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Laptop Riser, a Useful PBL Project for Diploma Students in Engineering Design

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ABSTRACT

A useful project is identified for the semester-four diploma students in their final workshop of mechanical engineering program in the school of engineering at Australian college of Kuwait (ACK). ACK is putting significant emphasis in project based learning (PBL) and is developing new courses for both diploma and degree programs according to PBL style. In the final workshop project, it is required that the students design and manufacture a foldable laptop riser during fourteen weeks of their works. This project uses welding, cutting, drilling, and bending processes. It is expected that the deliverable product of this workshop is to be used in offices of ACK faculties and staff to raise the laptop height to provide an ergonomic and healthy office use. Students gain experiences in developing their own ideas, acquainted with preliminary design calculations, make sketches and drawings, build their laptop risers, and report their learning outcomes. The students are allowed to work individually or in a team of two to three students. The students are asked to satisfy specific requirements and fulfill certain restrictions such as pre known available materials, sizes and dimensions, and quality of finished product. We found that students are satisfied with their learning and developed skills and also enjoyed to see their end products are utilized in the ACK offices.

Keywords: Design process, Laptop riser, Project based learning, Workshop project.

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INTRODUCTION

The concept of problem based learning (PBL) was probably initiated from McMaster University (De Graaff & Kolmos, 2007) although the idea was applied in nursery schools, medical sectors, and other areas earlier (Schweinhart & Weikart, 1997; Van der Vleuten et al., 1991; Sang, 2001; Schmidt, 1993). The acronym PBL was later extended to Project Based Learning in engineering discipline (De Graaff & Bouhuijs, 1993; De Graaff et al., 2006). A PBL facilitator guide was developed in Australian College of Kuwait (ACK) for consistency of delivering all PBL units in ACK in which the instructor job is described as "facilitator" rather than general lecturing (Jaeger & Adair, 2015; Jaeger, 2017). The effective learning of students in PBL are described by project oriented, student self-directed, activity-based, real life context, analytical thinking required, and team-based learning. In the PBL environment, students should work professionally to develop a useful end product satisfying customers, here stakeholders from the ACK staff and the workshop instructors and teaching and workshop assistances. During workshop sessions, students should follow all safety rules and should wear personal protection equipment (PPE) at all times. In the ACK PBL environment, the emphasis is on learning outcomes (Jaeger, 2017); therefore, students may pass their workshop if they perform their tasks professionally. It is important for the workshop unit that the end product is deliverable and meets requirements; although, more credential will be given to quality executed projects.

THE MECHANICAL PROJECT SEMESTER 4

The unit of "Mechanical Project Semester 4" delivered in the department of Mechanical Engineering at ACK, introduces occupational health and safety regulations regarding workplace, machines and hand tools; layout and mark dimensions on work piece; perform basic bench work operations: machining, such as drilling, tapping, forming, shaping, filing, welding, and cutting with hacksaw, assembling of components, and checking all components for conformance to specifications. The course objectives and student learning outcomes of this unit are listed as:

1. Independent and self-managed performance,
2. Work effectively with team - all team members are expected to contribute accordingly,
3. Apply knowledge on safety procedures and use personal protective devices,
4. Select materials according to the requirements specified in the drawing and provided materials,
5. Layout and mark dimensions and features in accordance with drawing specifications using bench work tools and equipment, and
6. Check the components for conformance to specification.

THE PROJECT OF LAPTOP RISER

The brief explanation of the project as was expressed for all workshop students in semester 4 in the department of mechanical engineering at the Australian College of Kuwait in fall 2016 is as follows:

Project Requirements

ACK requests the design and manufacturing of foldable laptop riser that will be used in offices to raise the laptop while working to provide an ergonomics healthy workplace (Ergonomic Benefits of a Laptop Stand, 2017). The design process will involve preliminary design calculations, sketches and drawings. As for manufacturing, your capacity must include:

(i) Welding,

(ii) Cutting,

(iii) Drilling, and

(iv) Bending.

The purpose of the final piece of design will be used later in ACK for other extra-curricular indoor/outdoor activities and for marketing purposes. The students will be divided in teams.

Design Restrictions

The task is to deliver a high quality laptop riser. The product should be stable, looks nice and rigid structure. The requirements are set by the instructor and he would like a student to be designer and manufacturer of the product. To complete this task, students must meet the following design minimum requirement:

1. Adjustable height to the maximum of 27 cm,
2. The size of the riser should not occupy more than 45x45 cm space on the table,
3. Inclination adjustment,
4. Laptop size (12-17 in),
5. Screen flexing backwards,
6. The space under the tray can be used to store external keyboard,
7. Laptop ventilation to take laptop heat away,
8. Safety features for example no sharp edges or harmful to touch,
9. Easy to handle or adjust,

10. Light in weight,
11. Aesthetics: looks good,
12. Balanced: doesn't fall when laptop is mounted, and
13. Must have good cables management.

