Izabel Miminoshvili, 2024)*

Figure 2.12: ChatGPT to Assist with Coding and Troubleshooting *(Google, n.d.)*

2.3 Review of Recent Research / Related Products

2.3.1 Related Patented Product

No.	Patented Product	Patent summary
1.		**Patent title**: A kind of flight simulation subsystem of simulated flight device **Patent no**.: CN110471313A **Publish date**: 2019-11-19 **Patent Office Country**: Shanghai, China. **Inventors**: Liang Lin, Feng Lingzhi, Wang Yanjun, Luo Jianbang, Xu Jiachun, Sun Liwei, Lin Qiaoyue **Abstract**: The invention discloses a kind of flight simulation subsystems of simulated flight device, comprising: aerodynamic model, equation of motion model, Landing gear model, steerable system model, fuel system model, propulsion system model and atmospheric environment model. The emulation subsystem comprehensively considers whole factors and data in aircraft flight, the flight parameters such as posture, position, speed and the height of real-time

		simulation aircraft, air flight environment can be reappeared, be more advantageous to assisting in flying person taken off, landed, being climbed, being turned, the training such as maneuvering flight The simulation objectives of output are more acurrate ; Further, these flight parameters can also be transmitted to other subsystems, input parameter as the driving instruction of other subsystems and operation.
2.	  	**Patent title**: Aircraft nose landing gear teaching model **Patent no**.: CN215730493U **Publish date**: 2022-02-01 **Patent Office Country**: Nanjing, China. **Inventors**: Jin Ran, Zhang Hengheng, Jiang Weihua, Zhao Caixia **Abstract**: The utility model discloses an airplane nose landing gear teaching model, which comprises a model fixing frame, a nose landing gear model and a hydraulic driving system, wherein the model fixing frame is arranged on the nose landing gear model; the nose landing gear model is arranged on the model fixing

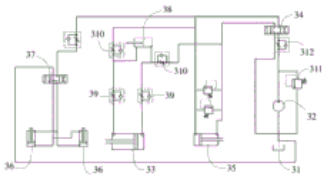
		frame; the hydraulic driving system comprises an oil supply device consisting of an oil cylinder and an oil pump, and further comprises a plurality of hydraulic cylinders and a plurality of control valves, wherein the hydraulic cylinders are used for driving the nose landing gear model to execute retraction and steering actions. The model design and the hydraulic control technology are adopted to display the real structure and function of the airplane nose landing gear to the maximum extent, the model can be used as a teaching tool for civil aviation courses, students can be helped to understand the structure and function of the landing gear more intuitively and more specifically when the students cannot contact the physical object of the landing gear, the model is favorable for guiding the students to explore and learn, and the model has important significance for training the scientific exploration capability of the students.

Table 2.1: Related patented product

2.3.2 Recent market product

No.	Market Product	Product summary
1.		Product name: Hydraulic Landing Gear Training System AL14 Publish year: 2007 Inventors: Avotek Description: If a landing gear system and a hydraulics training system are both on the AMT school wish list, then the Avotek AL14 Training System can fill both needs for the cost of one. This Hydraulic Landing Gear System is fully operational. Included in the unit are a complete brake system from pedal to wheel; a gear section that includes the gear, wing section and gear doors; hydraulic pump and power pack; sensors, switches and indicators. Unit requires 110V AC to run the hydraulic pump

2.		Product name: HYD-100A Publish year: 2020 Inventors: ADF (DIDACTIC ENGINEERING EXPERIMENTAL DESIGN) Description: HYD-100A Landing Gear Module for offers effective hands-on training for aircraft landing gear system maintenance trainees. It assures that technicians are trained to maintain the landing gear system in the best way possible and in accordance with safety standards. It displays the landing gear mechanism as found in actual aircraft. This trainer is designed to represent a landing gear system. It contains all components and assemblies of an actual hydraulic landing gear system. Model HYD – 100A features complete wheel and tire assembly with hydraulic brake system, including master cylinder and brake pedal. The control unit includes control throttles for landing gear and hydraulic flap operation. Indicators demonstrate show up, down, and in-transition conditions. A throttle warning horn is also mounted on the control panel.

Table 2.2: Recent Market Products

2.4 Comparison Between Recent Research and Current Project

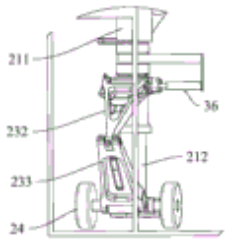
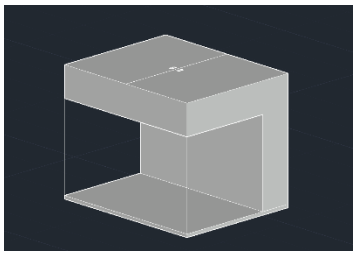
Product	Aircraft nose landing gear teaching model	AeroLand Kit (Current Project)	Avotek Hydraulic Landing Gear Training System AL14
Design			
Able to extend and retract	yes	yes	yes
Price	expensive	Affordable	expensive
portability	no	yes	no
Easy to operate	no	yes	no
Overall size	big	small	big
Features	- Detailed operation about landing gear mechanism.	- A great teaching aid for instuctor to help student visualize.	- A detailed mechanism of landing gear with every features there are on a real landing gear.

Table 2.3: Comparison Between Recent Research and Current Project

CHAPTER 3

RESEARCH METHODOLOGY

3.1 PROJECT BRIEFING & RISK ASSESMENT

This chapter will detail the different steps that were successfully performed in order to achieve the experiment's goals and objectives. These included completing the relevant documents and obtaining supervisor permission. Throughout the duration of the project. Several phases are involved in the manufacturing of hazardous materials such as aluminum sheet and acrylic board. Cutting, riveting, painting, and testing are all part of the process. The team took this safety precaution seriously.

3.1.1 Utilization of Polytechnic's Facilities

To use all the facilities supplied by Polytechnic, such as equipment, consumable materials, and tools, permission must be obtained from the supervisor and workshop coordinator by filling out the relevant paperwork. This form will detail the tools and equipment that is being used in order to execute the project.

