Advanced SolidWorks course curriculum development

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1 BACKGROUND

1.1 Introduction

The project is to design a new course of advanced SolidWorks. The objectives of the project are to come up with a course that will allow engineering students to do advanced engineering graphics using an available graphic software. At this stage, the student should have a basic understanding of engineering graphics and how to use computer-aided design. This new course will provide the student with advanced knowledge on design features and tools that will allow them to come up with more detailed and accurate engineering drawings using parametric computer aided design tools. This program is imperative for the engineering department and the university at large. The aim of the school is to produce competent students who can succeed in their various areas of specialization. This course is designed to allow engineering students to come up with advanced engineering graphics using parametric computer aided design software [4].

1.2 Project Description

The project for this class is to create a new course for advanced SolidWorks. The sponsor of the project wanted a new course created that built on SolidWorks. However, this was to be an advanced course allowing the student to learn about advanced aspects of SolidWorks. The course would focus on teaching the student advanced features, tools and techniques that enabled them to be more productive when using SolidWorks. This project description is the original description given by the sponsor. It aims to advance on several courses already available that introduce students to using parametric computer aided design software as well as SolidWorks software.

Our sponsor says about the project description is:

> "The Mechanical Engineering Department at NAU is interested in creating a new course to follow ME 180: Introduction to SolidWorks. This newly developed course will expand on the harder features of SolidWorks such as rendering, animation, multibody features, advanced sweeping, equations, sketch blocks, assembly visualization, advanced drawings, etc. This project will require the team to become SolidWorks experts in these advanced skills through the use of SolidWorks built-in tutorials, but be able to create their own tutorials and homework assignments."

It will provide the student with the extra knowledge and skills needed to make them more efficient when using this software for their work. The final deliverable for this project will be a 16-week sophomore/junior level SolidWorks course. The course will outline all the course content for the 16-week program including tutorials, homework instructions, and assignments. The deliverable will also include a breakdown of the course into teaching, homework, quizzes, attendance, exams, and the final project.

1.3 Original System

The original system is the ME 180 (Engineering Graphics) course. It is one of the classes that are offered in Mechanical Engineering plan. The ME180 course consists of an introduction of the SolidWorks program and 2D, 3D sketches. SolidWorks program is one of the most important parametric computer aided and design software available in the market today. It has many features that allow a user to build, design, create, and print. These features make it more advanced than other programs available. ME 180 aims to teach the student the basic understanding of the fundamentals of graphical communication, computer aided design, drafting and parametric modeling.

1.3.1 Original System Structure

ME 180 (Engineering Graphics) is a class that offers fundamentals of graphical communication including sketching, computer aided drafting, design and parametric modeling. The prerequisite for this course is MAT125 (Pre-Calculus) where some students should have qualified with a grade greater than equal to C. this will be a face-to-face instruction class with twice a weekly class each lasting 75 minutes. Typically, each week consists of one lecture, then one workday (the workday has little class instruction and more one-on-one help from the instructor and class aide).

1.3.2 Original System Operation

The ME 180 course met twice weekly for 75-minute sessions each. The coursework included 12 homework assignments from the main instruction book and the teacher, which made an overall of 20% of the final grade. Fourteen class activities and nine online quizzes come up with another 20% of the final grade with three exams, the first two equal to 15% each and the final exam equal to 20% of the final grade. Class attendance and participation make up 10% of the final grade.

1.3.3 Original System Performance

The objective of the original system was to provide students with fundamental knowledge of engineering graphics. It provided students with basic knowledge in parametric design, and computer aided drafting, design, and sketching. From these objectives, the system was successful. It was able to meet its aims. It resulted in students who were able to understand the basics of engineering graphics but was not professional enough to use SolidWorks advanced features and to draw advanced systems or designs by hand. However, the design of the course was acceptable to the students with clear workflow, which allowed the students to perform well in the course.

