

## Design and Development of Portable Pneumatic with Augmented Reality for Teaching and Learning Purposes

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### ABSTRACT

Immersive approach in learning pneumatic concepts help the learner understands better and retains information when ideas, and words are associated with images. Pneumatic is a power transferred system using compressed air and broadly uses in manufacturing meanwhile Augmented Reality, where the virtual reality added to the reality is an additional value in Beyond Education 4.0. A survey is conducted, and found that it is hard for student to understand the pneumatic systems with only displaying the figures of the circuit alone. This invention is to design and produce the portable training kit to facilitate lecturer to carry and explain about pneumatic circuit in the theory classes at any technical institutions. The body of the pneumatic components were designed and fabricated from the pallet wood. The recycle acrylic poster and screwed curtain rail were used as the board for pneumatic component circuit assembly. This board were attached to the box by the hinges, can fold and functioning as a top cover of the box too. For the Augmented Reality, students need to download the HP Reveal applications from the Play Store into their smart phone. They can scan 10 example of the circuits provided that will link to the learning videos of the real circuit. The result shows a small size and its 12 kg weight compared to the laboratory kits facilitate lecturers to carry into the theory classes. Using Augmented Reality, the teaching and learning session more interesting when students can choose the correct pneumatic component and construct the circuit by refer to the virtual reality in their smart phone.

#### Keywords:

Immersive approach, Pneumatic,  
Augmented Reality

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### 1. Introduction

Immersive approach in learning pneumatic concepts help the learner understands better and retains information when ideas, and words are associated with images. The choice of learning innovation is dependent on an individual's access to various technologies and the infrastructure environment of a person's surrounding [1]. Training aid in this study means teaching aids that is designed and placed in a mobile box as a convenience for lectures and students doing hands on. Training aid usage is one of the teaching aids in the process learning to help students to understand the subject more effectively [2].

Pneumatic systems are power systems using compressed air as a working medium for the power transmission [3]. Pneumatics is a field with high relevance to industrial production where 80% of the producing factories employ pneumatics to control and drive machines [4].

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Augmented Reality (AR), where the virtual reality added to the reality is an additional value in Beyond Education IR4.0. Displaying information by using virtual things that the user cannot directly detect with his own senses can enable a person to interact with the real world in ways never before possible [5]. Using augmented reality systems learners interact with the 3D information, objects and events in a natural way [5]. With the help of advanced AR technology, the information about the surrounding real world of the user becomes interactive and digitally manipulability. Information about the environment and its objects is overlaid on the real world [6]. In other words, AR bridges the gap between the real and the virtual in a seamless way [7].

In Polytechnic Malaysia, DJJ5123 Pneumatic and Hydraulic subject [8] are offered to the fourth semester students Diploma in Mechanical Engineering, Diploma in Manufacturing Engineering and Diploma in Mechatronic Engineering. In this Pneumatic and Hydraulics syllabus, there are 2 hours theory and 2 hours practical per week. Normally the theory sessions are occurring in the classroom. Lecturers only used the power point slides to teach and sometimes draw the circuits on the whiteboard in their explanations. The training kit in the lab restricted to take out due to big, heavy and furthermore its fixed on the laboratory floor. Musculoskeletal Pain (MSP) is a major cause of chronic pain, injury, illness, reduced educational attainment that may affect the quality of productivity, and absenteeism from university lessons [9] which will affect students' future careers. The prevalence of upper limb symptoms reported among Malaysian office workers (34%) and its association to computer use, [10] while low back pain among Malaysian teachers (40%) was associated with physical activity [11].