Design Factors & Criteria

In addition to the minimum requirements, certain design factors that students must consider to score highest marks are:

1. Safety,
2. Reliability,
3. Durability,
4. Recyclability,
5. Ease of storage, and
6. Ease of operation.

Available materials

1. The team is requested to design and build the structure based on the given constraints and criteria.
2. Each team will be provided with a set of raw material that must be used for the project.
3. The team will provide the instructor with final and confirmed design with CAD drawings showing all details (assembly and each part) about the design including all dimensions. Students are not expected to provide drawings on hardware such as screws, bolts and nuts unless designed especially for this project.
4. Any late submission (report or prototype) will cause a 5 mark deduction per day late (maximum 3 days after which no reports will be accepted!).
5. Sufficient materials will be provided. No additional materials will be provided.
6. It is unacceptable to change the design after submitting the final design.
7. Tasks should be divided among team members as each student will be evaluated based on his contribution instructor observations through the semester.

Report documentation & presentation

Final Report must be submitted on week 14. The report should include all details about the design. Additional details may include:

1. Mathematical calculations,
2. Component and assemble drawings,
3. Bill of materials,
4. Assembly instructions,
5. Tools information, and
6. Cost information.

Grading of Products

The instructor will give the highest mark to the best project based on the following criteria

1. Meeting the instructor requirements as stated above,
2. Stability of structure,
3. Precise connections of structural,
4. Quality of the finished product. (Welding, drilling, cutting & bending),
5. Resources used,
6. Sustainability impacts, and
7. Strength.

METHODOLOGY

The students start with developing their own ideas and complete their designs by week four. All drawings must be generated using a standard CAD and be completed by week 4. The system drawing details should be clear enough for manufacturing. Team should also provide extra information such as:

- Any extra materials, additional screws in case they are unavailable at the workshop.
- Cost comparison between the riser built by the team and risers already available in the market.

Students must show high level in the following skills in building the riser during weeks 5 to 14. They will be assessed on cutting, welding, drilling and bending. All the four skills must be used in these workshop sessions. No external work source or work outside of the workshop is accepted. Safety in attending the workshop is the highest priority. Any student does not follow the safety rules will automatically excluded from workshop. PPE must be worn at all times. Any student missing three workshops will fail the unit. Students should adhere with the ACK

workshop behavior policies. Students without PPE were not allowed to participate with the workshop activities. All products must be submitted by week 14 or earlier if completed.

RESULTS AND DISCUSSION

Team Design 1

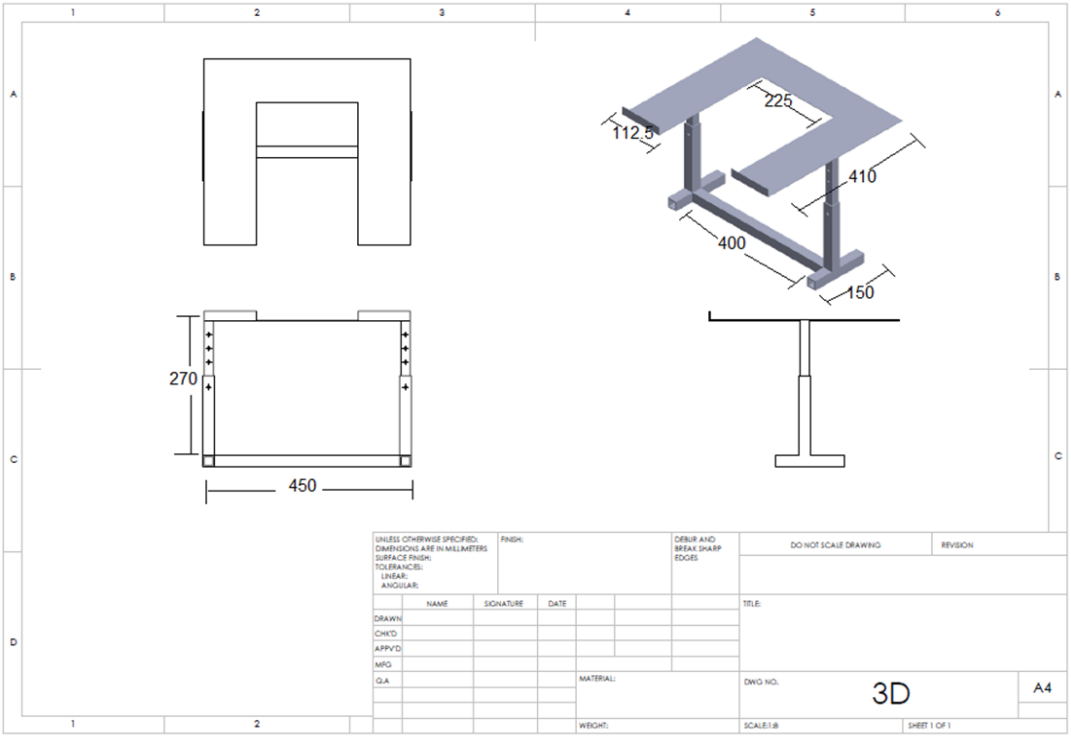

Figure 1: Team 1 design of a laptop riser

Team 1 had designed the laptop riser as shown in Figure 1. The inclination was provided with a locking knob and hinges are used to adjust the height of laptop riser to desirable height. The overall weight of the manufactured riser was 3.2 kg and all requested processes were applied (see Figure 2). The finishing of the product was impressive and the end product is adopted in one of ACK offices.