1.3.4 Original System Deficiencies

The original design of the system had some deficiencies that led it to not being able to meet certain requirements of the market. The original concept was basic in nature, which required that students were introduced to the fundamentals of engineering graphics. However, more professionals with advanced skills in engineering graphics were needed which resulted in the students who had completed the original course not being able to meet market demands. The employment market seeks graduates who could use advanced features of available programs and therefore produce drawings that are more sophisticated. The design of the class also had some problems with the lack of online classes being an issue for students unable to make the physical meetings. The design of the course also lacked sufficient drawing by hand which is an oversight as drawing by hand is necessary to improve the skills of the students.

2 REQUIREMENTS

This subsection contains the customer, engineering requirements and house of quality that the project should be in a position to meet. These requirements will also help guide the project team when making appropriate selections regarding the best solution. The main reason for this observation is that the best possible solution should satisfy all the requirements. The house of quality table will organize our ideas and manage them.

2.1 Customer Requirements (CRs)

There are seven customer requirements for this project, which are in HoQ table in section 2.3. The first of these is that the course should be more advanced than ME 180. It is imperative, as one of the deficiencies of the original system was that it was producing students with only a basic knowledge of engineering design. However, these students were not able to possess the advanced knowledge and skills needed by the design market. By making the course more advanced than ME 180, it will produce students who have advanced knowledge of engineering graphics which will be able to attempt more advanced and professional projects with available resources. The second customer requirement is that the course provides hand drawing 3D skills on paper. One of the significant deficiencies noted in the original course is that there were no enough hand drawing skills for the student. However, these skills were realized to be critical in making the students more creative and needed to be addressed in the new course. It would allow the students to be more creative and professional after the new direction.

The third requirement of the new course is that it provides quizzes and tests on student's ability in SolidWorks. One of the biggest problems identified in the original course was the lack of class work quizzes, which had been replaced entirely with online quizzes. Given that class, quizzes provide more motivation for the students and allow the instructor to be able to judge the progress of students. Therefore, this is of particular importance when assessing students' ability to use SolidWorks software as the instructor can provide immediate feedback.

Another customer requirement was to provide extra help beyond the classroom. Many students may experience difficulty if they are not able to keep up. It can be a particularly severe problem in the advanced class, and outside of class, help should be considered to ensure that no student is left behind. Another customer requirement was to use real world experiences and apply them in the course. It is imperative in the modern world. The class is aimed at equipping students with advanced knowledge of engineering graphics, and they will be expected to use this understanding in reality. By incorporating real-world experiences in the course work, the course prepares the students for life in the real world where they will have to apply the lessons they have learned to create real world projects.

Another customer request is to structure the course around themes. It is vital as it allows the students to identify the lessons with the themes, which the course is designed around. It provides better understanding and allows students to become more creative and comfortable while studying the course. The final customer requirement for the course is that students work in groups in some assignments inside and outside of class. It is a crucial condition for the course. In the modern world, different people have different specializations. However, to achieve some major projects, collaboration is necessary. Collaboration allows a complex problem to be broken down into smaller problems and the collaborators can address the issue. Group work provides an avenue for the students to learn how to collaborate to make efficient team players as this is a vital skill necessary in their professional working life.

2.2 Engineering Requirements (ERs)

The Advanced SolidWorks course has nine engineering requirements, which are in HoQ table in section 2.3. The first engineering requirement is that the class contains at least five assignments based on the 3D drawing. It is explanatory 3D drawing will act as the base for the course. It will allow students to have the required knowledge on advanced engineering graphics, which mainly involves 3D drawing. The second engineering requirement is that the class contains at least nine assignments based on advanced features in SolidWorks.

