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Using collaborative learning projects to blend teamwork and technical competences in an aviation technology curriculum

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ABSTRACT: There is a need for learners in aviation technology and engineering curricula to better develop and apply teamwork, communication and problem-solving competences in addition to technical degree skill sets as they prepare to enter industry. However, these competences are often underdeveloped due to a heavier focus upon the technical aspects of a learner's targeted degree area. Faculty at Purdue University in West Lafayette, USA, are exploring a collaborative learning approach within its aeronautical technology curriculum in which students practice interdisciplinary teamwork, communication and problem-solving competences within a simulated aviation production maintenance environment, utilising the University's large transport aircraft maintenance management and advanced materials manufacturing laboratories.

INTRODUCTION

Organisations in technology industries rely upon employees who can effectively wield both interpersonal and technical skill sets not only within their own work groups, but also across the organisation. The aviation industry in particular continues to call for maintenance and engineering graduates capable of adapting to rapid change both in technological and business model components of their work.

Effectively blending such competences with core technical skill sets is an expectation of new hires by many companies and a requirement of the aviation industry where services or products incorporate hazardous technologies, stringent regulations and time-driven work goals. Today's graduates must be able to *hit the ground running*, as fluent in teamwork, problem solving and communication skills as they are in their degree area skill sets. This poses significant challenges to educators preparing graduates in technical and engineering curricula, where such competences are often overshadowed by the pursuit of the learner's core technical degree skills and, in the case of certification or licensure, constrained by time and regulatory requirements as well [1].

THE NEED FOR INTEGRATED SKILL SETS

It is well known that strong communication skills (among other key competences) are critical to professional success within any organisation [2]. This is underscored by employers increasingly demanding a more comprehensive understanding of the engineering technology discipline and improved levels of communication skills from graduates of such programmes [3][4].

Workers in technology industries are challenged every day not only by hardware or product issues, such as aircraft or equipment, but equally by the human element in operations. It has been evident for years that even within the most highly regulated work environment, the human element still has a profound affect on the operation not only in productivity, but in achieving other critical benchmarks of quality and safety, and can become as big a roadblock to effective job accomplishment as any technical issue [5].

In the 1990s, researchers identified 12 of the most commonly observed factors affecting human decision-making and overall safety in hazardous industrial operations, which included communication, teamwork and assertiveness in the list [6]. This remains true for today's graduates entering any technical workforce, especially in aviation. Achieving success in industry requires collaborative problem solving, communication and teamwork capacities, which must be employed effectively across different departments of an organisation as well as among its local teams.

Learners in technology and engineering education run the risk of missing key technical teamwork and problem-solving abilities when a skill-specific degree remains the only educational goal. An educational and experiential gap exists for many graduates of technical programmes in which they often enter job roles based almost exclusively upon a technical degree qualification, only to encounter great difficulty overcoming commonly encountered people issues or barriers to process flow, finding it extremely difficult to adapt with the speed and resiliency necessary for problem solving required of the modern technical workforce [7].

Far from merely packaging and shipping out a bad part to be *fixed*, technical maintenance crews must interact with a variety of skilled support personnel to communicate, clarify and develop viable, airworthy repair paths or manufacture quality parts, all while ensuring timely delivery and cost control. Given the difficulty of communication involving technical information and rapid turnaround times, it is not enough to merely follow written instructions, or copy and paste a solution from an aircraft engineering diagram. Such scenarios challenge those in industry everyday and require a collaborative and proactive effort from both sides.

A specific example where such collaboration is required is the maintenance engineering department or machine shop supporting an aircraft maintenance line of work in advanced repair methods for mechanical or structural discrepancies. This example is the basis of a learning laboratory collaboration of a similar scenario currently being explored within an aviation maintenance technology curriculum at Purdue University in West Lafayette, USA.

CREATING THE CROSS-FUNCTIONAL SETTING

The scope of modern aviation maintenance operations is complex. A single aviation maintenance and repair operation can require an individual to working with several different aircraft fleet types, different customers with varying and sometimes conflicting requirements and, given the global nature of aviation and growing international markets, a multinational technical workforce. Business models have changed, requiring even frontline workers to take on the roles of leadership and teamwork once relegated to upper management. Hallmarks once used to determine effective leadership and *team building* capabilities of an upper manager are now everyday expectations of the frontline technical team. Communication, teamwork and problem solving are no longer just good ideas. They are essential, entry-level skills for effective cross-functional teams.

With this in mind, it was believed the skills gap identified in this paper – the same skills called for by industry – could be more explicitly addressed before the graduate enters the workforce through the purposeful, hands-on integration of collaborative learning projects among courses within the degree curriculum. It is well known that hands-on projects are motivating and help sustain students' interest in technology and the curriculum. As well, this concept has been used in university settings to prevent students from switching to other majors [8].

Purdue University faculty in the Aeronautical Technology curriculum have recently developed and begun practicing hands-on interaction between two aviation technology courses, in a similar fashion to interactions experienced in industry among production maintenance and related technical support groups.

Faculty determined that an ideal learning platform existed to address the need for communication and problem-solving experiences at a cross-disciplinary peer level through the incorporation of appropriate collaborative technical projects between two different technology courses. Among the requirements for such a link between courses were realistic and relevant projects that remained connected to technology and engineering principles with tangible deliverables, but that also promoted student-to-student communication, teamwork and problem solving. These courses are described below.

