Linkages of Undergraduate Students with Industry: The MMO Connections Program at the University of Toronto

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Introduction

This paper presents an initiative instituted in 1990 at the University of Toronto, Department of Mechanical and Industrial Engineering whereby students in their final year study take on a thesis that has practical significance with local industries. This initiative, entitled the *Materials and Manufacturing Ontario (MMO) Connections Program,* has the central objective to collaborate with industry in the definition of a real problem of relevance to that industry, and to subsequently introduce this problem to senior year undergraduate engineering students for resolution.

The MMO Connections Program facilitates the opportunity for talented students to work on these real-industrial problems, and as a result, both parties benefit. The MMO Connections Program therefore predominantly is one of technology transfer.

History of the MMO Connections Program

In 1990, when the MMO Connections Program was initiated, the undergraduate curriculum focused heavily on technical subjects with little formal attention to writing and communication skills. Additionally, exposure to real world industrial problems was not common amongst the undergraduate students. It was recognized that here has been an increasing need for students graduating with engineering degrees to improve their design and communication skills. Additionally, it was also recognized that there was little opportunity for interaction with engineering staff involved in engineering activity within an industry. Such interaction provides many opportunities to learn basic skills involving meeting schedules, setting deadlines, meeting expectations, use of various modes of communication, email, phone, etc.

To support a learning environment in which many of the above essential skills could be learned, as well as experience real-world engineering problems, an application was made to the Manufacturing Research Corporation of Ontario (MRCO), subsequently renamed Materials and Manufacturing Ontario (MMO) to provide funding for projects with industry, which would simultaneously serve as Fourth Year Undergraduate Thesis Projects. The MMO is primarily a research funding organization, with a mandate to support the training of highly qualified personnel, hence the MMO initiative is consistent with the overall MMO mandate.

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With an MMO funded project with industry, students in their final year can potentially achieve significant benefits from real-life engineering experiences to enhance their experience, better preparing them for their future careers. Additionally, in support of MMO Connections Program, the many industries, both small and large, have engineering problems which require solution within the time frame of a thesis project, thereby providing both practical and useful training problems.

The authors have been coordinators of this important program at the University of Toronto since its inception in 1990. Over 150 students have participated at the University of Toronto. This represents approximately 15 percent of the graduating students in the Mechanical Engineering program. Given the success of the program at the University of Toronto, similar programs have been established at five other Ontario universities, also supported by the MMO.

Objectives and Structure

The central objective of the Connections Program is to collaborate with industry in the definition of a real problem of relevance to that industry, and to subsequently introduce this problem to final-year undergraduate engineering students for resolution. This requires that new problems are identified annually. Problems can also be defined by students returning from 16 month co-op internships having worked with an industry that requires a particular problem to be solved.

In the MMO Connections Program, engineering students entering final their final year of study select to work on a real industrial project requiring solution. These projects are structured in one of two *formats:* a one term (semester) project (i.e. four months), or as a two term project (i.e. eight months) which is equivalent to an undergraduate thesis project. The vast majority of students select the two semester project format.

The cycle for the selection of projects commences in April when third year engineering students are required to choose a thesis topic as part of their undergraduate program of studies. In March or April, students essentially express an interest to undertake a project within the MMO mandate of the Connections Program. Between March and September, real industrial projects are identified and matched to each student interest. This requires numerous visits by the students to companies with whom the Professors, engaged with the Connections Program, have already outlined prospective projects for consideration.

Since the inception of the MMO Connections program, the Professors engaged with the Connections Program have created a significant network of participating industries and names of contacts. This provides a starting point whereby the industries are approached each year to seek out new projects for the next group of students. It is gratifying that many of the participating industries enthusiastically wish to repeat their involvement.

In September each student is assigned a contact person within the targeted industry whose project has been selected. All students are also required to arrange and maintain a regular visiting schedule with their industrial partners to develop the context of the project, the objectives, the budget and the proposed solution. The process for development of a project and all its details is not straightforward for the student, but the learning experience is exceptional. Since the industry is seeking a solution, it is a win-win situation.

Regular student meetings are held weekly on campus at which time each student is given the opportunity to deliver a brief presentation of the work as well as to share their experience with their industrial

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partner on the project. This format enables other students to contribute new ideas to the solution being proposed as well as the opportunity to learn of other real life engineering problems and their solution. These meetings are arranged, coordinated, and attended by the respective academic coordinators who serve as mentors for the program.

Students spend, on average, one afternoon a week with the industry which clearly requires a significant industry commitment. Industries have also contributed to the purchase of equipment specifically needed for the project and this equipment is retained by the industry. It is important to document all in-kind contributions by industry.