The course aims at enabling students to be able to use advanced features of engineering graphics. SolidWorks is the most appropriate program utilized in the field and being able to use its advanced features shows that the students have understood the course. The assignments on this will ensure that progress can be tracked and performance assessed. The course should consist of at least three exams. The distribution of exams will allow student grading and offering an opportunity for students to identify their weak areas. The course should also consist of at least nine quizzes. Quizzes are important in determining the progress of a student on a given task. It will help in their progression in the course. The course requires that there should be at least six lectures in the semester. It is crucial as it provides the tutor with the opportunity to offer instruction directly to the students. At least six labs in the semester is also a requirement of the course. It provides the students an opportunity to practice what they have learned in the presence of tutors. It allows direct instruction and feedback on the more practical aspects of the course.

The course should also consist of at least six different themes. Different themes allow the students to be aware of various situations where the knowledge gained can be applied in the real world. It made learning more enjoyable and directed at real world problems. The course should also consist of at least two extra-credit homework assignments. It is imperative as they provide an opportunity for students who might have started slowly to catch up with the rest of the students and be able to complete the course successfully. The final engineering requirement is that the course should contain at least three outside class tutorials. Outside of class, tutorials are paramount as they show the students a real life situation where the lessons they are learning are being applied. It provides motivation for the students and allows them to connect their theory and practical lessons with real world situations.

2.3 House of Quality (HoQ)

In the previous section, some customer and engineering requirements have been identified. These requirements will find use in the development of the HoQ which is in Appendix A. They will be added to the HoQ to determine their importance. It is achieved by assessing the relationship between the customers and engineering requirements. The HoQ is critical to the project since it determines the significance of the customer requirements as compared to the engineering requirements. It ensures that the final design selected meets the customer and engineering requirements.

3 EXISTING DESIGNS

This section examines the existing designs. It provides information relating to the research conducted to seek existing designs. In this case, three existing designs were considered (ME 105, ME 186, and ME 463). This section also presents the system-level description of the existing designs and their relationships with the requirements. The section also displays subsystem level descriptions for the existing designs. These include programs, 3D printing, and themes. Lastly, it shows the WBS of the new course.

3.1 Design Research

This project considered three existing course designs. ME 105 is a Mechanical graphics class in Boise state university. Students receive an introduction to drawing sketches and using the SolidWorks program. This class acts as a prerequisite for more advanced classes.

ME 186 (Computer aided design for mechanical engineering class) is offered at California State University at Northridge. This course introduces students to how to make parts, assembly, drawing sheet and 3D drawing. This class provides skills that are important in many advanced classes on the same subject.

Finally, ME 463 (Biomechanics) offered at Northern Arizona University is the last existing design. This class has been selected because it involves many SolidWorks. Specifically, it includes the creation of human bodywork, which will be designed in SolidWorks.

3.2 System Level

ME 186 (Computer Aided Design for Mechanical Engineers) is a course designed as an introduction to concepts in engineering graphics and their implementation with CAD parametric modeling tools. This course's design meets the requirements for the new system. The course design is designed in a manner that can meet the engineering requirements of the new course. For instance, it makes use of different exams, quizzes, projects, lab homework, and participation as all-important aspects to the final grade.

ME 105 is a class designed to introduce students to engineering design graphics theory and practice applied to manufactured products using hand drawing tools and SolidWorks CAD software. The course covers concepts required to transform a user form a novice level to the intermediate user of SolidWorks software. It is an alignment with the requirements for the new class.

ME 463 (Biomechanics) course is designed to provide students with an understanding of the mechanics and mathematical analysis of the musculoskeletal system, the materials used in orthopedic applications, and control system modeling of biological tissues for use in orthopedic devices. Most of this work will be achieved by the use of SolidWorks software at an advanced level and therefore meets one of the essential requirements for the course.

3.2.1 Existing Design #1: ME 105 from BSU

The system level existing design is directed towards introducing the students to a new dimension of

graphic designing. The new design will rely on the use of SolidWorks during implementation. The students in the system level design will also use hand-drawing tools. The design relates to my requirements in the sense that, it will involve the application of technical skills and use of hand tools; it will, therefore, help improve manual abilities that will encourage technological innovation.