3.2 OVERALL PROJECT GANTT CHART

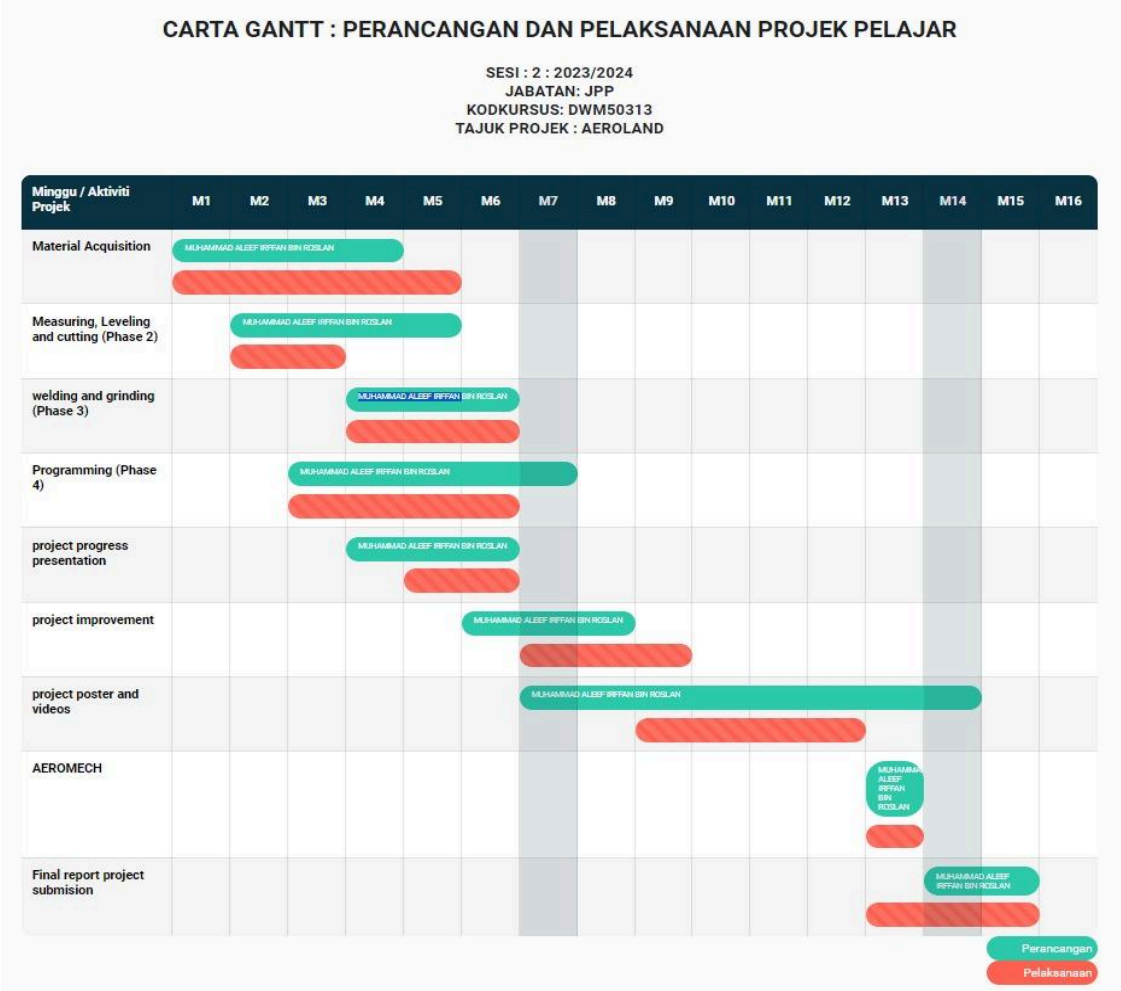


Figure 3.1: Gantt Chart Table

3.3 PROJECT FLOW CHART

3.3.1 Overall Project Flow Chart

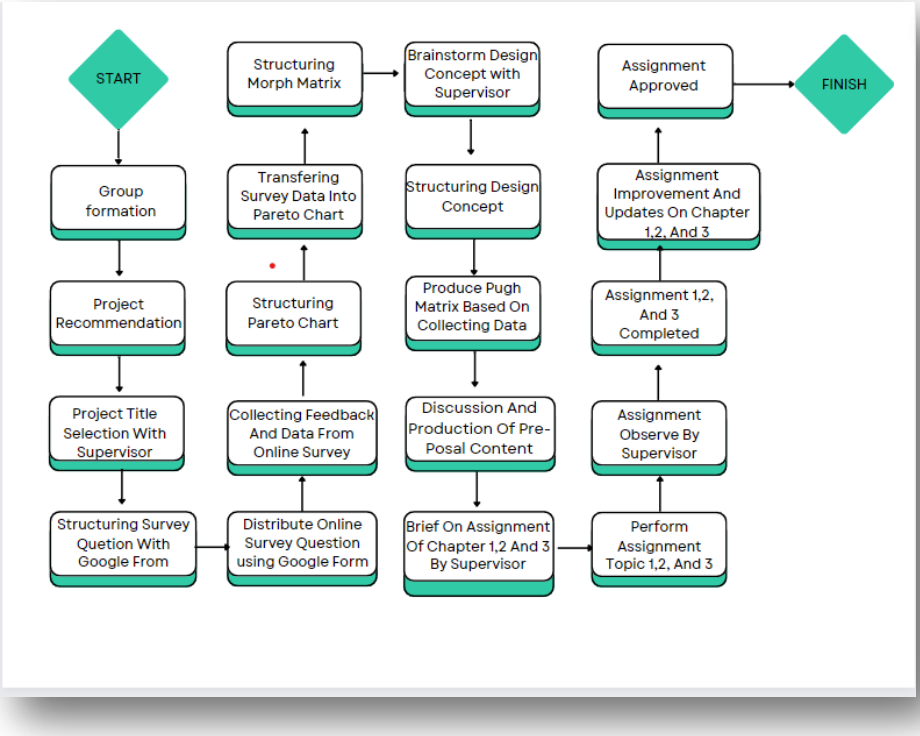


Figure 3.2: Overall Project Flow Chart for Aeroland Kit

3.3.2 Specific Project Design Flow/Framework

3.3.2.1 Product Structure

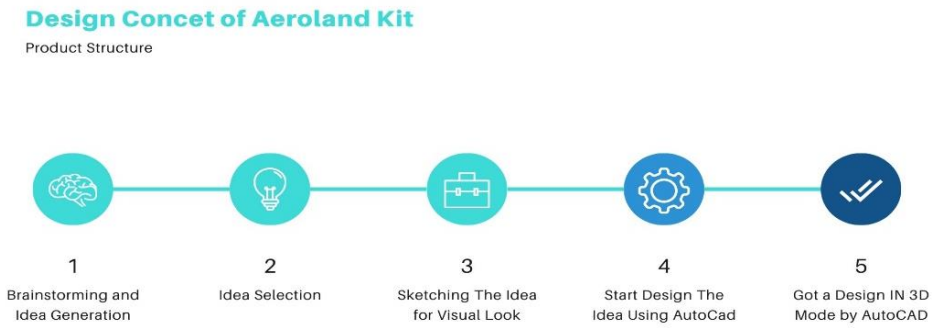


Figure 3.3: Product Structure for Aeroland Kit

3.3.2.2 Product Mechanism

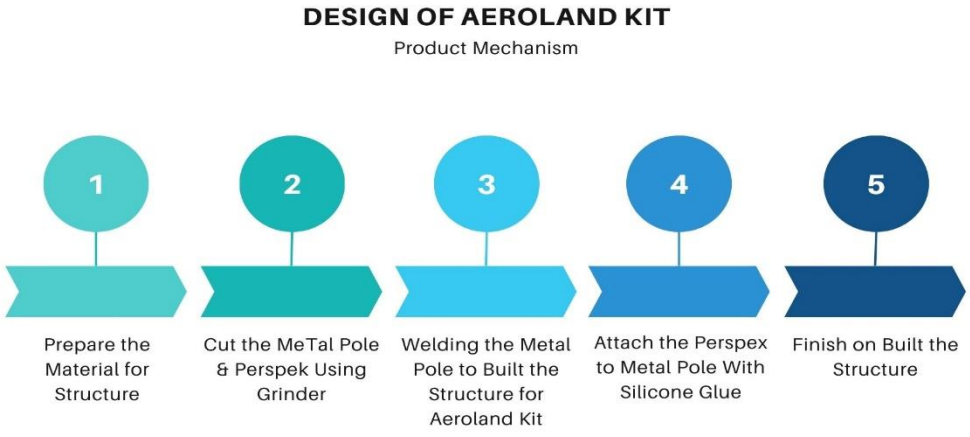


Figure 3.4: Product Mechanism of Aeroland Kit

3.3.2.3 Software/Programming

Figure 3.5: Software/Programming for Aeroland Kit

3.4 DESIGN ENGINEERING TOOLS

3.4.1 Design Requirement Analysis

3.4.1.1 Questionnaire Survey

A questionnaire is a structured set of written or electronic questions designed to collect information or opinions from individuals or a group of people. It is a widely used method

in research, surveys, and data collection, aiming to gather standardized and quantifiable data on a particular subject or topic. Questionnaires can be administered in various formats, including paper-based forms, online surveys, or interviews, and they may cover a broad range of topics, from demographic information to attitudes, behaviors, preferences, or experiences. The questions in a questionnaire are carefully crafted to elicit specific and relevant responses, and the collected data can be analyzed to draw conclusions, make informed decisions, or gain insights into the perspectives of the surveyed individuals.

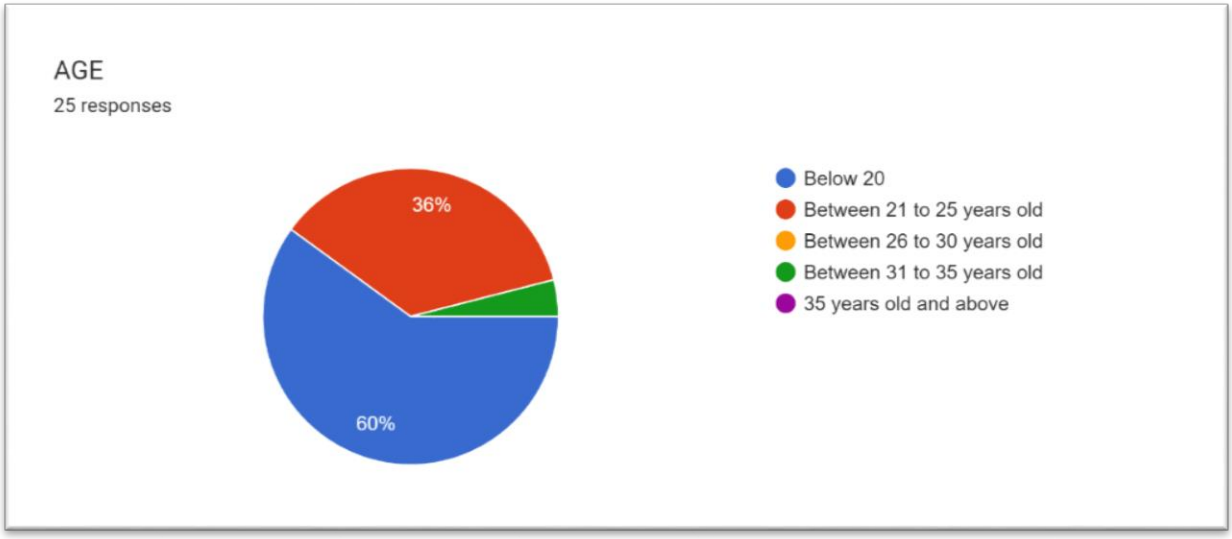


Figure 3.6: Age

This is the example data from our questionnaire by using google form. Our respondents were majority below 20 years old and between 21 to 25 years old. But minority were between 31 to 35 years old. Our target is achieved which is to get over 20 responses.

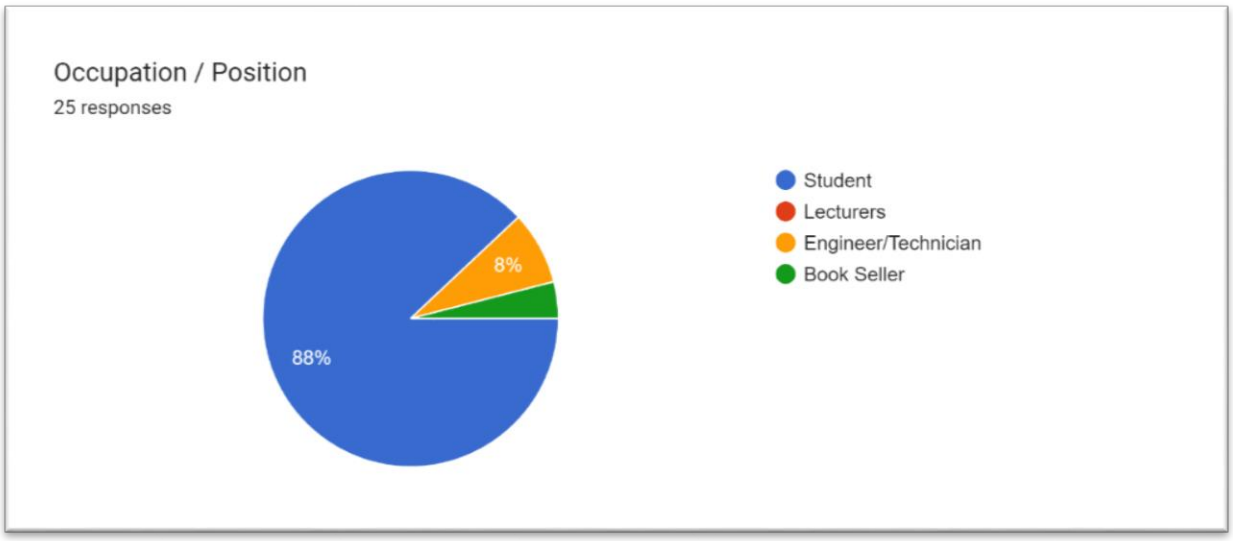


Figure 3.7: Occupation

Based on the charts, it is clear that most of our respondents are students but not just from our polytechnic, some of them also from another institute. There are also people who work as lecturers and engineer but the majority are student.

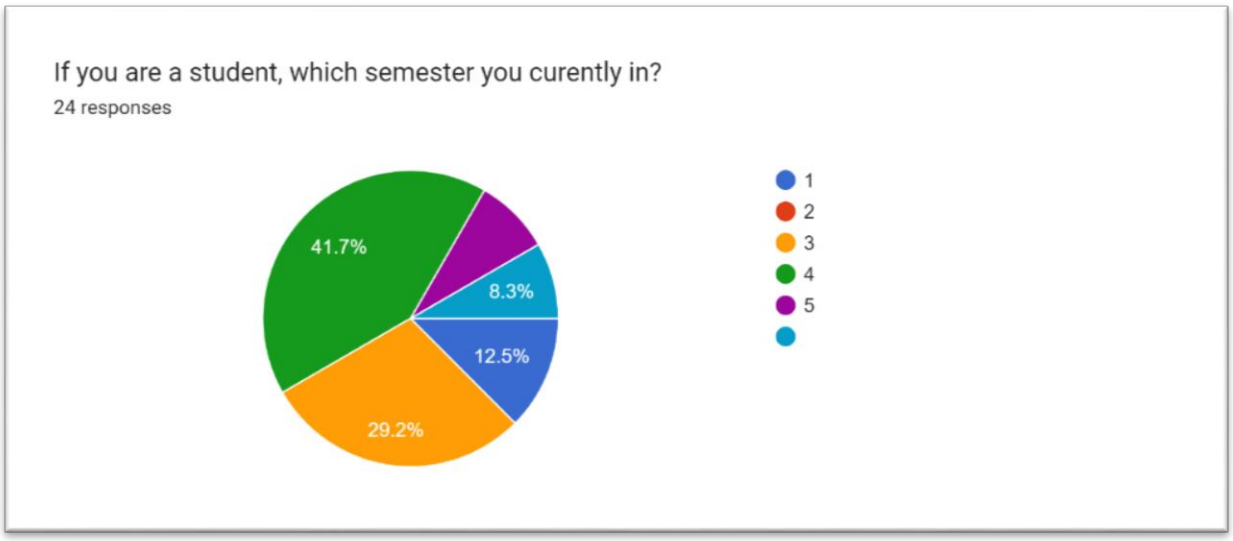


Figure 3.8: Current Semester

Based on our survey, the majority students' semester that answer this survey are semester 3 and semester 4. Meanwhile, the minority are semester 1, semester 5 and other people that are not student.