MMO provides real cash, albeit limited, to seed the project, and to pay for the small items that are essential for the development of these projects, for example travel funds for students, presentation materials, small equipment items, machine-shop time etc. Regular submission of travel claims, expense claims etc. are made as they would be in industry. Detailed project reports are a requirement as is a formal presentation of their work. Industrial partners are invited to attend the presentations to assess the contribution.

Each project is unique and industry specific, so that the expected results provides insight into the solution. With good project definition and an awareness of the time availability, mutual contributions are made and the linkages established to promote new forms of technology transfer. Ongoing interfacing develops an important dynamic interaction and ensure that information is shared. Student projects provide an industry with an injection of new ideas and often some basic technology of which they may be unaware. The exposure of the students to an industry environment represents an investment in the training of our students and accelerates their value to an organization, particularly when the individual is hired by the industry on completion of the project.

Each student participating within the Connections Program is required to submit a detailed report of the completed project. The reports are available to the supporting industry. Industry contributions, both in cash and in-kind, is monitored and reported to MMO at the end of each annual budgetary cycle, ending March 31st. The contributions from industries are several times that provided by MMO. The budgetary cycle extends over three quarters starting in July 1, October 1 and January 1.

Through the MMO Connections Program, students are given the chance to experience teamwork, problem solving, bench-marking and competition, product development and customer focus, as well as time perspective, and the communication and organization needs to get the job done. Students benefit tremendously by this exposure to the immediate needs of industry. Their confidence and interpersonal working skills are severely tested and developed. Industry gains access to bright inquiring minds, solutions and the equipment and services on the University campus that might otherwise not have contributed to the solution. The potential exists for the industry partner to assess the benefits of an engineering solution and to use the MMO Connections Program to evaluate the benefits of hiring these engineers into permanent positions. The work completed by students has included new product concepts, processes, a prototype designs, software that simultaneously permit the student to develop engineering skills. A few outlines of typical projects are provided in the Appendix.

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Many of the industrial partners have sponsored projects for several consecutive years. Some of the students who have participated in the program have gone on to be offered full time positions at the industries. These are clear indications of the significant success of the MMO Connections program.

Summary

This paper has described a highly successful Undergraduate program instituted at the University of Toronto for over a decade. Students in their final year of studies in the Department of Mechanical and Industrial Engineering are given the opportunity to work on real-like programs with participating industries. There has been significant benefit to both the students and industry. The program has strong support from Material and Manufacturing Ontario, who regard this program as an important component of their mandate to train highly qualified personnel. The success of the Program has been highlighted by its integration into a total of five other Ontario Universities, all with various levels of support by the MMO.

Appendix Typical Theses Completed

- **Design of a Top Wire Welder Mechanism for PAR 38 Lamps (Mr. D. Spector)**

The goal of this thesis is to design a top wire welding mechanism for 43/4 inch diameter Parabolic Aluminized Reflectors (PAR 38), intended to replace the top wire soldering process currently being used at General Electric Lighting, located in Oakville, Ontario, Canada. Recent environmental legislation changes have resulted in a hazardous product classification towards waste PAR 38 lamps, due to the lead contained within the solder used to fasten the top wire to the base of the lamp. Furthermore, it has been determined that the proposed welding process is more amenable to process control and stability. Accordingly, a decision has been made to investigate the merits and feasibility of implementing a new top wire welding operation in place of the current soldering operation. This project focuses upon the design of the mechanisms required to facilitate the implementation of a top wire welding operation that will deliver comparable performance characteristics of the existing solder operation. Figure 1 illustrates diagrams related to this thesis.

- **Design Study of IMAX 3D Camera (Mr. I. Al-Attar)**

The existing IMAX 3D camera is the world's most advanced 15 perforation 65mm stereoscopic motion picture camera. The camera runs two films horizontally through two identical mechanisms at a speed of 24 frames per second. Each mechanism relies on a transport arm to advance the film in a steady and precise manner. Each time the arm makes a complete cycle, it advances one frame. A need to reduce the size and weight of the camera was identified by IMAX Corporation in order to mount the camera on the window of the space shuttle. IMAX decided to focus on replacing the two driving mechanisms with one only mechanism. This thesis presents a design study to the new transport arm to satisfy the requirements specified by IMAX. The study involves proposing a new design in better understanding of the structural performance of the arm while keeping its mass at a minimum. Therefore, the study is focused on conducting finite element analysis for the proposed design. Figure 2 illustrates diagrams related to this thesis.