The key objectives for the system-level existing design are to introduce mechanical engineering students to engineering graphics by equipping them with the fundamental knowledge of graphical parametric modeling, design, communication, and computer-aided drafting.

ME 105 Engineering graphics, this course is to introduce students to engineering design graphics using hand drawing tools and SolidWorks. There is two lecture for this course that meets 75 minutes each week, and the prerequisites are math 170 (Calculus 1). Moreover, the syllabus of this course breaks down to attendance, design project, quizzes, in-class exams, and a final exam. The homework for this course will be assigned on the blackboard but is not required to turn in the homework, yet is necessary to understand the how to solve the problems because the quiz is going to be similar to it. The exams will consist of questions designed to test your knowledge of the material comprehensively. For the project, the student will create a 3D assembly, and on the last day of the semester, students are required to present the project to the instructor and save the project in his/her university account. The grading for this course is going to be ten percent of the attendance, twenty percent for the design project. For the quizzes, there are five quizzes each one 5 percent, so the total is twenty-five percent. For the exams, there are two in-class exams the total is twenty-five percent and twenty percent for the final exam.

The homework for this course is not required to submit it, which will make the student ignore the homework. Therefore, the homework has to be needed to do it so that the student will learn more from it to get a high score in the quizzes and exams in this course. Furthermore, the in-class assignment goes to the attendance grade. Also, it is required to buy a kit for the class to do the 3D sketches and measure the Lego parts to use it in SolidWorks for the dimension.

3.2.2 Existing Design #2: ME 186 from CSUN

The system-level existing design is related to the requirements since it incorporates modern a more efficient ways of communicating engineering designs. It is also founded on the most recent developments in technology and design engineering. It is, therefore, a proper suit for inculcating skills that are aligned to the current demands in graphic engineering.

ME 186 Computer aided design for mechanical engineering, this course is to introduction to concepts in engineering graphics and their implementation with computer-aided design. This course has one lecture that meets for 210 minutes each week. The syllabus breaks down to lab homework, attendance, in-class quizzes, reverse engineering project, written exam, hands-on exam, final design project, final written exam, and final hands-on exam. The grading for this course for the lab homework, in-class quizzes, reverse engineering project, written exam, and the hands-on exam is ten percent. For the final design project, final written exam and the final hands-on exam is fifteen percent and five percent for the attendance.

This course has too many assignments for one lecture each week; there should be at least two lecture each week. Also, the exams should be two exams and final exam, one is written and two on SolidWorks.

Moreover, for the project, the best thing is to combine the reverse engineering project and the final design project to one project for the course.

3.2.3 Existing Design #3: ME 463 from NAU

The primary objective of this class will be to equip students with competency skills that reflect the current demands in biochemical engineering. ME 463 Biomechanical Engineering, this course is designed to provide students with an understanding of the mechanics and mathematical analysis of the musculoskeletal system, the materials used in orthopedic applications, and control system modeling of biological tissues for use in orthopedic devices. In additional, this course is two lecture 75 minutes each week with four prerequisites. The syllabus is homework and quizzes for fifteen percent, a design project for ten percent, which includes SolidWorks on it, and three exams for seventy-five percent. There will be homework assignment every week. The quizzes will be one to two before each exam. The exams will be one in mid-semester and one before reading a week and the last one in the final week.

This course uses Top Hat that all class materials are in it, and it does not use Blackboard. The homework has a particular paper (engineering paper) and GIVEN-FIND-SOLUTION format. Additionally, all the quizzes are online on Top Hat.

3.3 Subsystem Level

This section includes the subsystem level descriptions for the existing designs, which include programs, 3D printing, and themes. The three programs considered in this project are AutoDesk, AutoCAD, and Catia. Under 3D printing, the solutions selected are Fortus 400MC, MakerBot, and Robo 3D R1. Lastly, the themes considered are Lego, Knex, and Meccano.