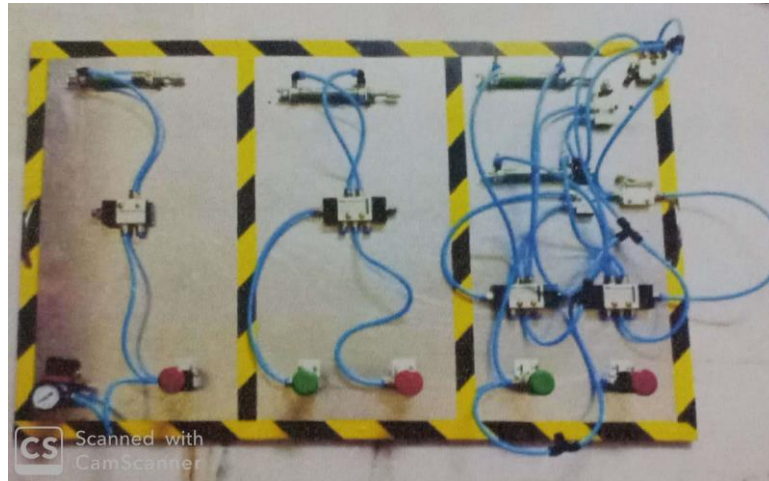
The magnetic symbols also cannot be used outside the laboratory because no magnetic board in the normal classroom. Students also have difficulties in construct a circuit in the theory classes because there is no guide or manual book to refer. The efficacy of laboratory simulations used as a prelab activity can be assessed by evaluating the performance of students when they do the physical laboratory exercise [12].

In like of these problems there are the needs to design and develop a training kit as an instructional device to overcome student problems according to understand the pneumatic circuit in the theory classes. This training kit should easy to carry when the circuit board and all the pneumatic components available in the same box, smaller than in the laboratory and the weight below 15 kg. Physical activity at its extremes could also be a potential risk factor for musculoskeletal pain [13]. The Augmented Reality application will link to the circuit pictures, video tutorial and the manual book help the students to understand better to construct at least 10 pneumatic circuits.

## **2. Methodology**

### **2.1 Design Stage**

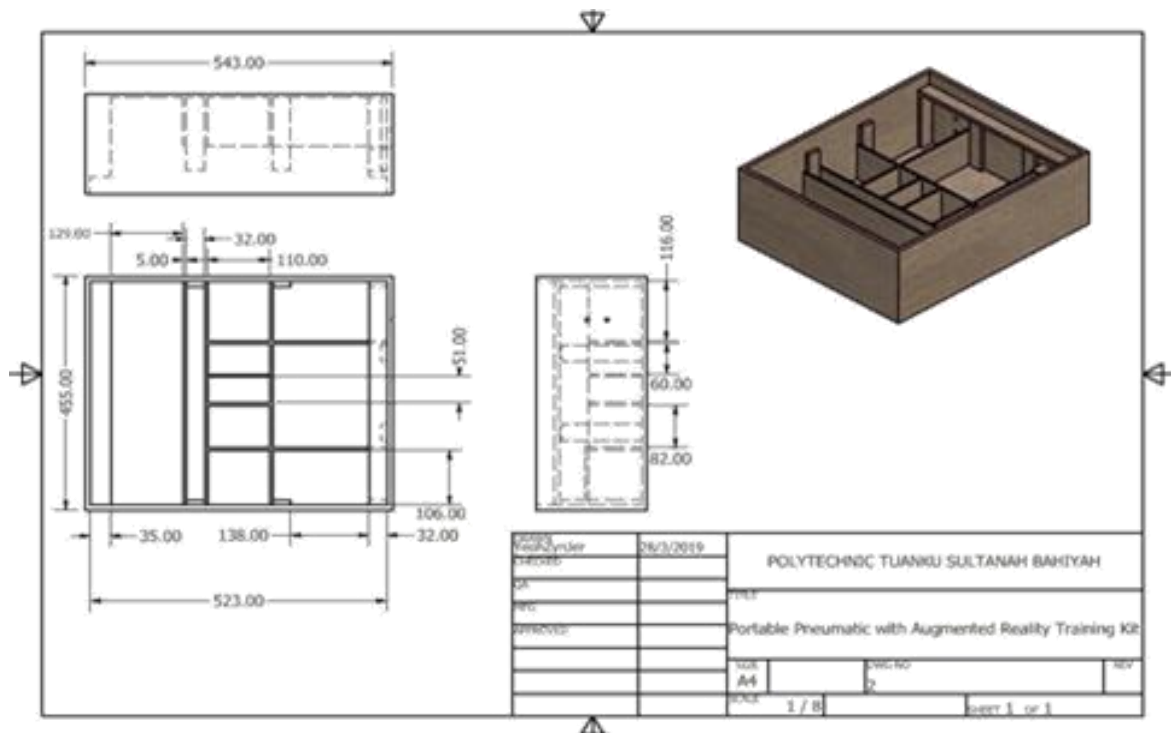
This research applied Pugh method by compared the previous Training Kit to get new idea in design and develop new Portable Pneumatic Training Aid. Pugh method is the decision-matrix method or Pugh Concept Selection, invented by Stuart Pugh [14], is a qualitative technique used to rank the multi-dimensional options of an option set. It is frequently used in engineering for making design decisions but can also be used to rank investment options, vendor options, product options or any other set of multidimensional entities. The first Pneumatic Training Aid in Mechanical Engineering Department (MED) were invented by Mohd Nasrullah, Muhamad Thoriq, Ahmad Azmir and Siti Aminah in Final Year Project as fulfilment for Diploma in Manufacturing Engineering in Julai 2010 [15]. Figure 1 shows the previous pneumatic training aid.



