Laboratory Projects Introduced in Teaching Manufacturing Processes Course

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Introduction

Mechanical engineering students should graduate with strong practical and interpersonal skills [1, 2]. Manufacturing Processes is a fundamental mechanical engineering course offered to junior students in engineering schools [3]. The primary objective of this course is to give students exposure to understanding of a range of modern manufacturing processes and practices. Students are expected to be able to select appropriate manufacturing processes and fabricate parts after completing the course. Normally, this course includes laboratory activities and fabrication projects. Students use different manufacturing equipment and make parts to get a "real" feeling of the manufacturing process. In the past two years, the author has introduced several innovative projects while teaching this course in University of the Pacific's School of Engineering and Computer Science. The goal of the projects is to inspire students' interest in the manufacturing engineering field. Students are expected to use the knowledge learned in this and other engineering courses such as Engineering Graphics and Materials Science to solve synthesis engineering problems. These projects are also aimed at helping students to better understand the fundamentals discussed in the classroom, making learning more enjoyable and improving student satisfaction. This paper will discuss these projects.

Lego block design and fabrication project

The lego block design and fabrication project is a class-wide team project. One objective of this project is to provide students with an opportunity to work with other students in order to improve their communication and team work skills. Each student is required to design a block piece as shown in Figure 1. All blocks have identical outer dimensions. Students are allowed to design geometric features on two planes of the block. The block designs form mating patterns with those designed and fabricated by other students. The instructor specifies the assembly order of the blocks. During the design phase, students must complete their designs and pass them to other students in a scheduled time frame. Students have to interact with each other frequently to discuss the design details and negotiate necessary modifications. Students must completely understand each others' drawings and check for possible mismatches both in dimension and shape. Once each design is completed, the drawing will be arbitrarily given to another student for fabrication.

The blocks are machined using manual Bridgeport mills and NC machines. Through conducting this project, students improve their Solidworks modeling skills learned from Engineering Graphics class. Students also learn that they can be very creative in terms of design; however there could be many constraints in reality of part fabrication. A design must comply with the manufacturing equipment's capability and availability as well as manufacturing time and cost

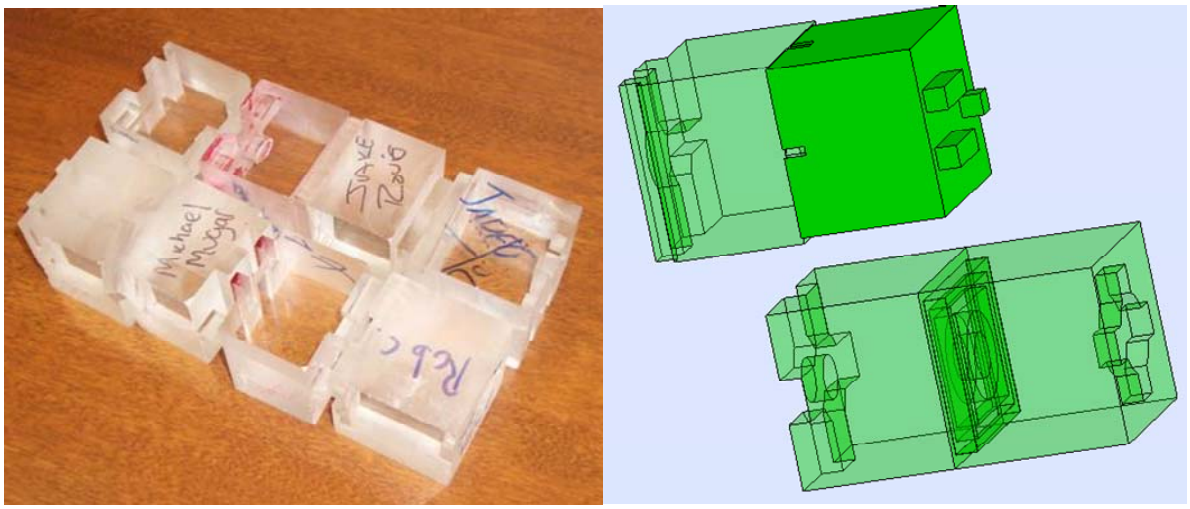

Figure 1 Examples of designed and fabricated lego blocks

requirements. Most importantly, students learn the importance of the team work and how to deal with project progress delays, iterative design modification caused by other team members and other challenges that arise over the course of a project. Figure 2 shows the design assembly and fabricated parts in the Fall 2008's class.

CNC programming and machining project

The CNC machine tool is one of the most important pieces of manufacturing equipment in industry. Almost all industrial products and every day consumer goods include components directly made using CNC machine tools. This project allows students to experience the operation of a modern NC machine. This activity obviously helps students to have a better understanding of the machine structure and component functions. This project also asks student to, using computer aided manufacturing (CAM) technology, create an NC program, which is used to drive the machine to move and act as desired. Using CAM to generate NC programming requires students to determine a machining strategy, operation sequence and cutting tools. Students must also decide the cutting conditions such as cutting speed, depth of cut, feed rate, and other parameters for each operation based on knowledge learned in classroom.