3.3.1 Subsystem #1: Programs

The following existing design programs will be used in the implementation of the syllabus: AutoDesk, AutoCAD, and Catia. The programs are designed to improve the efficiency of engineering project planning, execution, and evaluation. The programs have also made a significant contribution to the ability of engineers to develop both diverse and complex designs.

3.3.1.1 Existing Design #1: Autodesk

Autodesk is a program that allows the design of complex models [5]. It has many advanced features and allows compatibility with other programs. The user interface is intuitive and easy to understand, making it suitable for engineers and architects to use with no help. It helps the team to benchmark since it is possible to determine whether it meets the customer or engineering requirements provided. Furthermore, it will assist in ensuring that the students are in a position to produce complex engineering designs.

3.3.1.2 Existing Design #2: AutoCAD

AutoCAD is a complex program that requires a lot of training to use and perfect. It has professional level tools and is difficult for many students to understand [9]. The program also has a problem with compatibility even with the most standard computer programs. The base views for the program are also very basic making the design of complex designs difficult. This subsystem is important to the team since it will assist the team in benchmarking by determining whether the existing design meets the needed

customer and engineering requirements. This valuable tool allows students to improve their drawing and modeling skills, which are essential to the success of the project.

3.3.1.3 Existing Design #3: Catia

Catia is a professional level tool used to design a wide range of products. One of the major advantages of Catia is that it can model the item as well as its behavior in the real world making it easier to manipulate [2]. However, the program is highly advanced and requires a lot of training and learning to be able to use effectively. It helps the team to benchmark since it is possible to determine whether it meets the customer or engineering requirements provided. This tool will also assist the team in providing real-life experience to the students. It is mainly because it finds widespread practical use in engineering modeling and design.

3.3.2 Subsystem #2: 3D Printing

3D printing is the use of special purpose printers to print three-dimensional objects from three dimension measurements derived from computer software. The existing designs examined under this section are Fortus 400MC, MakerBot, and Robo 3D R1.

3.3.2.1 Existing Design #1: Fortus 400MC

It has exciting features that are compatible with most programs. However, better integration is needed by enhancing its features. It works well with other programs for 2D viewing but is hard to use with applications such as AutoDesk. It will, therefore, provide customers with a highly efficient interface unlike traditional programs [10]. It will help the team benchmark the system since it offers 3D printing solutions, which are an integral part of the engineering requirements for the project.

3.3.2.2 Existing Design #2: Maker Bot

It is an existing 3D solution that is compatible with most 3D graphics programs such as SolidWorks. However, it is proprietary which means that the level of integration is better suited for proprietary software owned by its owner [7]. It will help in benchmarking the system since it provides a 3D solution compatible with SolidWorks, which meets part of the project requirements. Although it has advanced features, it does not support much 3D software. It means that maximum utility for this system can only be obtained when using software provided by the manufacturer.

3.3.2.3 Existing Design #3: Robo 3D R1

This 3D printing solution offers compatibility with most of the available 3D graphics software. The company offers highly innovative 3D printers that provide plug and print options, as well as, allowing large build volumes [8]. The solutions provided by the company will be highly applicable in 3D printing. It makes it appropriate for benchmarking the systems since it offers and innovating 3D printing solution.

3.3.3 Subsystem #3: Themes

The themes that will be used in the class are all based on construction sets designed to allow people to come up with three-dimensional models of real life objects. The themes selected are Lego, Knex, and Meccano. These three provide building block sets, which are critical to the construction of 3D models.

3.3.3.1 Existing Design #1: Lego

It provides building blocks that can be connected in multiple ways to come up with different three-

dimensional models [6]. The use of various blocks in multiple combinations means that the number of possible models is limitless. It helps the team benchmark the systems since part of the customer requirements need to course to be structured around themes. Lego provides an excellent solution for building models. Lego bricks have been used in numerous projects. The different Lego kits offer options for various types that can be created. The interconnectivity of the different building blocks makes it possible for the user to recreate a model of almost anything in the physical world as long as the components are larger than a single Lego block. It is important as it will provide the students the much-needed skills in 3D modeling.