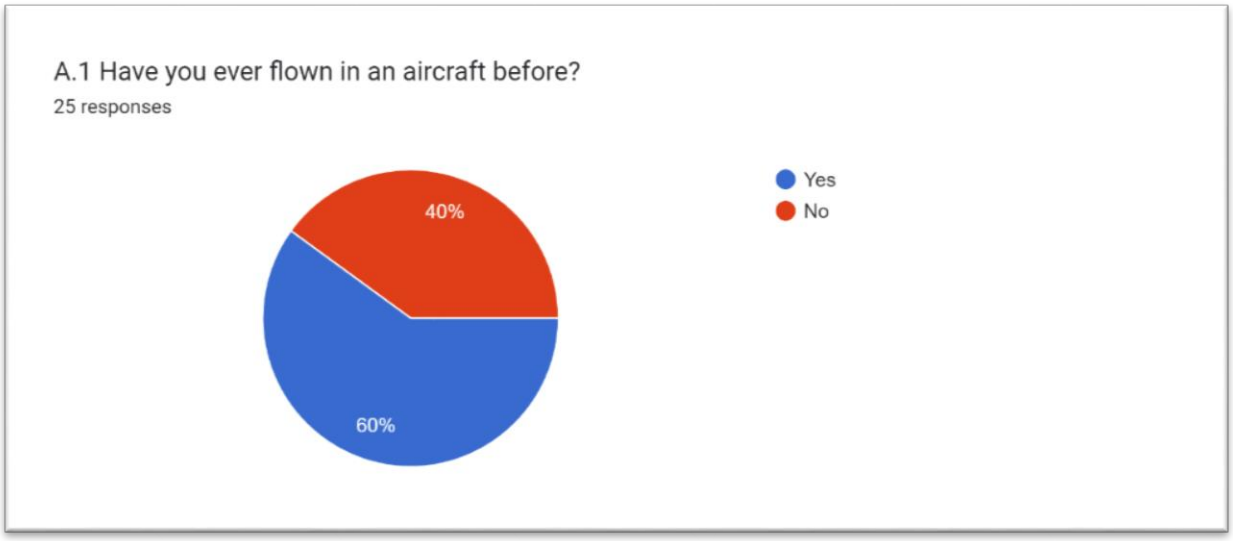


Figure 3.9: Experience flown in aircraft

For the next survey, we ask the respondent about experience on taking a flight. The majority of respondent have flown in aircraft which is about 60% of the respondent while 40% of the respondent never have flown in an aircraft before.

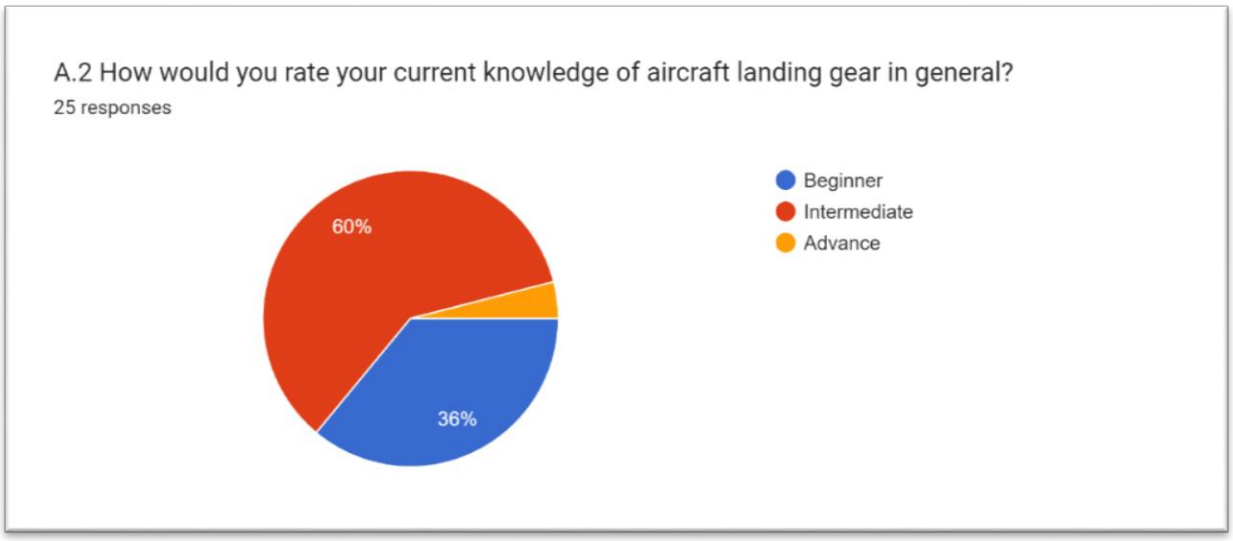


Figure 3.10: Knowledge about landing gear

Based on the survey above, we questioned people about their experience and knowledge on aircraft landing gear which is based on certain level beginner, intermediate, and advance. The majority of respondent knowledge on aircraft landing gear are intermediate followed by beginner then advance.

3.4.1.2 Pareto Diagram

Features	Frequency	Cummulative Percentage	Pareto Baseline
Aesthethic	9	9%	80%
Strength	14	24%	80%
Reliability	11	35%	80%
Safety	17	53%	80%
Workability	14	67%	80%
Effectiveness	19	87%	80%
Ease of use	13	100%	80%
GRAND TOTAL	97		

Figure 3.11: Pareto table for feature on Aeroland Kit

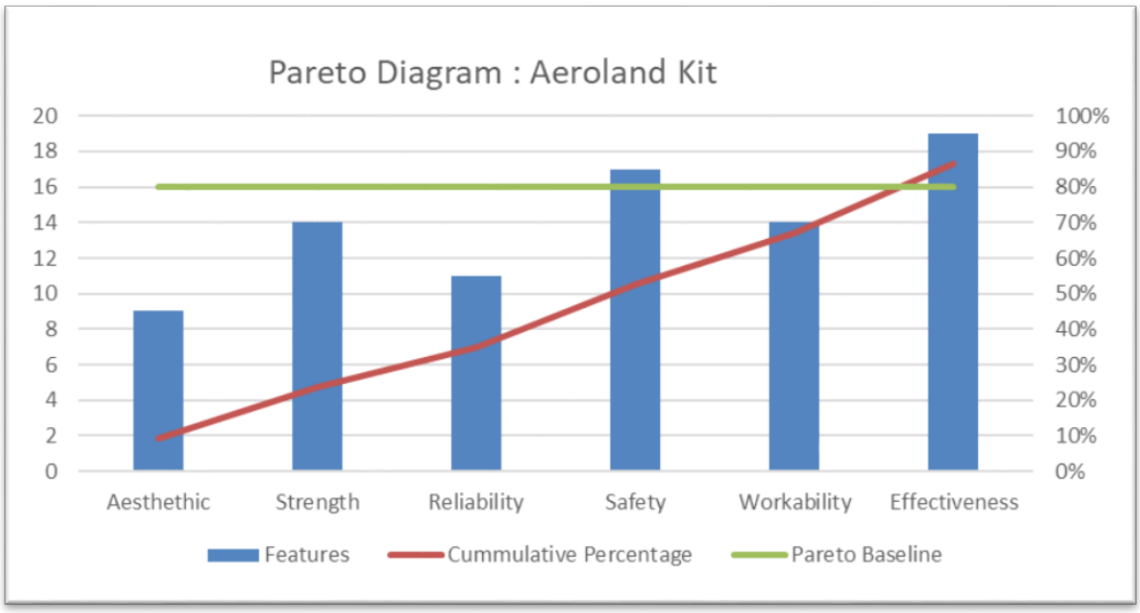


Figure 3.12: Pareto diagram on Aeroland Kit

Based on our research on the Pareto diagram, we can conclude that effectiveness, has the highest priority and the second highest is safety.

3.4.2 Design Concept Generation

3.4.2.1 Morphological Matrix

	IDEA 1	IDEA 2	IDEA 3	IDEA 4
MAIN SHAPE	The gear landing in the square box with the panel button on it	The gear landing in the rectangular box with the support by wheel for stand	The gear landing will only operation of extension and retraction without wheel well panel door	The gear landing will only operation of extension and retraction without wheel well panel door And support by a stand
COVER SHAPE				
WHEEL CONFIGURATION				
SOURCE OF POWER	HYDRAULIC	PNEUMATIC	HYDRAULIC	ELECTRICAL
MATERIAL USED FOR PANEL	SHEET METAL	• PERSPEK • CLEAR PLASTIC	•PERSPEX •CLEAR PLASTIC	• POLYSTYRENE/ PVA FOAM
MATERIAL USED FOR STRUCTURAL	METAL POLE	WOOD POLE	METAL POLE	ALUMINIUM
ACTIVATION METHODS	WIRELESS PHONE BLUETOOTH	DIRECT BUTTON PANEL	BUTTON PANEL	VOICE
MATERIAL FOR LANDING GEAR (OLEO STRUT)	METAL	PLASTIC	3D PRINT (POLYLACTIC ACID/PLA)	WOOD

Figure 3.13: Table of Aeroland Morphological Matrix

Based on our discussion about Morphological Matrix, we conclude that idea 3 is the ideal choice for our Aeroland kit. The criteria are including main shape, cover shape, wheel configuration, source of power, material used for panel, material used for structural, activation methods, and lastly material for landing gear (oleo strut). These criteria are used in our project in order to make it meet our expectation on how aircraft landing gear training kit would work.

3.4.2.2 Proposed Design Concept 1

CONCEPT 1: CONCEPT GENERATION OF AIRCRAFT LANDING GEAR

FUNCTION	CONCEPT 1	JUSTIFICATION
MATERIAL USED FOR PANEL	**SHEET METAL**	Sheet metal, such as aluminum or steel, is known for its high strength and durability. These components can endure these stresses, making the training kit realistic and long-lasting
SOURCE OF POWER	**HYDRAULIC**	Hydraulic systems offer precise control over the movement of landing gear components
MATERIAL USED FOR STRUCTURAL	**METAL POLE**	Stainless steel exhibit resistance to environmental factors such as corrosion, making them suitable for long-term use in various conditions
ACTIVATION METHODS	**WIRELESS PHONE BLUETOOTH**	Bluetooth activation can be controlled via a smartphone or tablet, providing an intuitive and user-friendly interface
MATERIAL FOR LANDING GEAR (OLEO STRUT)	**METAL**	Corrosion Resistance: Depending on the choice of metal, such as aluminum or stainless steel, landing gear oleo struts can exhibit good corrosion resistance.

Figure 3.14: Table of Proposed Design Concept 1

From the concept 1, material used for panel we use sheet metal because it known for its high strength and durability make it ideal for panel but cons are metal tend to corroded and

loss its strength when it happened. Source of power we used hydraulic that offer precise control over the movement but it to complex and expensive. Next is material used for structural which is metal pole. Activation methods we use wireless phone Bluetooth because it is providing user-friendly interface. Lastly, material for landing gear which is metal because its provide high strength and durability.

3.4.2.3 Proposed Design Concept 2

CONCEPT 2: CONCEPT GENERATION OF AIRCRAFT LANDING GEAR

FUNCTION	CONCEPT 2	JUSTIFICATION
MATERIAL USED FOR PANEL	•PERSPEX •CLEAR PLASTIC	Interactive Learning: Clear plastic components can be paired with instructional materials, allowing students to interact with the system by observing
SOURCE OF POWER	PNEUMATIC	No Risk of Hydraulic Fluid Leakage: In a training environment, the use of pneumatic systems eliminates the risk of hydraulic fluid leakage
MATERIAL USED FOR STRUCTURAL	WOOD POLE	Wood is generally more affordable than metal or other materials commonly used in landing gear systems. Using wood can help create an effective training kit without excessive costs.
ACTIVATION METHODS	DIRECT BUTTON PANEL	Button panels are straightforward and familiar to users. This reduces the learning curve, making it easy for trainees to grasp the operation
MATERIAL FOR LANDING GEAR (OLEO STRUT)	PLASTIC	Reduced Maintenance: Plastic materials generally require less maintenance than metals.

