

THE UNIQUE CHALLENGES AND ADVANTAGES OF DEVELOPING AN INTERACTING PARTNERSHIP BETWEEN AN AERONAUTICAL TECHNOLOGY PROGRAM AND MAJOR AIR CARRIERS

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Abstract— *This paper will explore the ongoing partnership between Purdue University's Aviation Technology Department and United Airlines and other industrial partners. This partnership has been mutually beneficial to both partners. It has given students and faculty unprecedented access to the "real world" of airline maintenance operations. This has resulted in unparalleled educational opportunities for students and opportunities for faculty to assure the relevance and currency of their course material. United Airlines has also benefited through the use of student driven applied research projects in such areas as safety and process improvement. Additionally, the partnership has contributed to United Airline's organizational globalization efforts, supervisor training and employee professional development efforts. Furthermore, United Airlines has donated two large commercial aircraft and they support the maintenance of the Aviation Technology department's aircraft. Faculty of the Aviation Technology Department and United Airlines personnel have developed and organized workshops and tours of the maintenance facility for the students.*

Introduction

There are many outstanding aviation technical and management education programs diligently laboring to prepare next generation aviation industry leaders. Many of these programs provide the students with the theoretical knowledge and skills to successfully meet the emerging needs and challenges of tomorrow's rapidly changing aviation requirements.

While aviation industry employers generally agree that aviation education programs are providing excellent foundational technical and managerial knowledge and skills, they continue to report that students lack confidence in applying their education during the initial phases of their aviation careers. When placed in positions requiring effective communication, graduates are often reported to lack persuasive presentation and interpersonal communication as well as effectual written communication skills.

During a meeting with the Department's Industry Advisory Committee in 1995, faculty members were made

aware of the industry's concerns regarding experimental needs. Two faculty members began to explore various ways in which students could develop and refine their skills at applying the knowledge gained during undergraduate aviation coursework. Additionally, these faculty members were concerned with identifying a venue through which students might gain a better, more comprehensive understanding of the complexities of aviation industry commerce and practices. It was decided that to be successful such an initiative would necessarily require the exposure of students to actual aviation work settings. Through such an experiential construct, students would benefit enormously from an opportunity to address actual problems in real-world aviation work settings encompassing widely varying and dynamic operational variables and constraints. Such an initiative would, by necessity, require the active participation of industry partners who were willing to identify salient problems and project issues, provide access to their work environments and data, foster working relationships with company representatives and work groups, and provide resources to support project initiatives.

The Strategy

While the benefits to students of such an initiative were obvious, the faculty members recognized that it would be necessary for the program to provide participating companies with tangible benefits or practical solutions to troublesome problems in order to gain the necessary cooperation and support of industry partners. The two faculty members developing the strategy had worked extensively in the field of aviation before becoming university professors and, therefore, had a good grasp of how to approach industry based problems. Additionally, each had developed a strong interest in aviation safety management, human factors, work process analysis and continuous improvement strategies as areas of research interest. Recognizing that these were areas of considerable concern within the context of contemporary aviation operational environments, the concept developers felt confident that they could gain the interest and support of industry partners if they used these topical areas as the focal

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point of their efforts. The strategy that evolved took the form of student driven applied research teams mentored by the faculty members. A team would begin its endeavors by defining a research project structured around problems centered in one or more of the previously defined areas and presenting a proposal for the study to a potential industry partner. If the industry organization expressed an interest in supporting the project, the team and company representatives would negotiate the details of the project and initiate the study. In each project, study details included the scope of the project, details about how the study would be performed, the definition of resource needs, the identification of project “stakeholders” within the company and the university, and the deliverables for the project. The concept developers envisioned that each endeavor would require student team members to make formal presentations to the company’s upper management and to submit a project report. It was also hoped that students would carry the concept further by preparing contributions to the body of knowledge in these research areas by preparing journal articles for publication and through conference presentations.

CONCEPT EVOLUTION

The program had its meager beginnings during the 1996 school year when two graduate students teamed with the faculty members to respond to a request from United Airlines to help them determine the causes of aircraft ground damage within their fleet. Throughout the school year, the student and faculty team worked closely with United representatives to review historic data, interview workers, and observe operations at numerous stations throughout the air carrier’s system. At the conclusion of the project, students presented their findings to two Vice Presidents and thirty-five upper managers at United. The findings delineated several of the most common causes of damage to aircraft during ground operations as well as provided suggestions on possible ways to mitigate the problem. The project was deemed highly successful by United and was the first of many studies performed for the carrier.