3.3.3.2 Existing Design #2: Knex

It provides building sets designed for different scientific projects that allow models of scientific objects to be created. The biggest problem is that the models are limited in number meaning that the numbers of objects that can be modeled are limited [3]. The model will help achieve client design specifications more efficiently. It will also assist the project team benchmark the systems as part of the customer requirements need to course to be structured around themes.

3.3.3.3 Existing Design #3: Meccano

It provides a set of color-coded building blocks that can be assembled to create intricate models. It allows for creativity by allowing builders bring their imaginations to life using the construction systems offered by the company. The company achieves this by providing building blocks that can find use in building models. It will help the project team benchmark the systems since part of the customer requirements need to course to be structured around themes. Despite the ease of use and color-coding, the number of options available with Meccano is limited. The products offer a limited set of building blocks that can only be used for specific types of models. It means that there would be a problem with the user if the design they would want to create cannot be accommodated by the building blocks available [14].

3.4 Work Breakdown Structure (WBS)

The team developed a work breakdown structure (WBS) which is in Appendix B. It provides an overview of how the new course will be organized. It will start with the course outline, course materials, and course prerequisites and progress systematically to the lowest level that will include individual tasks such as grading and TA sessions. The WBS provides an easy guide to determine how the work will flow in the new course and the people responsible for different tasks. It helped the team because it was possible to determine the course, materials, and pre-requisite classes needed for the Advanced SolidWorks class. It was critical towards the development of a solution meeting the laid out requirements.

4 DESIGNS CONSIDERED

In this section, a number or tools, programs, and a variety of user interfaces are described. It will also include the different kits that engineers and clients could use to analyze designs and the possible outcomes from projects depending on input from both engineers and client. Sources for insights and inquiry that could aid clients and engineers are also discussed. A description of the various merits and demerits associated with each is also included.

4.1 Ideas on Themes Project

For this project, ideas on the themes it will be indicated on the new course that our team will structure like Lego, advanced tutorial from SolidWorks and apply real world experiences. Topics ideas it will help the student to be more creative and smart.

4.1.1 Design #1: Lego

Students can use Lego bricks in classrooms or as part of homework in building 3D models of different designs. The students could receive different Lego kits, and each kit can be used in multiple ways. This means that Lego kits can find use in creating a wide range of projects. The parts can be used in SolidWorks software and also be physically built using the kit. Lego kits are cheap and allow multiple designs to be used. Therefore, the institution can afford to provide each student with a Lego set.

4.1.2 Design #2: Advanced Tutorials from SolidWorks

The students are going to use advanced tutorials from SolidWorks in the classroom to equip themselves with the skills taught. Furthermore, students will be required to review some of the advanced tutorials outside the classroom as part of their homework. Advanced tutorial from SolidWorks can provide a lot of the instruction needed to use all the features of the software. However, it only provides instructions, and a person needs to practice and be guided through the more sophisticated features of the software. The advanced tutorial provides step by step instructions to use the advanced features of SolidWorks. However, if a student is unable to understand a problem, there can be a problem since they would not be in a position to interact with someone more knowledgeable.

4.1.3 Design #3: Apply Real World Experiences

The students will be provided with problems relating to real-life examples as part of their assignments. They will be required to provide realistic solutions to the problems posed. Applying real world experiences is crucial for this situation as the course is designed to make students more productive in reality. However, replicating real world experiences can be difficult in the classroom especially for new students. It can more easily be achieved by providing the students with examples from industry that require the particular skill set they possess.

4.2 Ideas on Course Structures

In our project, course structure will be the different types of a syllabus that the team creates like syllabus A, B, and C. It will help the student to throw the course with good grade and understanding.

4.2.1 Design #4: Syllabus A

The first syllabus will be composed of Exam (60%), Quiz (5%), Homework (20%), Project (10%), and

Attendance (5%). The syllabus consists of 4 exams, quizzes in each week out of 10 Q, homework two part, first 3D drawing 5% and other SolidWorks 15%, one project, attendance.