AT 402 - Aircraft Airworthiness Assurance

The first is a capstone aviation maintenance management course: AT 402 - Aircraft Airworthiness Assurance, which simulates a maintenance operation utilising the University's large transport Boeing 737 and 727 aircraft. Senior maintenance technology students function as operations managers and are tasked with researching, planning and implementing a simulated large aircraft maintenance operation in which they manage lower level student technical crews in accomplishing segments of a specified maintenance check.

Initially beginning with the construction of a simplified maintenance process and general job task card development, the course has grown to incorporate more robust concepts of safety management systems, the use of process mapping in problem solving and process streamlining, technical writing, the creation of engineering job card change requests, training development and delivery, as well as the incorporation of key leadership competences in communication, team building and process management into laboratory maintenance activities.

AT 408 - Advanced Aircraft Manufacturing Processes

The second course is AT 408 - Advanced Aircraft Manufacturing Processes. This course was selected in that projects and outcomes for the course fit with the AT 402 philosophy, targeting both technical and team work/leadership competence outcomes. Students in AT 408 have developed basic aircraft materials skills from previous coursework as regulated by US Federal Aviation Regulations (FARs) [1]. Students have learned to integrate larger problem-solving skills and next-step processes including structural joint design, in-depth manufacturing processes, the use of CNC equipment and working within quality control frameworks like QC 9000.

AT 408 is a final senior level course performing advanced materials manufacturing, and is almost entirely project-based allowing students to perform research and design products to better understand engineering fundamentals and technology applications in industry. It also requires communication and planning skills as students acquire the new language of manufacturing and take projects from planning to hands-on delivery, which includes following all stages of the design process, as well as the development of project costs, establishing timelines and producing process sheet and work instructions.

MAKING IT WORK

Actual aircraft discrepancies identified as possible project candidates during the maintenance process in the AT 402 laboratory are first evaluated for repair options by the AT 402 maintenance team and instructor approval is obtained to initiate a project request for manufacturing support. A non-routine job card write up is generated and, just as in industry, placed on the local maintenance job board with the part's status and routing documentation.

Once an item has been identified and prepared for routing to the AT 408 manufacturing laboratory, specifications are further researched and documented on an Initial Project Request form prior to routing. This form is then provided to the advanced manufacturing laboratory team, where a brief project support meeting between the two student teams is then held to further discuss and evaluate details of manufacture, cost and delivery estimates.

A Team Performance Feedback Form was created and is being utilised as one initial testing method to evaluate overall student team performance in both courses. The form is designed to measure performance in planning, problem solution setting, communication and product final delivery quality in terms of customer satisfaction at the team level.

A six-question survey asks each team to assess the other team's aggregate performance for each project initiated throughout the semester. Questions one through four assess team performance utilising a five-point Lichert scale, and the last two questions are Yes-No. The assessment areas are:

1. Planning, preparation and documentation;
2. Verbal communication during team meetings;
3. Participation in setting process direction and deadlines;
4. Incorporation of safety considerations;
5. Were agreed upon project deadlines met?
6. Did the final product meet design requirements?

CONCLUSIONS

While the design and manufacture of a useable, airworthy part with a timely turnaround is the ideal target in industry, such expectations are projected to be, at times, unrealistic given the real life constraints of laboratory timeframes, limited resources and lack of technical field experience among both student groups. However, it is believed the educational value of student teams applying skills in communication and problem resolution in a hands-on technical work environment scenario is significant, closely resembling a common on-the-job scenario in industry, and is indeed the more important metric in this particular setting.

Although still in the early phases, initial observation of team performance in both classes is very promising, bringing an added dimension of realism to both laboratories while widening the student's breadth of experience collaborating outside of their routine work environments.

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11th Baltic Region Seminar on Engineering Education: Seminar Proceedings

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The yearly *11th Baltic Region Seminar on Engineering Education* was organised by the UNESCO International Centre for Engineering Education (UICEE) and held Tallinn, Estonia, between 18 and 20 June 2007. The Seminar attracted participants from 10 countries worldwide. Almost 40 papers have been published in this Volume of Proceedings, which grossly document and present academic contributions to the Seminar. All of these published papers present a diverse scope of important issues that currently affect on engineering and technology education locally, regionally and internationally.

The principal objective of this Seminar was to bring together educators from the Baltic Region to continue dialogue about common problems in engineering and technology education under the umbrella of the UICEE. To consider and debate the impact of globalisation on engineering and technology education within the context of the recent economic changes in the Baltic Region, as well as in relation to the strong revival of the sea economy. Moreover, the other important objectives were to discuss the need for innovation and entrepreneurship in engineering and technology education, and to establish new links and foster existing contacts, collaboration and friendships already established in the region through the leadership of the UICEE.

The papers incorporated in these Proceedings reflect on the international debate regarding the processes and structure of current engineering education. They are grouped under the following broad topics:

- Opening address
- Education and training for engineering entrepreneurship
- Innovation and alternatives in engineering education
- New developments and technologies in engineering education
- Quality issues and improvements in engineering education
- New trends and approaches to engineering education
- Simulation, multimedia and the Internet in engineering education

It should be noted that all of the papers published in this volume have undergone an international formal peer review process, as is the case with all UICEE publications. As such, it is envisaged that these Proceedings will contribute to the international debate in engineering education and become a valuable source of information and reference on research and development in engineering education.

To purchase a copy of the Seminar Proceedings, a cheque for $A70 (+ $A10 for postage within Australia, and $A20 for overseas postage) should be made payable to Monash University - UICEE, and sent to: Administrative Officer, UICEE, Faculty of Engineering, Monash University, Clayton, Victoria 3800, Australia. Please note that sales within Australia incur 10% GST.

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