Encouraged by the first year’s success, faculty members formed two research teams during the following year. The two experienced graduate students became the team leaders for the new teams and recruited five additional students to work on the industry based projects. The team leaders developed strategies for “team building” to provide cohesiveness and unity within the teams. They designed and developed training in research methods, problem solving techniques, and project management. Each team leader assumed the role of establishing a working relationship with their industry partner and the logistics of making research visits and team presentations. The faculty devoid of these responsibilities assumed the role of advisors and mentors for the team leaders and members. One of the teams explored an expanded project with United that encompassed

maintenance errors and the further development of strategies to reduce aircraft ground damage. The other team struck off in a new direction and worked on a University-based project to help identify barriers to effective communication of maintenance discrepancies between flight crews and maintenance professionals. Both projects proved highly successful. In addition to providing presentations and project findings to the industry partner, each of these teams presented their project findings at national conferences and authored papers for journals and conference proceedings so that others in the industry could benefit from the studies.

Word rapidly spread throughout the industry concerning the effectiveness of Purdue’s student research teams. Soon, the team’s faculty advisors were receiving requests from numerous aviation companies and organizations for assistance in various safety management and human factors related problems. Recognizing that the concept could grow to unmanageable proportions, the faculty advisors restructured the strategy into a more formal organizational structure, the Purdue Aviation Human Factors Research Team. The restructured organization consisted of formal procedures for project selection, team member recruitment, participant qualifications, and team leader selection. A steering group, known as the Research Oversight Committee, composed of three faculty advisors and three experienced student researchers provided direction, guidance, and oversight of all team activities.

During the intervening years, the Research Team has engaged in widely varied research projects with numerous air carriers, corporate flight departments, general aviation companies, and military and governmental organizations. Research projects have included a study of Flight Attendant lost-time injuries, heavy maintenance shift-turnover communication improvement, maintenance error reduction, operational safety infrastructure development, safety management strategies, real-time safety level assessment, the development of an “at-risk behavior” safety metric, and a strategy for changing worker unsafe behaviors.

Since the research projects were not limited to any specific air carrier or geographic region, teams have traveled extensively and been exposed to widely varying work environments. Team members have worked at stations and work environments throughout the United States, the Hawaiian Islands, South America, Europe and Asia. Currently the research program’s fifty-three student researchers and four faculty mentors are performing five research projects with three major commercial air carriers and one cargo operator. In each case, the projects are focusing on improving operational safety, reducing workers’ unsafe behaviors, and addressing worker Lost Time Injuries through ergonomic improvements and training. The program has also secured funding to support facets of the research from the Federal Aviation Administration. Encouraged by the pragmatic solutions and tools generated by the program for industry partners, the Federal Aviation Administration provided research grants to refine many of

the techniques, safety measurement processes, and error management strategies into generic strategies and tools and make them available to all of the industry.

The research methods utilized by the student teams in the studies covers a wide variety of techniques. Common approaches include statistical analysis of existing data, surveys, interviews, focus groups, workplace observations, and repeated measures. Often these activities are quite labor intensive. In a typical study, the research team will generally begin by reviewing and analyzing historical error or injury data. Once they have gained a perspective of how the problem is manifested in the partner's work setting, the team will often perform workplace observations and /or job shadow employees. This provides important insight into the perception of workers in the affected environment. Employee perception surveys are often employed for this purpose as well as one-on-one interviews. Focus groups are also utilized to gain insight and to foster discussions between work groups concerning important issues salient to the problem under study or in order to help understand the culture of the organization as a whole. Student researchers have analyzed five major air carrier accident and incident historical databases, analyzed more than 2800 responses from surveys, logged over 11,000 hours of job shadowing, held over 300 interviews and facilitated well over 23 focus groups.