Figure 3.15: Table of Proposed Design Concept 2

Based on our proposed concept 2, material used for panel we use Perspex/ clear plastic because since it transparent it's easy to understand the operation. Source of power we used pneumatic because it offers simpleness compare to hydraulic. Next is material used for structural which is wood pole that offer affordability than other materials. Activation methods we use direct button on panel because its straightforward and familiars to user. Last but not least, material for landing gear which is plastic because it requires less maintenance than metals.

3.4.2.4 Proposed Design Concept 3

CONCEPT 3: CONCEPT GENERATION OF AIRCRAFT LANDING GEAR

FUNCTION	CONCEPT 3	JUSTIFICATION
MATERIAL USED FOR PANEL	•**PERSPEX** •**CLEAR PLASTIC**	Interactive Learning: Clear plastic components can be paired with instructional materials, allowing students to interact with the system by observing.
SOURCE OF POWER	**HYDRAULIC**	Hydraulic systems offer precise control over the movement of landing gear components
MATERIAL USED FOR STRUCTURAL	**METAL POLE**	Stainless steel exhibit resistance to environmental factors such as corrosion, making them suitable for long-term use in various conditions
ACTIVATION METHODS	**BUTTON PANEL**	Button panels are straightforward and familiar to users. This reduces the learning curve, making it easy for trainees to grasp the operation
MATERIAL FOR LANDING GEAR (OLEO STRUT)	**3D PRINT (POLYLACTIC ACID/PLA)**	Rapid Design Iterations: 3D printing enables quick design iterations and modifications.

Figure 3.16: Table of Proposed Design Concept 3

For the next concept which is concept 3, material used for panel we use Perspex/ clear plastic because when the material is transparent it's easy to understand the operation. Source of power we used hydraulic because its offer precise control on the movement of the actuator. Next is material used for structural which is we use metal pole because it provides exceptional strength integrity on structure. Activation methods we use button or lever because it's simple and easy to use. Last but not least, material for landing gear which is polylactic acid/PLA which is used in 3D printing. It provides quick design iterations and modifications.

3.4.2.5 Proposed Design Concept 4

CONCEPT 4: CONCEPT GENERATION OF AIRCRAFT LANDING GEAR

FUNCTION	CONCEPT 4	JUSTIFICATION
MATERIAL USED FOR PANEL	**POLYSTYRENE/ PVA FOAM**	Customization: Foam materials are easily cut, shaped, and sculpted with basic tools, providing flexibility in creating landing gear components and configurations.
SOURCE OF POWER	**ELECTRICAL**	Efficiency and Precision: Electrical systems can provide precise and efficient control over landing gear movements, allowing for accurate simulation.
MATERIAL USED FOR STRUCTURAL	**ALUMINIUM**	Aluminum is known for its excellent strength-to-weight ratio, aluminum allows for components that can handle the required loads while keeping the overall weight within acceptable limits.
ACTIVATION METHODS	**VOICE**	Efficiency and Speed: Voice activation can expedite training processes. In real-world scenarios, quick and accurate communication is essential for aircraft operations.
MATERIAL FOR LANDING GEAR (OLEO STRUT)	**WOOD**	Environmental Considerations: Wood is a renewable and environmentally friendly material.

Figure 3.17: Table of Proposed Design Concept 4

For the next concept which is concept 4, material used for panel we use polystyrene/PVA foam because it provides flexibility in creating the design. Source of power we used electrical because it provides precise and efficient movement. Next is material used for structural which is we use aluminum because of its excellent strength to weight ratio. Activation methods we use voice activation because its quick and easy. Last but not least, material for landing gear which is wood because renewable and environmentally friendly.

3.4.2.6 Accepted Vs Discarded Solution

According to all concept that we research, we decided to choose concept 3 as our final project that we will make it. This is because concept no 3-material used for panel is Perspex/clear plastic which is provide exceptional strength and durability. Other than that, the source of power for actuation is hydraulic which is excellent because mechanical systems are straightforward and easy to understand, making them an excellent choice for training beginners. Furthermore, material used for structural is metal pole which is lightweight making it easy to handle. Moreover, activation method used in concept 3 is button panel safe to use, straightforward and familiar to users. Finally, material for landing gear (oleo strut) is 3d print (polylactic acid/PLA) which is perfect because enables quick design iterations and modifications.

3.4.3 EVALUATION & SELECTION OF CONCEPTUAL DESIGN

3.4.3.1 Pugh Matrix

CRITERION	FACTOR	CONCEPT 1	CONCEPT 2	AEROLAND KIT	CONCEPT 3
Cost	0.2	1	2	D	2
Portability	0.2	2	3	A	3
Durability	0.2	2	1	T	3
Long lasting	0.2	3	2	U	3
Safety	0.1	1	2	M	3
Total Score	1.0	7	10		14
Ranking	-	3	2	-	1

Figure 3.18: Pugh Matrix for Aeroland Kit

As for the Pugh Matrix, we make concept 3 as the DATUM because it has the best concept among others. Its source of power, material used for panel, material used for structural, activation methods, and lastly material for landing gear (oleo strut) are top notch compared to other. It maybe has a weakness but the most effective design in those 3 concepts, that would make concept 3 is the best. Based on the discussion about the cost, portability, durability, long lasting, and safety concept 3 majority would dominate the others concept.

3.5 PRODUCT DRAWING / SCHEMATIC DIAGRAM

3.5.1 GENERAL PRODUCT DRAWING

3.5.1.1 Orthographic & Isometric View

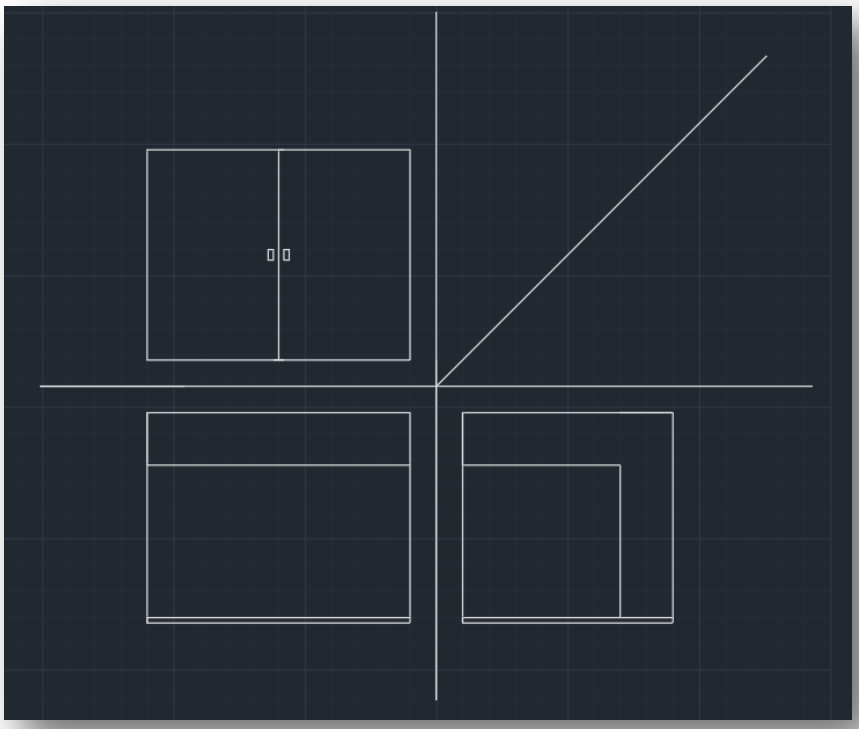


Figure 3.19: Sketch for Aeroland kit panel

By projecting three-dimensional objects onto planes parallel to their coordinate axes, orthographic projection is a technical drawing technique used to portray objects in three dimensions. Because it gives precise, true-to-size measurements, it is essential for technical and engineering representations. Isometric projection, on the other hand, uses a two-

dimensional plane to visually depict objects in three dimensions. With equal foreshortening along all three axes, usually at 120-degree angles, it creates a more realistic image. In architectural and creative contexts, isometric projection is frequently used, sacrificing exact measurements for aesthetic appeal. Both techniques have different uses; orthographic projection is more accurate, while isometric projection provides a more logical visual depiction.

3.5.2 SPECIFIC PART SKETCHING

3.5.2.1 Product Structure

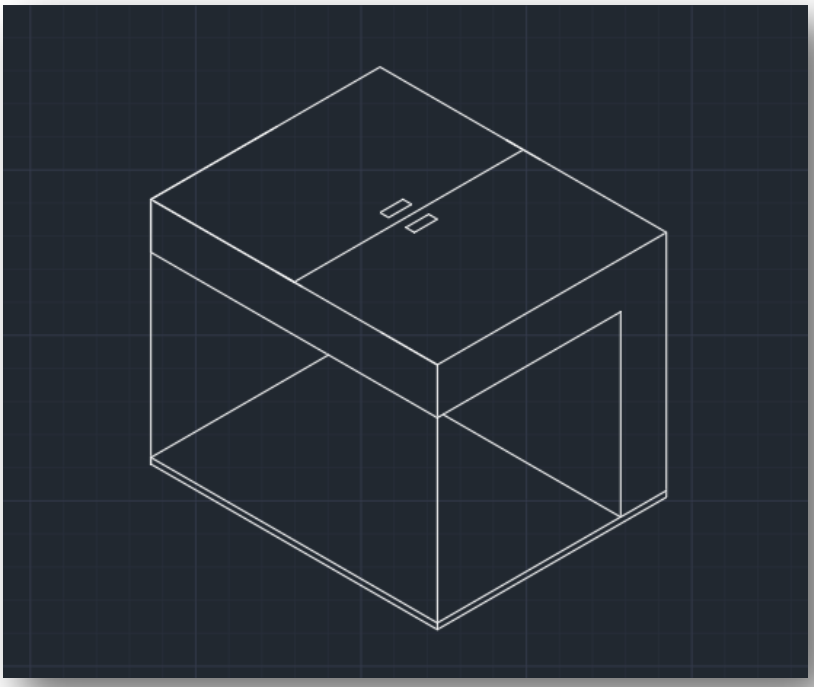


Figure 3.20: Product Structure of Aeroland Kit

Figure 3.20 shows product structure that will operate as a panel for landing gear training kit with the door installed at the top part for easy access during troubleshooting and

maintenance of the landing gear. At the side of the panel would be clear Perspex or plastic to provide enclose case and visualization for the whole process of landing gear operation.