**Fig. 1.** Pneumatic Training Kit [15]

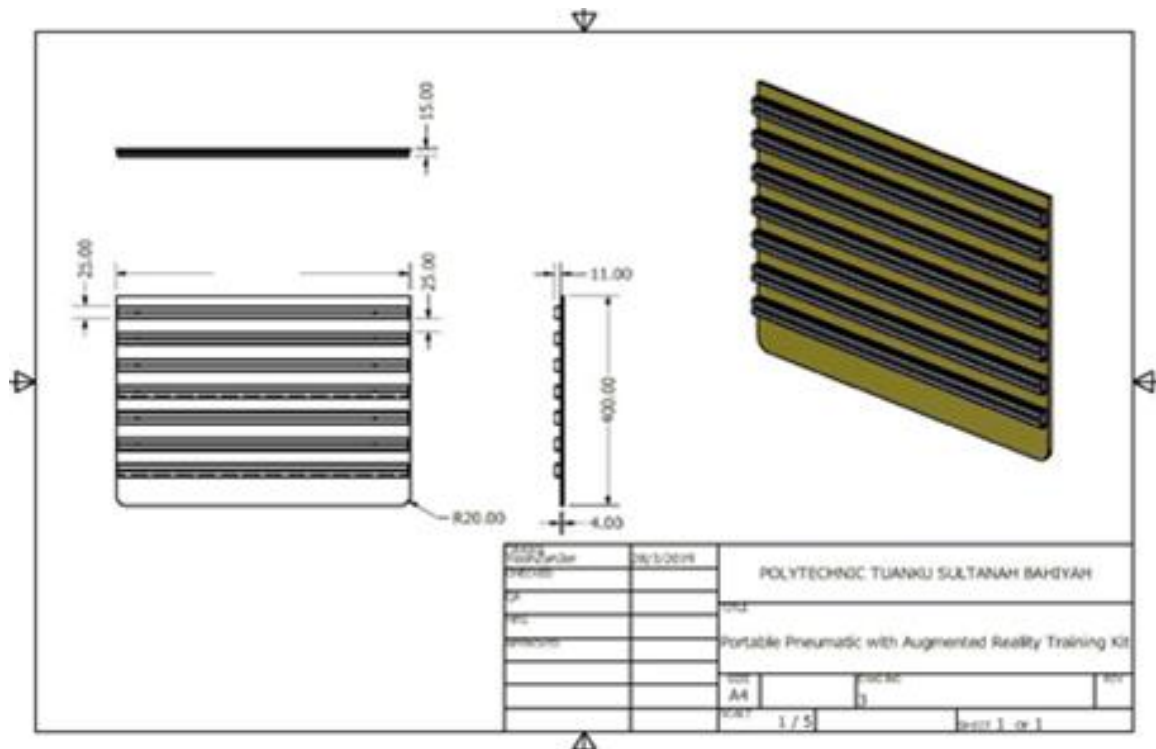
This training kit have 3 circuit and permanently installed on the aluminium base plat 980 mm x 600 mm in sizes. From the conclusion and recommendation, this training kit bit heavy and hard to bring into the theory class especially if no compressed air supplied. From this idea for the new training kit, material, mobility, size and weight are the main value to improve.

For the new innovation, the use of Perspex which form of acrylic plastic, wood plank to build a box storage, plywood to build the compartment in the box storage to keep the component tidy, compress wood as the bottom base of the box, aluminium curtain rail to install the circuit apparatus, hinge to fold the board circuit to reduce the size of box, hook supporter to support the board circuit when open and use it and two door bolt to lock the cover board fit to the box to prevent all component inside felt out. Design and drawing stages using Inventor Software done in the AutoCAD Laboratory in MED PTSB. Figure 2 shows the design of Component Storage made from wood plank, plywood and compress wood.