Figure 2: Team 1 the manufactured laptop riser

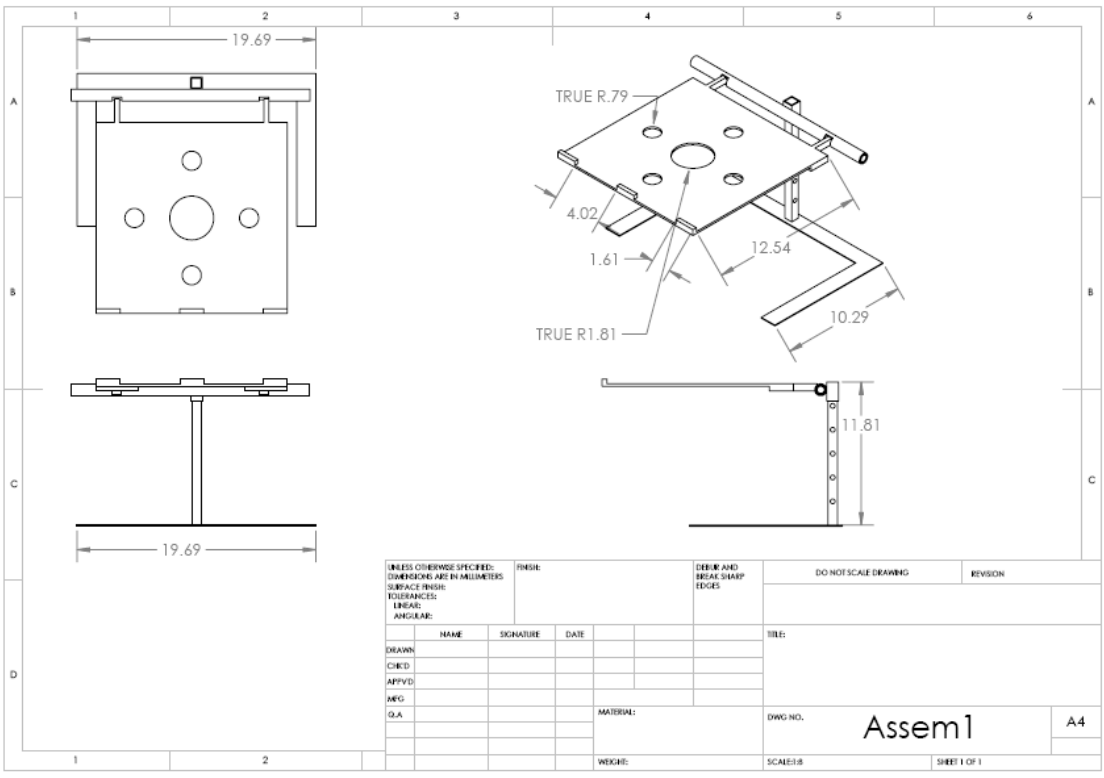

Figure 3: Team 2 the design of a laptop riser

Team 2 designed the laptop riser as shown in Figure 3. The inclination was provided with a new idea of using double tubes and hinges to adjust to desirable angles. The height of the laptop riser was adjustable using square tubes. The overall weight of the manufactured riser was below 3.5 kg and all requested processes were applied. The finishing of the product was satisfactory and the end product is used in an ACK office.

CONCLUSIONS AND RECOMMENDATIONS

ACK has a rigorous plan to promote PBL courses in the Engineering departments, including Mechanical Engineering, to foster sustainable engineering development. The unit of "Mechanical Project Semester 4" has progressively been improved over the past few years. This workshop unit is now developed to expose our final year diploma students with real life problems and challenges. This would allow students to familiarize themselves with the PBL style of learning.

Most of the successful students in the diploma program are now pursuing degree studies. At ACK school of engineering presents some of the students' achievement in PBL units in the exhibition day. Since PBL scheme is introduced to both diploma and degree programs we recommend arranging a PBL exhibition day alongside the ACK PBL symposium day or side by side to the school of engineering graduation exhibition day. By sharing the details of course and reporting experiences we aim to provide some insight for implementation of the course in other institutions.

The restrictions are imposed to student are the required processes of welding, cutting, drilling, and bending and also to use ACK workshop materials and tools. During the first four weeks students develop their design ideas and finalize their Auto-CAD drawings and for the rest of weeks they build their laptop risers. Students have to follow supervision of instructors, workshop tutors, and workshop technicians. Based on the experience of this course we would add an estimate of the needed budget for the future semesters detailed about materials and processing cost and required man power which will be used for assessment of the product.

Students are encouraged to send and receive feedbacks which have helped considerably on how to run this workshop unit and how to help students to achieve their best. From the received feedback, more examples of previous semester project ideas shared with students, and the developed knowledge are shared among lab technicians, instructors, and new students. Examples of what entries are expected in their final reports are explained. These changes, together with the eagerness of ACK students to learn and to have hands on works, created a promising learning environment.

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