3.5.2.2 Product Mechanisms

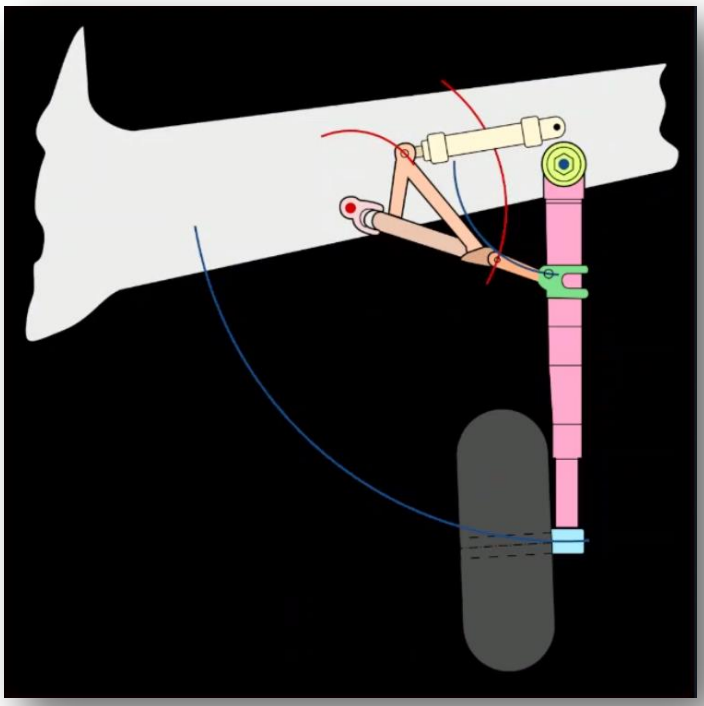


Figure 3.21: Product Mechanism of Aeroland Kit

For the Figure 3.21 above shows that the product mechanism that allows users to simulate the retraction and extension of landing gear before take-off and after take-off/landing, respectively. The landing gear training kit which is Aeroland kit covers the simple hydraulic and electronic systems associated with landing gear operation for the trainees to

gain insights into the functioning of these systems, understanding how they contribute to the smooth operation of the landing gear and learn the sequence of actions and cockpit controls associated with gear retraction and extension.

3.5.2.3 OVERALL DIMENSION OF THE PRODUCT

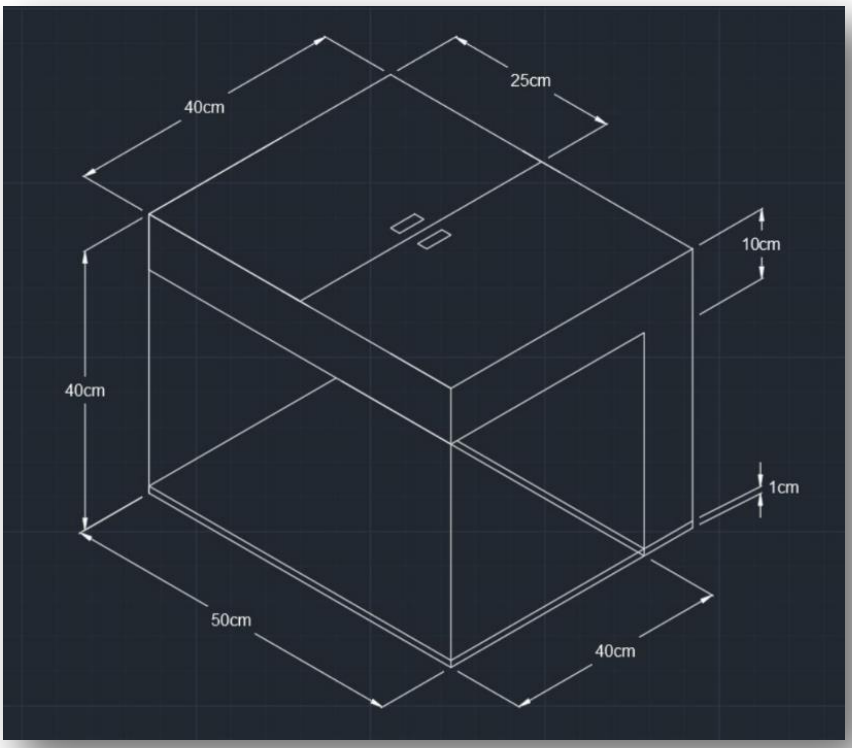


Figure 3.22: Overall dimension of the Aeroland kit

Figure 3.22 shows the overall dimension of the panel used in this project. After extensive consideration and discussion, we decided to used ratio of 1:10 from the landing gear

training kit that we find in the current market. The reason we decided this value because of the portability and convenience.

3.5.2.4 DETAILED DIMENSION OF THE PRODUCT PARTS

3.5.2.4.1: Main Structure

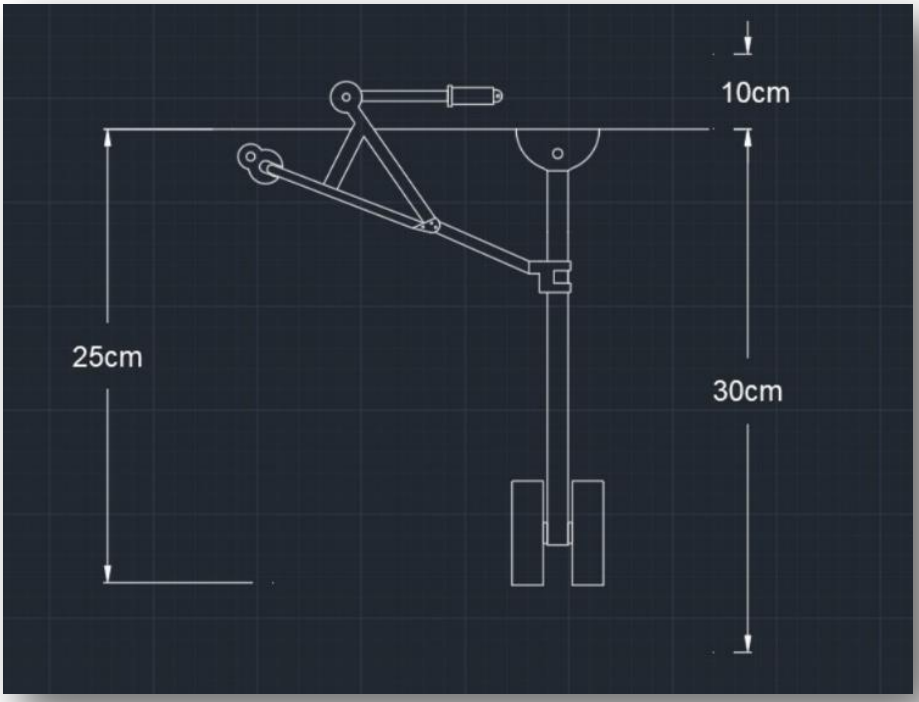


Figure 3.23: Dimension of landing gear

From figure 3.23 the overall length for the landing gear from the top to the bottom of the wheels are 25cm and will be have 5 cm of clearance from the base of the panel. As mention before we decide to used ratio of 1:10 form the actual size of the landing gear so that we can fit in the panel to showcase the operation of the aircraft landing gear

3.5.2.4.2: Top/ Front/ Side Section

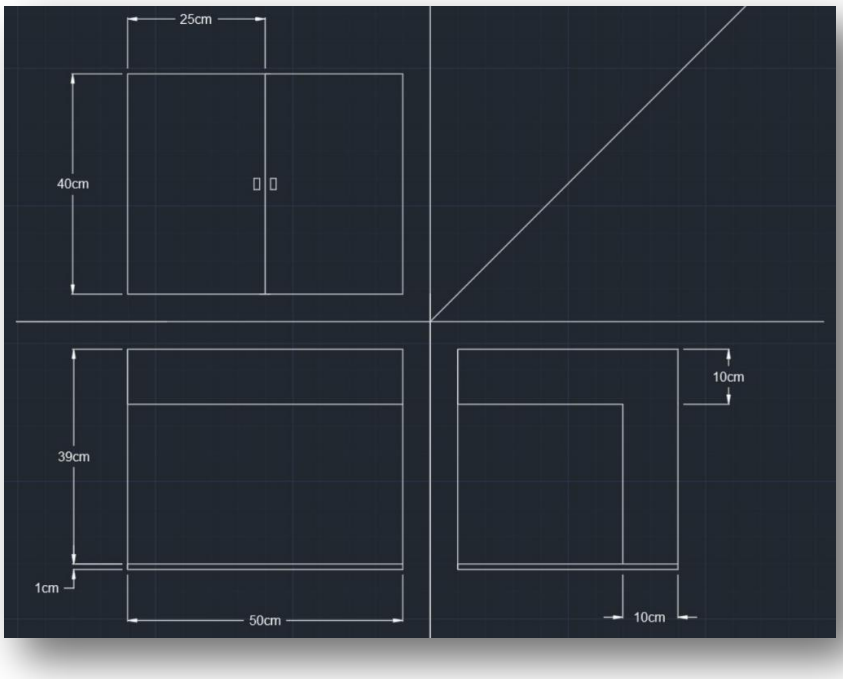


Figure 3.24: Dimension of the orthographic view of each section

Figure 3.24 shows the dimension of the orthographic view of each top, front and side view. From the top view, the width of the panel door is 25cm and the length of the panel door is 40cm. Next, for the front view the width of the panel is 50cm from left to right meanwhile the height of the panel is 40cm including the base thickness of the panel which is 1cm. Next, for the side view of the panel, the thickness of the landing gear compartment is 10cm and the thickness of the accessories compartment also 10cm.

3.6 PRODUCT DECRIPTION

3.6.1 General Product Features & Functionalities

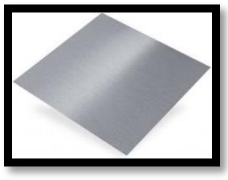
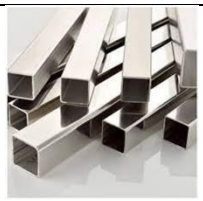
Modern simulation technology is used in the training kit's basic design to emphasis realism. It offers customers an immersive learning experience by accurately and remarkably replicating real-world landing gear circumstances. Another notable aspect of the kit is its modular construction, which enables students to analyze and comprehend each landing gear system component separately. This method develops a profound understanding that is necessary for future aviation professionals. This training kit also consist of physical components that represent the landing gear system. This could include models, diagrams, or interactive simulations. The training kit's interactive controls are a major factor in how user-friendly it is. Encouraging learning experiences are provided by the user-friendly design, regardless of experience level. Additionally, the kit's portable compatibility improves accessibility, making it appropriate for both conventional classroom settings and virtual learning environments.

3.6.2 GENERAL OPERATION OF THE PRODUCT

This product is operated using Arduino uno board, hydraulic actuator, and button or lever that will actuate the actuator. The training kit would cover fundamental concepts related to landing gear, such as the different types of landing gear (tricycle, tailwheel), retraction and extension mechanisms, shock absorption systems, and emergency procedures. Other than that, the training would likely cover routine maintenance procedures and inspections of landing gear components. This might include visual inspections, lubrication, and troubleshooting common issues. Furthermore, users might be taught how to identify and troubleshoot common landing gear issues. This could involve understanding warning indicators, interpreting system feedback, and taking appropriate corrective actions.

3.7 DEVELOPMENT OF PRODUCT

3.7.1 Material Acquisition

No	Material	Description
1	 Mild steel sheet	It was used for base of the structure and rear sidewalls. The thickness of this material was 3mm.
2	 Plastic Panel	It was used for the back and door at the up side of Aeroland because of the light weight. The thickness of this material was 0.5mm.
3	 Bold and nuts 8mm	It was used for tight the actuator with the metal structure.
4		Used as the main structure of Aeroland kit design.

	Metal Pole	
5	 Hinges	It was used for allowing the upper hood easily accessible inside the Aeroland kit device.
6	 Perspex/Acrylic board	Acrylic board was used for the front, left and right side as for the cover that can be see thru it.
7	 Trolley tires	It was used for transferring the mock of aircraft landing gear.