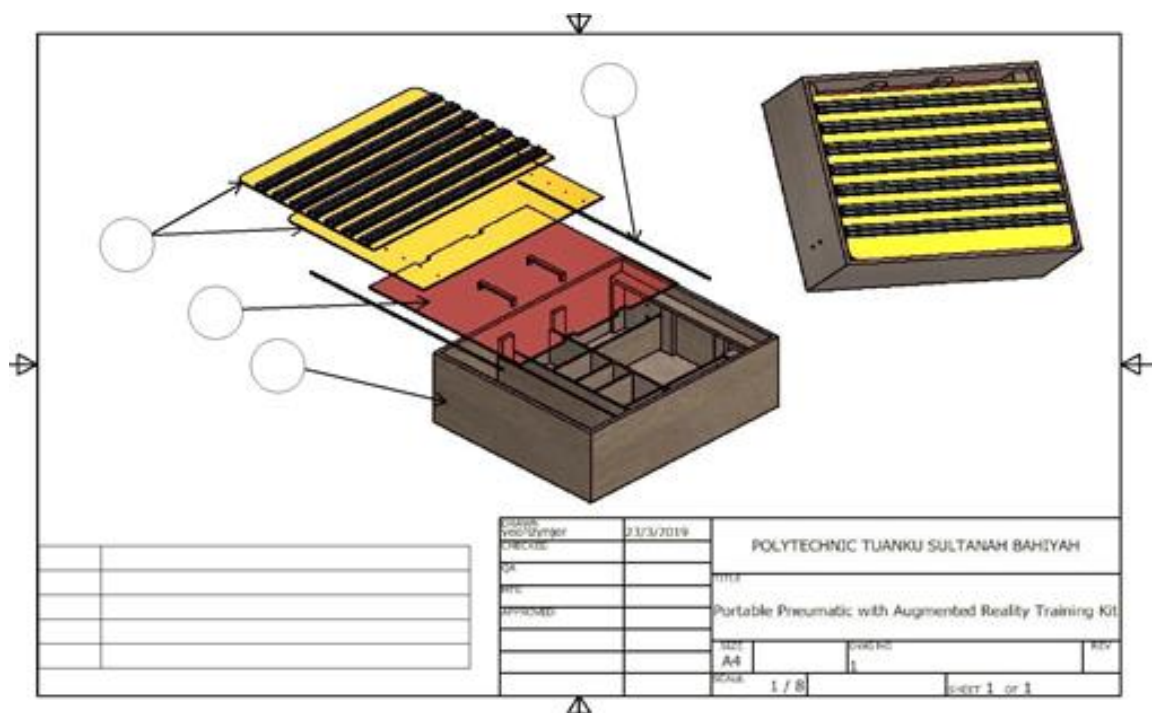
**Fig. 2.** Components Storage

Figure 3 shows the Circuit Attachment Board made from used poster Perspex acrylic.



**Fig. 3.** Components Attachment Board

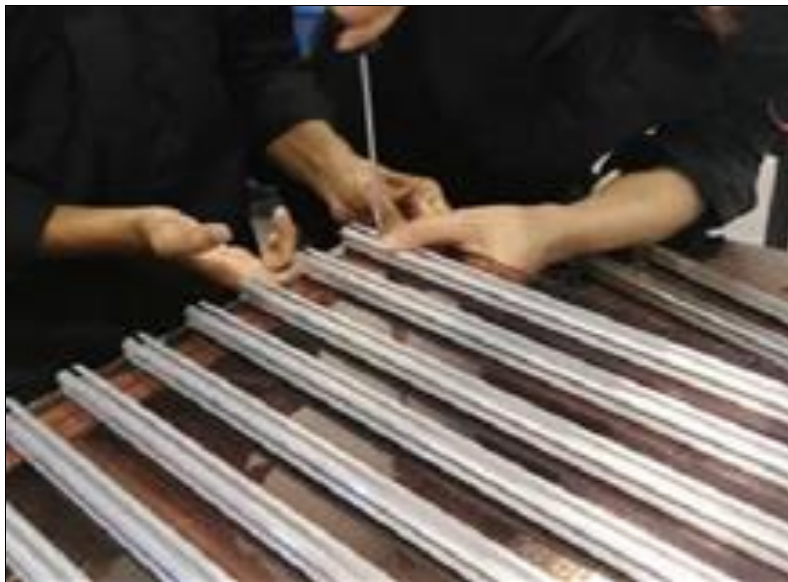
Figure 4 shows the Complete Bag Structure in Isometric View. The red colour is storage cover to make sure all the component stays inside.