Syllabus A concentrates mainly on the exam, which provides the biggest grading opportunity for the students. It can be a problem for the syllabus as this is a practical course and relying on exams can paint an inaccurate picture of the progress of students. However, if the exams concentrate on the most important aspects of the course, syllabus A can prove to be the best in examining these issues.

4.2.2 Design #5: Syllabus B

The second syllabus will be composed of Exam (25%), Quiz (7%), Homework (50%), Project (15%), and Attendance (3%). It consists of 2 exams one 10% and the second 15%, quizzes in class 5%out of 10 and 2% online by a TopHat out of 5, homework 10% 3D drawing and 40% SolidWorks, project 15%, attendance 3%.

This syllabus mainly focuses on the homework bit, which provides the biggest percentage for grading. It can help students because homework is taking ways providing students opportunity for scoring highly. However, it can be inaccurate since homework can be assisted and would not paint the best picture of the progress of students. However, this syllabus is the most well rounded as it will cover every aspect of the course with the weight it deserves, including in exams, projects, and assignments.

4.2.3 Design #6: Syllabus C

The third syllabus will be composed of Exam (30%), Quiz (15%), Homework (25%), Project (20%), and Attendance (10%). It consists of 3 exams each 10%, 10% quizzes in class out of 10 and 5% online out of 5, homework 20% SolidWorks and 5% 3d drawing, two projects each 10%, attendance 5% class activity and 5% top hat

It is the most evenly distributed syllabus with different aspects of the course contributing towards the final grade. The even distribution of grading makes this the most appropriate syllabus as it will test all the different dimensions of the course equally and has the potential of producing the most well rounded and therefore qualified students. However, there are some areas of the course that are considered to be more important than others. With the distribution of the syllabus, it can be difficult to correctly examine the proficiency of students in these aspects since they are best tested using exams and projects.

4.3 Ideas on Outside Help

The project goal for our team is to make sure that the student gains more help and opportunity to understand the course, our focus is offering all the help outside and inside the class to meet all their needs to be professional.

4.3.1 Design #7: TA Sessions

Students will receive teaching assistance (TA) classes once every week. These courses will aim at ensuring that the students understand the contents of the course. TA sessions designed to helping the students understand the course materials outside the class. It will include assistance in classwork and

projects. Teaching assistant sessions are crucial as they provide the student an opportunity to interact with their instructors. They can allow for immediate feedback although they can be time-consuming.

4.3.2 Design #8: Video Tutorials from Instructor

The instructor will make videos and PowerPoint presentations. This material will be availed to the students as part of the tutorial aimed at ensuring students better understand the course content. It will contain the notes that he explains it to class with more details like showing how he did it step by step. It will help the students to understand the concept of the course. Teach the student new techniques for extra credit. Tutorials can provide the students with information to use the software and other resources for the course. However, they can be misleading or confusing for entry-level students.

4.3.3 Design #9: Group Work

Students will be required to form groups of between 4 to 6 students. The groups will be assigned assignments that they will submit for review. Students can help each other on homework but not copy their work, study exams, and quizzes together. Create new idea to apply it to SolidWorks. Group work is vital for students as it allows them to collaborate on ideas and build on their knowledge. Group work is also important in preparing students to work in teams, which is the reality of their jobs. However, group work can be time-consuming to organize.

4.3.4 Design #10: Instructor Office Hours

Students are allowed to use office hours in meeting instructors and asking questions relating to the content taught in class. They can also seek clarification, as well as, help regarding assignments. The instructor will be required to offer such students the assist the need. Students can meet their instructor on office hours to help them with anything related to the course and make sure each student understand the course. The engineering department can assist any student on the course during office hours. It allows a student to identify their problem and seek assistance. It can be very useful in addressing individual student problems.