Table 3.1: Material Acquisition

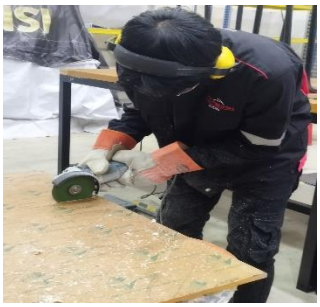
3.7.2 Machine and Tools

No	Machine	Description
1	 Cordless drill	Project purpose: It was used for drilling the hinges to the structure pole.
2	 Hand grinder	Purpose project: It was used for grinded all rough surface on metal pole before spraying this material. Also cutting the metal pole and acrylic board
3	 Welding machine	Purpose project: It was used for attached the metal pole for the structure of Aeroland Kit.
4	 Bench drill	Purpose project: It was used for drilling the metal pole.

Table 3.2: Machine and Tools

3.7.3 Specific Project Fabrication

3.7.3.1 Phase 1 (Base Structure)

No	Fabrication process	Description
1	 Material was checked	The quality of the raw material was checked for the any physical damage such as corrosion and crack.
2	 Material was measured	The length all the dimension was measured and marking on the metal pole and a Perspex/acrylic board before cutting.
3	 Material was cutting	All the pieces of the frame components were cute using the grinder.

4	 Material was welded	All a metal pole as a frame and mild steel sheet as a base was welded using the welding machine.

Table 3.3: Phase 1 (Base Structure)

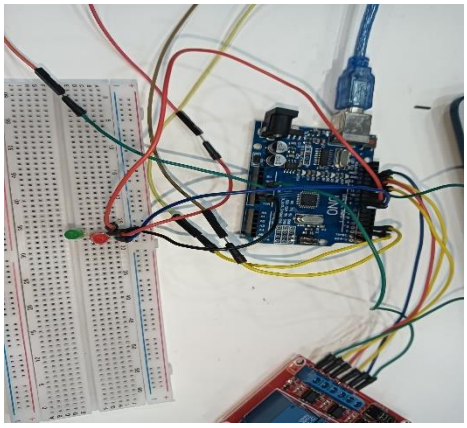
3.7.3.2 Phase 2 (Accessories & Mechanism)

No.	Fabrication Process	Description
1.	 Measure the size of sprocket before cutting process	This metal pole was measured for cutting process to make a frame of Aeroland kit.
2.	 Cutting the mild steel plate	The metal pole was cut into a specific size that have been measured for the frame structure.

3.	 Measure and grind before bracket hinge installation	The rail bracket hinge was measured before drilling to make a hole for a bolt and attach to the mild steel plate.

Table 3.4: Phase 2 (Accessories and Mechanism)

3.7.3 Phase 3 (Programming & Electrical Circuit)

No	Fabrication Process	Description
1.	 Component assembly	All components have been assembled according to the circuit diagram.

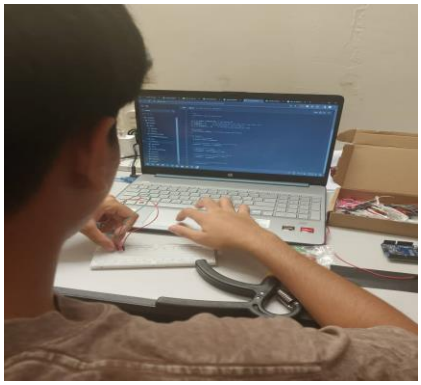
2.	 Programming	Arduino Uno 3 have been coded and programmed via Arduino IDE.
3.	 Programming test run	All the components have been assembled and the code also have been uploaded. Then the components fitted to the software housing and tested right away.

Table 3.5: Phase 3 (Programming and Electrical Circuit)

3.8 PRODUCT TESTING / FUNCTIONALITY TEST

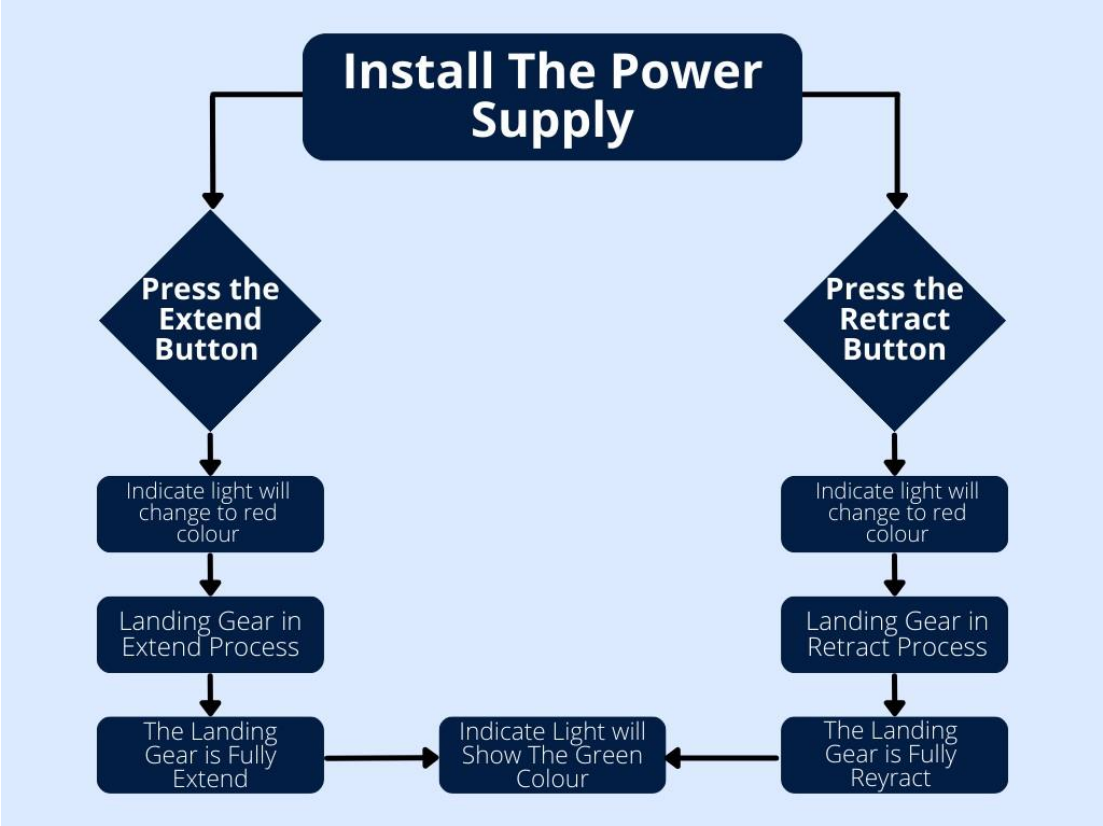


Figure 3.25: Flow Chart of Aeroland Kit Functionality

3.9 LIST OF MATERIALS & EXPENDITURES

3.3.1 Product Structure				
No	Items	Unit	Price/Unit	Total (RM)
1.	Perspex	-	-	-
2.	Wheel	4	RM3	RM12
3.	Door Hinges	4	RM4.50	RM18
3.3.2 Mechanical Mechanism				
No	Items	Unit	Price/Unit	Total (RM)
1.	Hydraulic Actuator	1	RM58.50	RM58.50
2.	3D Printing Service	1	RM2	RM2
3.3.3 Electrical Mechanism				
No	Items	Unit	Price/Unit	Total (RM)
1.	Arduino uno board	1	RM40	RM40
2.	Battery 12V 2.6Ah	1	RM18.90	RM18.90
3.	LED Strip	1	RM7.90	RM7.90
GRAND TOTAL				RM157.30

Table 3.6: List of Material & Expenditures

CHAPTER 4

RESULT & DISCUSSION

4.1 PRODUCT DESCRIPTION

4.1.1 General Product Features & Functionalities

The Aeroland training kit is an advanced training tool designed specifically for landing gear maintenance training. Equipped with basic of landing gear features. Additionally, the Aeroland training kit includes a built-in compartment for storing a range of small to medium-sized tools.

The primary objective of the Aeroland training kit is to enhance the efficiency of maintenance personnel during landing gear training sessions. Unlike conventional training aids, which are static and require manual handling, this innovative device streamlines the learning process by enabling the landing gear model to be brought directly to the trainee.

This proximity facilitates practical training scenarios and enhances overall learning outcomes.

Moreover, the Aeroland training kit incorporates a LED light indicator, providing convenient component required for comprehensive training exercises in base maintenance scenarios. This added functionality allows the users to see the indication during operation of the landing gear.

4.1.2 Specific Part Features

4.1.2.1 Product Structure

The structure of the Aeroland training kit is made from various materials. Some of it consist of a corrugated board for the base, top cover and a place to keep the electronic parts. The tools compartment which is made from aluminum sheet are made to be strong enough to withstand the weight of the tools needed for the specific task. Moreover, the acrylic optimize panel that is made into a rectangular shape to be used for support for the side and its see through characteristic is perfect to see the operation of the landing gear. This acrylic board is also used as a place to keep an electronic compartment because it is safe from any FOD or any hazard that can damage the electronic parts. Lastly, the structure frame material is square metal pole because its structural integrity and strength.

4.1.2.2 Product Mechanisms

The crucial part in this product mechanism is the actuator. 12V Linear Actuator Self Locking DC Linear Electric Motor Drive. This feature could optimize energy consumption for sustainable and economical use, and facilitates efficient and controlled waste disposal operations.

4.1.2.3 Electronic / Programming

The electronics in Aeroland training kit are made up of a Arduino board, 4 channel relay module board, 6 pin momentary switch and LED that are crucial for the training kit to operates.

Lastly, the training kit electrical system is provided by an Arduino UNO R3 board. This is because it is capable of performing a wide range of tasks and duties with ease. It also acts as the primary brain of the system, instructing the different components to do their designated tasks.

4.1.2.4 Accessories & Finishing

The functioning of the Aeroland training kit is improved in a number of ways by the addition of accessories like LED strip, electrical tape, power bank to power LED strip light, and black and yellow stripe tape to improve the looks. The landing gear model in training kit visibility is improved by the LED strip light, particularly in low-light conditions.

4.1.3 General Operation of the AFD

When the system is powered on, the Arduino is turned on and the 4-channel relay module is also turn on. The primary function of a relay module is to switch electrical devices or systems on and off. It also serves to isolate control circuits, ensuring that low-power devices can safely control higher voltages and currents. With the help of relay module, the actuator can be extended and retract.

4.1.4 Operation of the Specific Part of the Product

4.1.4.1 Product Structure

The Aeroland training kit has a convenient and unique structure that improves the user experience. For the top lid of the training kit, corrugated board was used and equipped with the small hinge that attached to the metal frame of the structure. This will help to troubleshoot maintenance our problem at the same time provides closer insight of the landing gear operation. Furthermore, acrylic Perspex panel was used as support and window for the training kit since it is transparent or see through at the same time provide structural integrity for the training kit. With this, the technician should be able to see the operation without opening the lid of the training kit.

4.1.4.2 Product Mechanisms

This training kit used 12V Linear Actuator attached to the landing gear model in order to moved it. The linear actuator used is model HY01-12, this actuator provides 100mm of

maximum length strokes, also extend and retract speed is about 20mm/s which perfect to simulate how the aircraft landing gear works. This linear actuator helps the Aeroland training kit to operate efficiently and effectively as it should.

4.1.4.3 Electronic/ Programming

Aeroland training kit is using the Arduino Uno R3 and the relay board, 6 pin momentary switch and 2 LED which is red and green to functions properly as intended.