**Fig. 4.** Bag Structure in Isometric View

## 2.2 Development Stage

This part concerns with the construction and assembly of the Portable Pneumatic training aid. First is the aluminum curtain rail has been attaching together on the Perspex board as in Figure 5.



**Fig. 5.** Base plate for components attachment

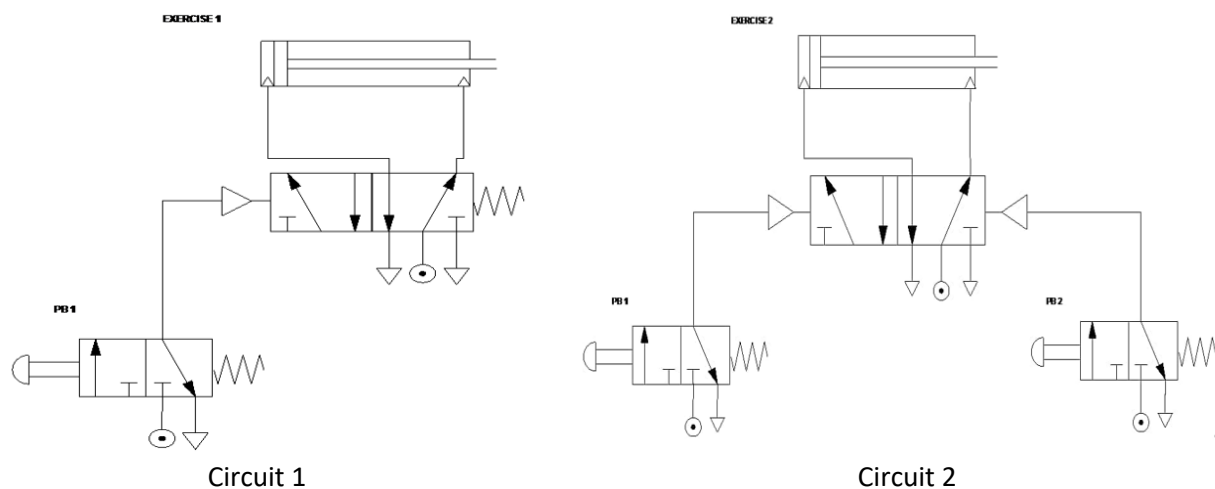
After measuring and cutting the wood plank, plywood, compressed wood then attached together according to the box drawing. After painting the box as in Figure 6 then the cover board attached onto the box using two hinge followed by the installation the hook support and door bolt. Lastly, installed the manifold and regulator on the outer box.



**Fig. 6.** Painting the Compartment Box

### 2.3 Pneumatic Circuit

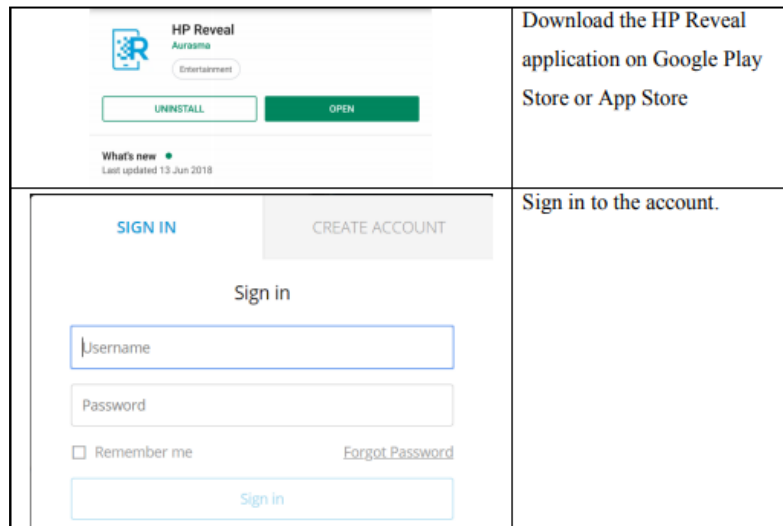
For this training aid we decided to design 10 types of different circuit use Automation Studio software. The circuits consist of direct and indirect control of a double acting cylinder extending task, automatic return and continuous operation using one or two push button. All components bought which needed to use in the 10 circuit as well. Figure 7 below shows two example of the pneumatic circuit. Circuit 1 has Indirect control of a double acting cylinder including of Double acting cylinder, 5/2 Directional Control Valve (DCV) single pilot and 1 push button to control extending process. While circuit 2 has Indirect control of a double acting cylinder using a 5/2 DCV double pilot valve and 2 push button to control extend and retract process.