- **Design of the Oscillating Coanda-Based Air Vent (Mr. P. Lewis, Mr. D. Hester)**

The goal of this thesis was to design and prototype a new air vent for the Chrysler Voyager. Collins and

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Aikman Plastics requested that this air vent have some type of additional functionality at a minimal added cost. The Voyager air vents currently use five mechanical vanes to deflect the airflow, which are manually controlled by the passenger of the vehicle. This is the air deflection mechanism used by all current air vents. To increase the functionality o(the Voyager air vent, it was decided that a motorized mechanism be added that drives the mechanical vanes (and therefore the airflow itself) in an oscillating pattern. This oscillation mechanism is currently used in only one air vent, that of the Mazda 626. The approach was to redefine the traditional air vent so that it was both simpler and cheaper. As a result, an oscillation mechanism could be added for a minimal net added cost. The air vent was made simpler by the application of the Coanda Effect; the adhesion of a fluid stream to a curved surface. In this way the air deflection function of 4 of the 5 vanes could be served by curving the wall of the air vent. This results a Single-Vane Coanda-based Air Vent. The benefits of such an air vent include increased airflow rate, decreased noise, decreased material and decreased assembly cost. In terms of the new mechanism, it represents an improvement over that of the Mazda 626 in that the users have independent oscillation control and only one motor and no electrical switches have been used for a cost savings. Figure 3 illustrates diagrams related to this thesis.

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(a) **(b)** **(c)**

Figure 1 Top Wire of a PAR38 Light Lamp
(a) Lamp
(b) Existing Design
(c) Proposed Design

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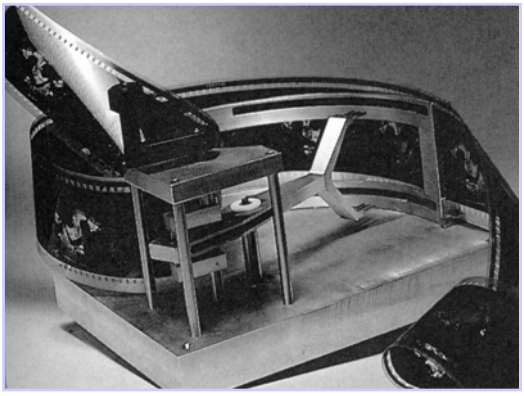
(a)

(b)

(c)



(d)

Figure 2 Design Study of the IMAX 3D Camera
(a) Space Shuttle
(b) Stress Analysis of Camera Arm
(c) Deflection Analysis of Camera Arm
(d) Camera Prototype

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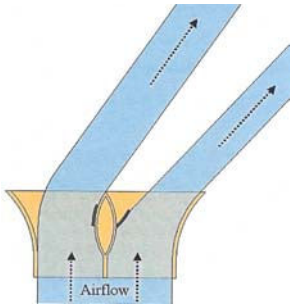

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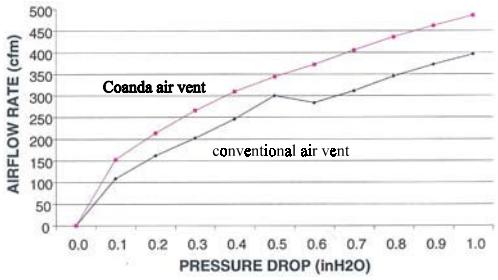

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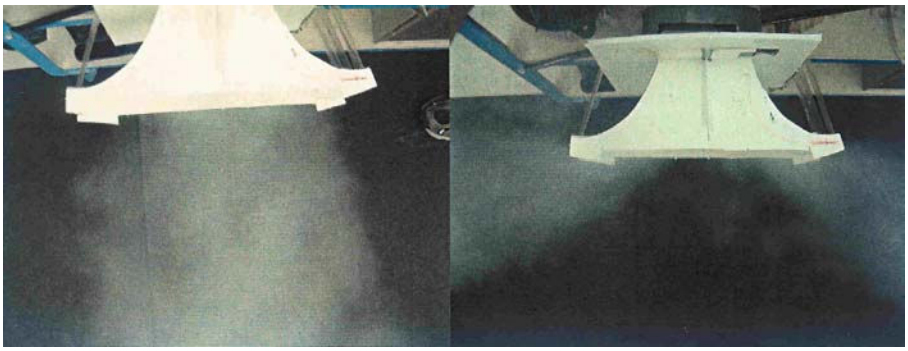

(c)

Figure 3 Design of the Oscillating Coanda-Based Air Vent
(a) Theoretical Modeling
(b) Comparative Analysis with Conventional Vent
(c) Air Flow Analysis

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