Arduino was programmed using the Arduino IDE software, with the help of Arduino the relay and 6 pin switch can be utilizing and function properly. It also determines the indication of the LED, which is red during the movement of the landing gear and green when the landing gear is successfully retract and extend.

The relay that is used in the training kit is 4 channel relay board with working voltage is 5V/12V DC and action time is 10ms to 5ms. A relay is like an electrically controlled switch. It turns circuits on or off using a small electrical signal. When a signal is send to a relay, it uses this signal to open or close a larger circuit. This allows a small control signal to operate a bigger load safely. Relays also provide a way to separate control circuits from high-power circuits, adding safety and flexibility to electrical systems.

4.1.4.4 Accessories & Finishing

The operation of the Aeroland Training kit is enhanced in a number of ways by the inclusion of accessories like LED strip, wiring tape, power bank to power LED strip light, and black and yellow stripe tape to improve the looks. The LED strip light increases the visibility of the landing gear model in the training kit, especially in dimly lit conditions.

For the finishing, the black spray paint was used on the metal frame structure and acrylic Perspex in order to make it appear more appropriate and presentable. Black and yellow stripe tape was used on the Perspex to cover the rough edges of the spray paint.

4.2 PRODUCT OUTPUT ANALYSIS

NO	PARAMETER	RESULT	REMARK/DESCRIPTION	ANALYSIS
1.0	SPEED LIMIT			
1.1	Speed limit (unloaded)	20mm/s	The fastest an Aeroland training kit can go when unloading	In terms of speed limit, Aeroland training kit linear actuator is capable to reach 20mm/s top speed during unloaded. However, its speed capability will drop up to 15% during FULL load condition.
1.2	Speed limit (partially load)	19mm/s	A maximum speed that Aeroland training kit can go during 50% load	
1.3	Speed limit (Fully loaded)	17mm/s	The fastest speed at which an Aeroland training kit operate while fully loaded	

NO	PARAMETER	RESULT	REMARK/DESCRIPTION	ANALYSIS
2.0	OPERATION			
2.1	Max times	12 Hours	The maximum time that Aeroland Training kit can operate	The Aeroland training kit is rechargeable since it uses 12V lithium battery
2.2	Weight/Load	8.5 Kg	The overall weight of Aeroland training kit	The weight of Aeroland kit is 8.5 Kg
2.3	Capacity	15 Kg	The maximum capacity that Aeroland training kit can carry	The maximum capacity it can carry is 15 Kg

Table 4.1: Product Output Analysis

4.3 ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTION

4.3.1 Product Structure

A few issues occurred during the creation of the product structure. Among these is the difficulty of cutting the acrylic board. The issue is that the heat from the friction caused when cutting acrylic board with a grinder slightly melts the board. All that was needed to

address this issue was to sandpaper the melted area to make it appear great. Also, the acrylic Perspex sticker is too difficult to remove even after scrapping using scrapper, thinner was used but it also not solved the problem. But this problem is solved by just using WD-40 spray and let it soaked for couple minutes and peel it, the result is much better and much effective than other method that was used.

When welding using MIG weld, the problem that happened is the metal pole is melted even when using at the lowest amp and power, in order to solved this problem is that we use tag method which is avoid arching for too long so that the metal not melting. Also, when the metal pole having too much gap that makes hard to weld properly. In order to solve that problem, the wire used for weld which is MIG welding was used to fill the gap and the result is pretty satisfactory.

4.3.2 Product Mechanisms

There are few problems that have been encounter while doing this part. Firstly, finding the correct position to align the landing gear model and the linear actuator if doesn't align properly, the landing gear wouldn't extend and retracted at the desired angle. In order to solved this problem, left over metal pole was used and extend the position of the linear actuator away from the frame structure and attached the linear actuator using joint so that it would be move freely.

4.3.3 Electronic/Programming

There are number of difficulties that comes up during Arduino Uno programming process. Firstly, during the coding and programming using Arduino IDE there are so many errors

in the codes. In order to counter this problem, using ChatGPT to examine and corrected the error in the codes.

Furthermore, the wiring on the Arduino and relay are not working properly as intended. Connections, wiring and linear actuator are checked thoroughly, but the problem still occur. The problem has been solved by the helped of the consultant that help during the wiring on the Arduino and relay. The outcome of the solution is pretty satisfactory because the component work as desired

Moreover, last difficulties that encounters are during the soldering of wire connection. The soldered wire doesn't seem to attached properly and will probably come lose if there is too much movement. To counter this problem, the lose soldered wire change to the crocodile wire clip.

4.3.4 Accessories & Finishing

There are many difficulties that are encountered during adding the accessories to the Aeroland training kit. One of them is during the attachment of the LED light strip, the glue on the strip seems too weak and comes lose after some times. To counter this problem, stronger adhesive was used on the LED strip which is double side tape and it is quite effective since the strip doesn't come of easily. Moreover, during the attachment process of Perspex and the metal frame structure. The excess silicone glue seems to ruined the appearance of the training kit. In order to counter this problem thinner and tissue was used to wipe the excess glue on the surface before it dry.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 ACHIVEMENT OF AIM & OBJECTIVES OF THE RESEARCH

5.1.1 General Achievements of the Project

Upon the completion of final project testing, Aeroland is able to operate and produce the output as intended. Aeroland is able to operate by extending or retracting the mechanism via the actuator with only a push of button located on the right side of the Aeroland. Besides that, the QR code also produce the output as expected by showing the notes and infographic regarding the landing gear system and operations.

Other than that, a post survey is conducted to gather user satisfaction. Based on the data collected, the majority of respondents agreed that it is effective to use Aeroland as a visual aid and teaching material for lecturers when learning about landing gear topics so that it can help student understand more about landing gear system and operation.

5.1.2 SPECIFIC ACHIEVEMENT OF PRODUCT OBJECTIVES

5.1.2.1 Product Structure

The goal of creating the Aeroland structure have been met. To achieve this goal the suitable shape and dimensions of the structure are identified, and Aeroland is developed in accordance with this aspect. The Aeroland structure was methodically created ad built by using AUTODESK-AUTOCAD, since we already have already experienced using it beforehand and also because of its user-friendly design and modelling applications. Once the ideal shape and dimensions were determined.

5.1.2.2 Product Mechanisms

The objectives to achieve in the product mechanism section is to ensure that all the actuator and battery are functioning as it has to be, this helps the Aeroland to function perfectly. When the button is pushed, the actuator is functioning making the Aeroland to operate as it supposed to be.

5.1.2.3 Electronics / Programming

As the Aeroland's electronics were being built and the codes were being assembled, the objective was to make the actuator move when the button is pushed by using Arduino Uno for the whole mechanism to operate. By having the actuator to function properly, it shows the extension and the retraction of the landing gear mechanism in the training kit.

Moreover, the Arduino also contains programming for the LED lights indication where the light will turn green when the landing gear assembly is in fully extended or fully retracted position and the light will turn red whenever the landing gear assembly is transitioning in between fully retracted and fully extended.

Finally, the use of LED light strip for the purpose of illuminations and cosmetics which powered up by a USB port from an external power source.

5.1.2.4 Accessories & Finishing

The goals for AeroLand incorporation of accessories like caution tape and LED strips have been effectively met. The Aeroland kit is now looks much more vibrant and interesting with the help of the caution tape and also the LED strips adds an illumination feature and cosmetic value for Aeroland. The Aeroland is now much more informative thanks to the addition of laminated labels for the button extend and retract and also for the indication light. By adding the labels, this achievement has significantly increased the level of difficulties for operating the Aeroland because was more straight forward making it user-friendly. Other than that, by making the Aeroland more effective as a landing gear training kit, QR codes about landing gear system and operations were added on the top left of the front part of the Aeroland.

5.2 CONTTRIBUTION OR IMPACT OF THE PROJECT

Most aviation institution benefits greatly from Aeroland where the training kit itself is full of great feature and information's. by offering a indications feature, the retraction and

extension of the landing gear seems more informational as it mimics the indication lights that are used on a real aircraft.

Moreover, the Aeroland also provides QR codes about landing gear system and operation related notes, which helps student to learn more about landing gear and also visualize the operation of the landing gear by using the Aeroland.

5.3 IMPROVEMENTS OR IMPACT OF THE PROJECT

5.3.1 Product Structure

In the future, there is a lot of improvement that can be made to the structure of the product. One of them included using a much thinner acrylic panel for the side panel to replace the thick acrylic panel. This can make the product much lighter while retaining the overall structural integrity. The other improvement that can be made is to make the back panel can be open and closed instead of the top panel. This improvement can make the maintenance of the landing gear mechanism much more easy because it was more manageable to handle it from the back panel instead of the top panel.

5.3.2 Product Mechanism

For the next idea to improve this project is to spray paint the landing gear mechanism to a light gray color as on the actual aircraft. By spray painting the landing gear mechanism to a light gray color, this feature improves the visibility of the landing gear mechanism as the background for the compartment were spray painted in black color.

Moreover, the next idea is to implement AR/VR into AeroLand. The enhancement is to incorporate IR 5.0 which shows a 3D model and infographic about landing gear assemblies that student can interact and learn. This will indirectly increase students' interest in learning more about landing gear.

Other than that, the idea of adding a shock absorber in the oleo strut is possible to be added. This improvement can be beneficial to the student as an informational purpose and also the realistic value of the landing gear training kit to the actual landing gear.

The Aeroland can be develop into more comprehensive and effective solutions that meets the needs for an effective teaching material in aviation institutions and it also promotes the importance of learning efficiency by concentrating on these enhancements and recommendations for further study.

5.3.3 Software / Programming

The improvement that will be considered in the future is that Aeroland can add a wireless activation system, such as using the mobile phone to enable hands-free operations. Establishing a Wi-Fi or Bluetooth connectivity to enable hands-free and remote control through a dedicated mobile app or integration with well-known smart home platforms.

Furthermore, the feature of emergency situations implemented into Aeroland. By programming the mechanism to extend nor retract halfway making the LED lights indication red. Indicating the emergency situation that might happen on an actual aircraft for learning purpose. This improvement is crucial for student to relate and visualize the landing gear emergency system in a more effective way. In order to create an effective and comprehensive landing gear training kit for a solution as a teaching material. Lastly, make sure that continuous support is provided through remote diagnostics and support integration.

5.3.4 Accessories & Finishing

Beyond the addition of the caution tape and LED strips, research and development in Aeroland offers bright opportunities for improving the education sector specifically in the aviation institution. Adding a clear acrylic panel on the front, back and both side of the Aeroland. By doing so, it will provide a 360-degree clear view of the landing gear mechanism, in which will increase the visibility of the landing gear mechanism and also indirectly increase the apprehensibility of the landing gear.

Next, the use of smart identification tags, or QR codes, for an AR/VR feature which shows the 3D model of the of the landing gear assemblies. These tag or QR codes enable users to scan and identify which student can interact and learn more about the specific components on the landing gear assemblies, supporting a comprehensive learning method.

Furthermore, studies into self-cleaning coating and anti-rust coating which could reduce the need for manual maintenance and ensuring the metal structure to be free from corrosions, guaranteeing the Aeroland performance and overall cleanliness with the least amount of assistance from humans. Studying the air circulation system within the Aeroland landing gear mechanism compartment which would prevent any moisture that could be a threat for the metal structure around it and also preventing any mold from growing, significantly enhance user experience in high humidity areas. The study of Iota-Based remote monitoring capabilities, interactive user interfaces, and the combination of AI and machine learning has the potential to transform educational methods, optimize the managements, promote the pursuit of knowledge in the education sector specifically in aviation.