**Fig. 7.** Two examples of pneumatic circuit

### 2.4 Install the HP Reveal into the smart phone

HP Reveal is an Augmented Reality site which allows to see and interact with the world in a new way. With HP Reveal, every image, object and even place can have its own aura. Auras can be as simple as a video and a link to a web page or as complex as a lifelike 3D animation. The HP Reveal application downloaded from Google Play Store or App Store. Sign in to the account. Create the Aura then upload the trigger. Click images which people to scan to get information. Choose an overlay. Can pick from the library or from the device. Name the Auras. Make sure to switch the Auras to public. Then shared that Auras. Figure 8 shows the User guide to install HP Reveal.



**Fig. 8.** User Guide to Install HP Reveal

### 3. Results

#### 3.1 Design the Kit

Figure 9 shows the new training kit. The FRL unit and the manifold installed outside the box. The circuit board acted as the top cover of the box after folded it. To construct the circuit, this folding board can open straight. The wood colour painting made this box neat and beautiful.



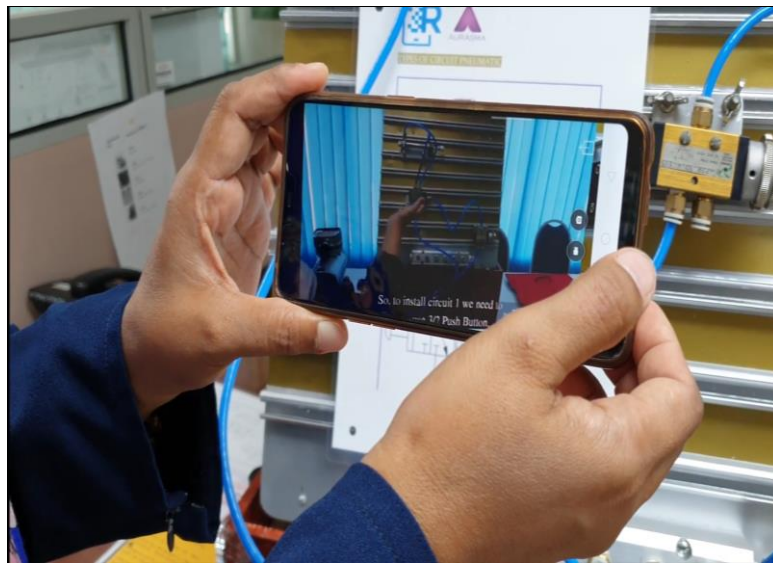
**Fig. 9.** Completed training kit Box

This new Pneumatic Training kit has weight 12 kg. Its more lighter than the previous one, easy to carry in the smaller box sizes after used the wood material.

#### 3.2 Implementation Augmented Reality

In order to facilitate this understanding of pneumatics, this research provided manuals in which its describes the use of components and how to install the circuit. Furthermore, to understand more easily about this pneumatic circuit, tutorial videos are provided which can only be played by

downloading the Augmented Reality application. Figure 9 shows the Augmented Reality application will link to the circuit pictures, video tutorials and the manual to help the students interested and understand better to construct at least 10 pneumatic circuits.



**Fig. 9.** Augmented Reality application to scan the tutorial videos

## 4. Conclusions

### 4.1 Design the portable, light and easy to carry

For this training aid, we need a bag used to store pneumatic components. Light materials which are wood, perspective and aluminium were chosen. The bag size 54.3 cm x 43.5 cm x 19.5 cm and the size of the circuit board 49.5 cm x 40 cm. The components bought come in a relatively small size and cause the bag looks great when stored them. By switching the size, materials and the small pneumatic components the weight reduced to 12 kg. For mobile-related, this storage bag was designed and fabricated similar to a briefcase easier for one user only to carry. With this new storage bag we have achieved our first and second objective.