4.3.5 Design #11: YouTube Videos

The instructor will find various videos on YouTube relating to the course content and make the links available to the students. In turn, students may also search and find videos on the platform that can help them learn new techniques in SolidWorks. YouTube can be an outside support resource. It is freely available and allows students to compare tips from different users of the same programs. However, the quality of material can be diverse, and students can end up using inappropriate material from the site. YouTube is mainly favored because it is available freely.

4.3.6 Design #12: Outside Help for 3D Sketching from Other Classes

Encouraging students to seek outside help for 3D sketching when they are having trouble would implement this. The use of outside help such as a separate 3D sketching class can be imperative. It would allow students who do not have the necessary knowledge to gain the knowledge without dragging the rest of the class behind. It is also important because it allows students to gain practical knowledge they will need in a new class independently. It means that students who have not had experience in 3D sketching can quickly join the new course.

5 DESIGN SELECTED

5.1 Rationale for Design Selection

The solution selected is the new course, Advanced Tutorial from SolidWorks. It has been achieved because the existing designs of solutions do not expressly meet both the customer and engineering needs of the new system. Pugh chart used in determining the best option contain six criteria. Each has a particular weight (percentage) that it contributes to the final score.

From the Pugh chart below the best design is design # 2 under themes, design # 6 under course structures, and design #9 under outside class help. These solutions had the highest number of positives in the chart. It implies that it is better than the baseline in each of the criteria they received a positive. However, it is important to note that even though the Pugh chart narrows each category down to one idea that only means team is focusing on those ideas now. However, the team will revisit the other ideas as the project progresses. It allows the team to not eliminate the other options for themes and outside help, but allows our team to determine how to create a theme (homework, exams, etc. that revolve around that theme) and how to develop outside help options.

Table 1: Pugh Chart

Ideas	Themes project			Course structures			Outside class help					
Criteria \ Design #	1	2	3	4	5	6	7	8	9	10	11	12
More advanced work than ME 180	+	+	D	-	D	+	+	-	+	-	D	+
Hand drawing 3D skills on paper	-	-	A	-	A	+	+	-	+	-	A	+
Quizzes and tests on their ability on Solid Work	-	+	T	+	T	+	+	+	-	-	T	-
Use real world experiences and apply it in the course	-	+	U	-	U	-	-	-	+	-	U	-
Structure course around themes	+	+	M	-	M	-	+	+	-	-	M	-
Work in groups in some assignments inside and outside the class	-	+		+		+	+	-	+	-		-
∑ +	2	5		2		4	5	2	4	0		2
∑ -	4	1		4		2	1	4	2	6		4

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7 APPENDICES

7.1 Appendix A: House of Quality (HoQ)

Customer Requirement	**Weight**	**Engineering Requirement**	at least 5 assignment based on 3D drawing	at least 9 assignments based on advanced features in SolidWorks	at least 3 exams	at least 9 quizzes	at least 6 lectures in the semester	at least 6 labs in the semester	at least 6 different themes	at least 2 extra credit homework	at least 3 outside class tutorials
1. more advanced work than ME 180	4		6	9	3	6	9	9	6	6	6
2. hand drawing 3D skills on paper	4		9	1	3	1	6	6	3	6	3
3. quizzes and tests on their ability on SolidWorks	5		3	6	9	6	1	6	3	1	9
4. provide outside class extra help	2		3	3	3	1	3	3	1	3	9
5. use real world experiences and apply it in the course	4		1	6	1	1	1	3	6	1	1
6. structure course around themes	3		1	6	3	1	6	1	9	1	1
7. work in groups in some assignments inside and outside the class	4		6	6	1	3	1	9	1	3	6
Absolute Technical Importance (ATI)			112	142	92	79	97	147	108	78	130
Relative Technical Importance (RTI)			4	2	7	8	6	1	5	9	3
Target(s)			7	12	4	12	7	7	7	4	7
Tolerance(s)			5	9	3	9	6	6	6	2	3

7.2 Appendix B: Work Breakdown Structure (WBS)