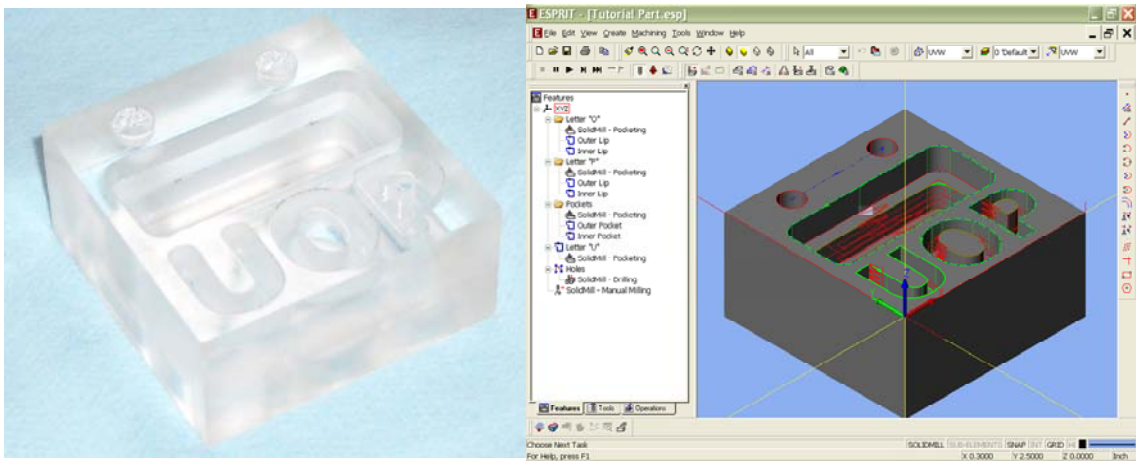

Figure 2 NC programming and machined part

This practice helps students to solidify their understanding of metal cutting theory. A commercial CAM system called “Esprit”, which was donated by the DP Technology Corporation, was used for this project. Students were impressed by the intelligent functions and cutting simulation embedded in this software package. Each student designs a part as shown in Figure 3 and then creates an NC program using Esprit. The NC programs are then uploaded to a CNC machine center (HAAS VF-1) for machining. Students machine the parts themselves under the supervision of the instructor, giving them hands-on experience with CNC machine tools. Through completing this project, students practice the entire part manufacturing cycle from design to manufacturing using the modern manufacturing technology. Students also experience the “joy of ownership” of the parts they make in the laboratory activities.

Part rapid prototyping project

Part rapid prototyping is a non-traditional part fabrication technology used to make product prototypes for design verification before mass production in industry. Using this technology, a part can be fabricated within hours. It is widely used in many engineering fields. This project requires students to design a part by following specifications determined by the instructor. Students then make the parts using a 3D printer purchased from Z-Corp.

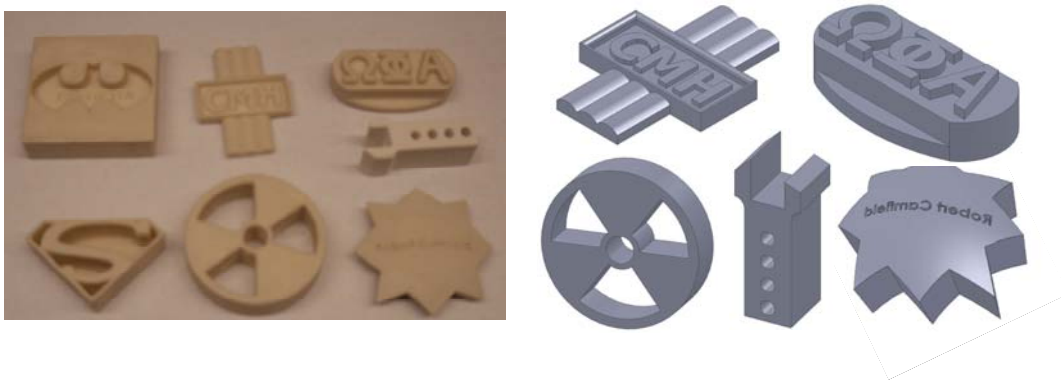

Figure 3 Examples of designed models and fabricated parts

Concluding remarks

Several student projects introduced in teaching manufacturing processes course were shared in this paper. These projects provided students with an integrated environment to work as a team and apply the knowledge and skills learned from other courses to solve engineering problems. These projects improved student's learning and satisfaction.

References

1) Liu, J., (2005). "Digital Engineering Technology in Machine Tool ." Keynote Speech for CIRP/SME SME/CIRP International Conference on Manufacturing Engineering Education, June 22-25, California.
2) Liu, J. (2008), Brown, A, "Enhancing Machine Design Course through Introducing Design and Analysis Projects, " Proceedings of 2008 ASEE PSW conference, March 27th~ 28th 2008, Arizona.
3) Kalpakjian, S and Schmid, R (2001), "Manufacturing Engineering and Technology, 2nd , Prentice Hall(ISBN 0-201-36131-0)

Author's Biography

Dr. Liu has published more than 70 technical journals and conference papers. He was awarded four patents. His research and teaching interest includes manufacturing system and processes, machine design and analysis, and CAM/CAE.