### 4.2 10 pneumatic circuit with laminated manual and Augmented Reality

In order to achieve the third objective which is to facilitate the understanding of pneumatics circuits, we have provided laminated of 10 example of circuit completed with its manual and value added with Augmented Reality. It can use as portable lab sheet too. This manual describes the use of components and how to install the circuit. To understand more easily about this pneumatic circuit, 10 video tutorials are provided. These video can be played by downloaded the HP Reveal application into the smart phone. It can help students learn how to sketch and construct each circuit after scanned to the number on the laminated circuits. Videos will be playing on their smart phone. This will cause students understand better about the installation of the circuit or the movement of the cylinder. By using this training aid, students can learn not just in the classroom but also in the outdoor class.

## References

- [1] Lee, Kangdon. "Augmented reality in education and training." *TechTrends* 56, no. 2 (2012): 13-21. <https://doi.org/10.1007/s11528-012-0559-3>



- [2] Kesan Penggunaan Educational Multy Functional PLC KIT; Noorlin Rawaida bt Mohdlsa, Retrieved:27September2018, <http://eprints.uthm.edu.my/4236/1>
- [3] Introduction of pneumatics written by lecture 33, Retrieved 20 January 2019 from: <https://nptel.ac.in/courses/112106175/Module%204/Lecture%2033.pdf>
- [4] Schudlach, Kai, Eva Hornecker, Hauke Ernst, and F. Wilhelm Bruns. "Bridging reality and virtuality in vocational training." In *CHI'00 Extended Abstracts on Human Factors in Computing Systems*, pp. 137-138. 2000. <https://doi.org/10.1145/633292.633370>
- [5] Kesim, Mehmet, and Yasin Ozarslan. "Augmented reality in education: current technologies and the potential for education." *Procedia-social and behavioral sciences* 47 (2012): 297-302. <https://doi.org/10.1016/j.sbspro.2012.06.654>
- [6] How Augmented Reality Works. (February 28, 2017). In Augmented. Retrieved March 14, 2019, from <https://www.augment.com/how-augmentedreality-works/#>
- [7] Chang, George, Patricia Morreale, and Padmavathi Medicherla. "Applications of augmented reality systems in education." In *Society for Information Technology & Teacher Education International Conference*, pp. 1380-1385. Association for the Advancement of Computing in Education (AACE), 2010.
- [8] DJJ5123 Pneumatik dan Hidraulik, Chapter 3, Politeknik Kementerian Pendidikan Malaysia Version Jun 2019
- [9] Buckle, Peter. "Ergonomics and musculoskeletal disorders: overview." *Occupational medicine* 55, no. 3 (2005): 164-167. <https://doi.org/10.1093/occmed/kqi081>
- [10] Rahman, Zairina Abdul, and Abdul Sallam Atiya. "Prevalence of work-related upper limbs symptoms (WRULS) among office workers." *Asia Pacific Journal of Public Health* 21, no. 3 (2009): 252-258. <https://doi.org/10.1177/1010539509341423>
- [11] Nurul, Izzah, Abdullah Haslinda, Moin Saidi, Bahri Shamsul, and Hashim Zailina. "Prevalence of low back pain and its risk factors among school teachers." *American Journal of Applied Sciences* 7, no. 5 (2010): 634-639. <https://doi.org/10.3844/ajassp.2010.634.639>
- [12] Nippert, Charles. "On line experiments-the results of the Online Widener Laboratories." In *32nd Annual Frontiers in Education*, vol. 1, pp. T2E-T2E. IEEE, 2002.
- [13] Rajagopal, Venkatesan, Rosmah Mohd Rosli, Pederlia Rintai, Nurani Rustim, Rita Benadus, and Warni Usai. "The prevalence of computer-related musculoskeletal pain among college students: a cross-sectional study." *Am Med J* 3, no. 1 (2012): 33-36. <https://doi.org/10.3844/amjsp.2012.33.36>
- [14] Pugh, Stuart. "Concept selection: a method that works." In *Proceedings of the International conference on Engineering Design*, pp. 497-506. 1981.
- [15] Pneumatic Training Kit Mohd Nasrullah, Muhamad Thoriq, Ahmad Azmir and Siti Aminah (Julai 2010) Final Year Project Report Diploma in Manufacturing Engineering , Politeknik Tuanku Sultanah Bahiyah.