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APPENDIX A: LIST OF TASK SEGREGATION

SUB CHAPTER	DESCRIPTION
MUHAMMAD ALEEF IRFFAN BIN ROSLAN	
1.1	Background of Study
1.3.2	Specific Individual Project Aim
1.3.2.1	Product Structure
1.4.2	Specific Individual Scope
1.4.2.1	Product Structure
1.4.2.4	Accessories and Finishing
2.1.1	Aviation in Malaysia Industry
2.2.1	Product Structure
2.2.1.1	Basic Design of Main Structure
2.2.1.2	Types of Material Used For Product Structure
2.2.4	Accessories and Finishing
2.4	Comparison Between Recent Research and Current Project
3.1	Project Briefing and Risk Assessment
3.3.2	Specific Project Design Flow / Framework
3.3.2.1	Product Sketch
3.3.2.5	Accessories and Finishing
3.4.1	Design Requirement Analysis
3.4.1.1	Questionnaire Survey
3.4.1.2	Pareto Diagram
3.4.2.2	Proposed Design concept 1
3.5.1	General Product Drawing
3.5.2.1	Product Structure
3.7	Expected Expenditures
4.1.2.1	Product Structure

4.1.4.1	Product Structure
4.1.4.4	Accessories and Finishing
4.2	Project Impact / Purpose of Project
4.3.1	Product Structure
5.1.2.1	Product Structure
5.3.1	Product Structure
5.3.4	Accessories and Finishing

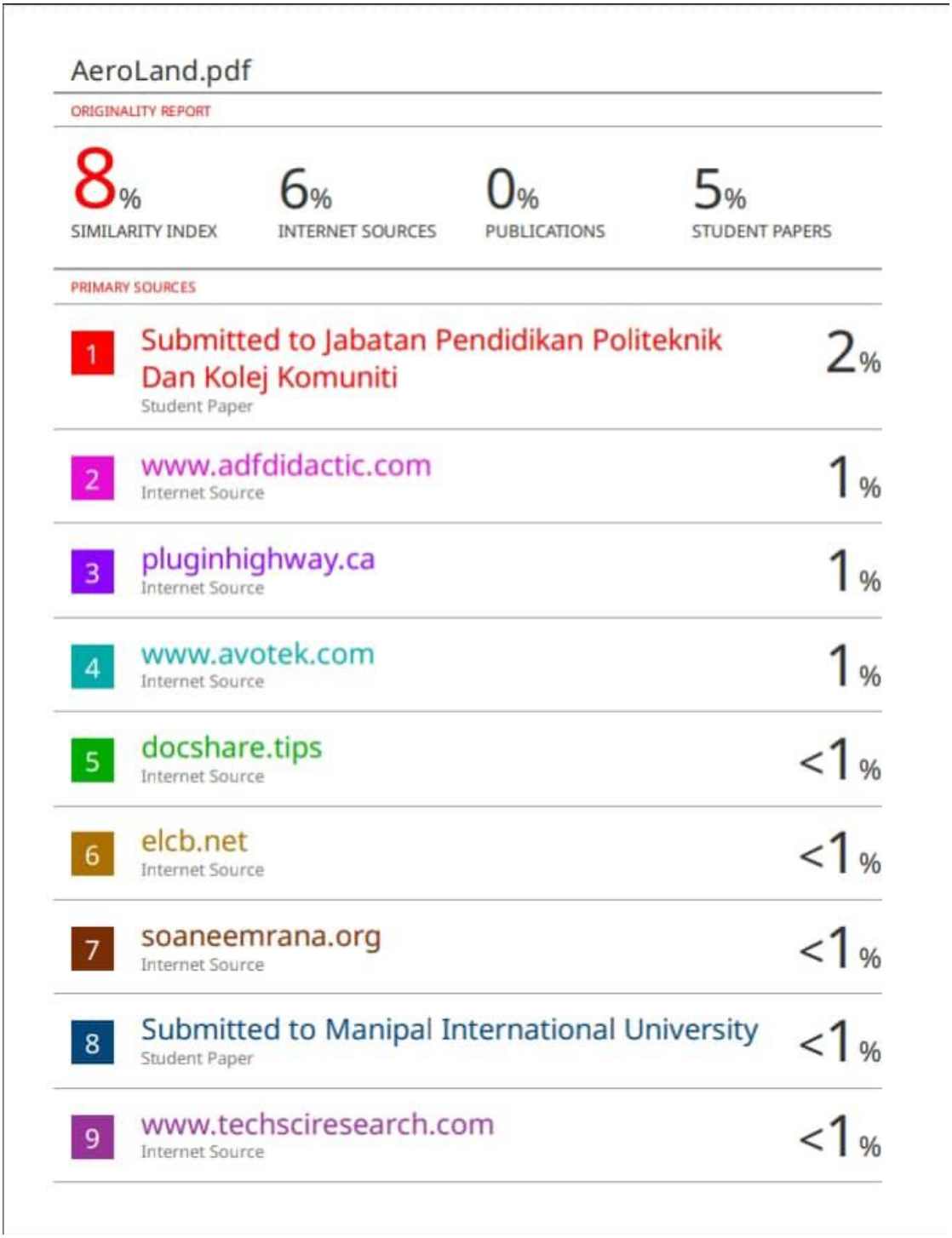
SUB CHAPTER	DESCRIPTION
MUHAMMAD NABIL BIN TAJUL ARIFFLY	
1.2	Problem Statements
1.3.2.3	Software / Programming
1.3.2.4	Accessories and Finishing
1.4.1	General Project Scopes
1.4.2.3	Product Software / Electronics
2.1.2	Demand for Aircraft Landing Training kit
2.2	Specific Literature Review
2.2.3	Software / Programming
2.3.1	Related Patented Products
3.2	Overall Project Gant Chart
3.3.2.4	Software and Electronics
3.4.2	Design Concept Generation
3.4.2.1	Function Tree
3.4.2.3	Proposed Design Concept 2
3.4.2.5	Proposed Design Concept 4
3.5.2.3	Product Software / Programming
3.6.1	General Product Drawing
4.1.1	General Product Features and Functionalities
4.1.2.3	Electronics / Programming
4.1.2.4	Accessories and Finishing

4.1.4.3	Electronics / Programming
4.3.3	Electronics / Programming
4.3.4	Accessories and Finishing
5.1.1	General Achievements of the Project
5.1.2.3	Software / Programming
5.3.3	Software / Programming

SUB CHAPTER	DESCRIPTION
MUHAMMAD SHAFIQ IMAN BIN SUFIAN	
1.3	Project Objective
1.3.1	General Project Objectives
1.3.2.2	Product Mechanism
1.4.2.2	Mechanical Mechanism
2.1.3	Types of Aircraft Landing Gear Training Kit in Market
2.2.2	Product Mechanism
2.3	Review of Recent Research / Related Products
2.3.2	Recent Market Product
3.3	Project Flow Chart
3.3.1	Overall Flow Chart
3.3.2.2	Product Structure
3.3.2.3	Product Mechanism
3.4.2.4	Proposed Design Concept 3
3.4.2.6	Accepted VS Discarded Solution
3.4.3	Pugh Matrix
3.5.2.2	Product Mechanism
3.6.2	Specific Part Drawing
3.8	Product Testing / Functionality Test
4.1.2.2	Product Mechanism

4.1.3	General Operation Of the ALT
4.1.4.2	Product Mechanism
4.3.2	Product Mechanism
5.1.2.2	Product Mechanism
5.1.2.4	Accessories and Finishing
5.3.2	Product Mechanism

APPENDIX B: TURNITIN SIMILARITY REPORT



AeroLand.pdf

ORIGINALITY REPORT

8%	6%	0%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti Student Paper	2%
2	www.adfdidactic.com Internet Source	1%
3	pluginhighway.ca Internet Source	1%
4	www.avotek.com Internet Source	1%
5	docshare.tips Internet Source	<1%
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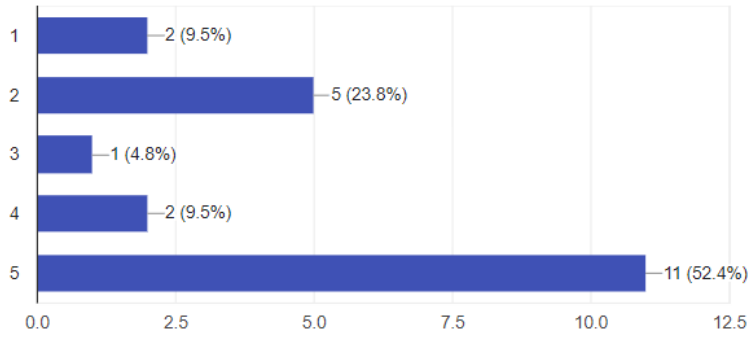
Exclude bibliography	Off		

APPENDIX C: POST SURVEY

Which semester are you?

Copy

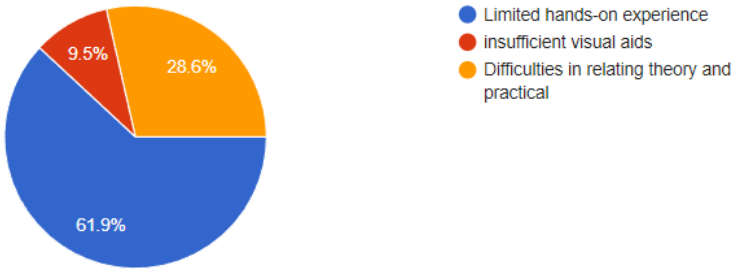
21 responses



What are the challenges in learning about Landing Gear that you currently facing? (you may choose more than one)

Copy

21 responses



please choose one for each statement.

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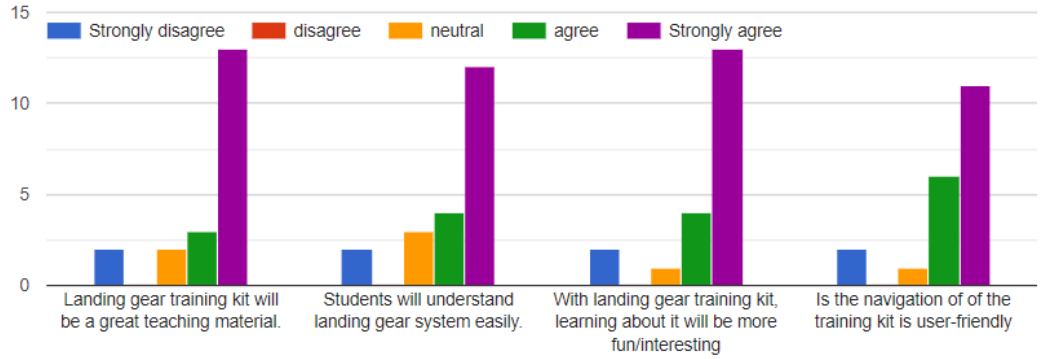

What are the recommendations or suggestion to make some improvements on this product. (please specify)

14 responses

.

Maybe add more feature for example AR/VR implementation into the landing gear training kits

make it more interactive

-

make more training kits so that people can experience how to use training kits more widely

add more feature

develop a variety of training gear other than just landing gear

Nothing

If it came with a mock look of a real landing gear(no need to function just mock)

APPENDIX D: ARDUINO IDE

APPENDIX E: CODING FOR ARDUINO UNO R3