CURRENT PROGRAM STRUCTURE

The goal of the Applied Research Program is to provide real-world life experiences for students while offering applied research services to aviation organizations in need of assistance. This is accomplished through industry partnerships between aviation companies or organizations and Purdue University. The research projects are results oriented, providing practical solutions for improved safety, efficiency, and profitability. The research program is open to any qualified student at Purdue University, regardless of their major. This interdisciplinary approach is one of the strengths of the program since it promotes student researchers with widely ranging academic talents and backgrounds and promotes working relationships among diverse disciplines. To become an active research team member, students must participate in several orientation and methods training programs and complete coursework in aviation human factors. To insure that students do not sacrifice their commitment to their academic coursework for more interesting and enjoyable team activities, each student must have a minimum of a 2.5 Grade Point Average in order to qualify for team membership and must maintain this level to remain on the team.

Students work in teams under the mentorship of supervising faculty. The main goal of project participation is for students to obtain aviation life experiences, enhance their leadership and team skills, develop project management and problem solving skills, and to improve their presentation and communication skills. Students

coordinate all activities and develop all of the project strategies from identifying and defining salient project problems, to designing intervention and analysis processes, and even to coordinating industry partner activities and research team travel. This creates highly qualified, confident, and mature students with enhanced skills that are heavily recruited upon graduation. The Aviation Human Factors Research Team acts as a partner, not a consultant to the industrial participant. Solutions are devised, tested, and implemented through the cooperative efforts of the students and the aviation industry partner representatives. As the project evolves, the Research Team gradually withdraws to an advisory position providing the air carrier with something they helped devise and can continue to implement on their own.

The program structure consists of a Research Team Oversight Committee, graduate assistant, and the various project teams. The role of the Oversight Committee is to determine which projects to undertake, monitor student participation, mentor students, and assist with the student-industry interface. At present, there are four faculty members from the Aviation and Communication departments participating on the Oversight Committee. Each faculty member is assigned to work specifically with one project team but is available to members of all projects. The role of the graduate assistant is critically important due to the nature of his or her placement in the structure of the program. The research graduate assistant is usually the most experienced student researcher and generally has participated in several projects and is familiar with numerous techniques and strategies utilized by the research teams. Most often, the graduate assistant has been a research team member as well as a successful project leader. The graduate assistant acts as a mentor for the other members and leaders, runs the oversight committee meetings, and generally acts as a liaison between the committee and research teams. Part of the duties of the graduate assistant are to ensure the research teams have the resources, information, and training to meet their objectives and to help the leaders organize their projects. The graduate assistant also ensures team accountability by monitoring the roles and responsibilities of the team members and project leaders. Techniques used to maintain program communication and coordination include an interactive website for members to post meeting minutes, project timelines, group presentations and a general calendar of all activities accessible by all team members. This has proven to be highly successful in promoting shared knowledge as well as the ability to track team progress.

Another facet of the graduate assistant's responsibilities is that of monitoring and developing the knowledge and skills of research team leaders so that they may eventually become qualified for the graduate assistant position. To this end, the program's graduate assistant holds regular meetings with the student project team leaders to facilitate the sharing of information. Discussions often include common

problems related to running projects and how others have successfully handled similar situations in past projects. Issues such as how to promote team member participation and group motivation are often discussed. During the early history of the Team everyone involved in any of the projects was familiar with each other. The popularity of the program and the number of projects have grown in recent years (currently there are 53 students involved in 5 research projects) to the point that not all team members know each other. For this reason, the graduate assistant coordinates monthly social gatherings involving all of the project leaders, team members, and faculty mentors in order to help every team member become acquainted with other research program participants.

Individual student team members may participate in projects in one of two ways depending on their educational level and ability to travel. As a research team member, the student chooses his or her own level of involvement with a project based upon their available time and level of interest. Students may take a very active role working on project teams that directly interface with the industrial partner and visit their work settings. This level of activity requires a high degree of dedication and hours of work each week in strategy development, data analysis, and preparation for industry partner visits. Each of these team members travel to the industry partner's location and conduct studies and observations and work closely with company managers and employees to identify and analyze the problem and implement solutions. A second less demanding level of involvement is available for students who cannot dedicate a high level of time or commitment due to academic loads or work constraints. These students provide project team support during the school based development and analysis phases of the projects. Together teams made of students from each level of involvement analyze the issues central to the problem, identify potential causes and formulate solutions for test implementation. Team Leaders establish project timelines and milestone presentations, which are then given by the team members to the industry partner's upper management. Once implementation occurs, the team establishes follow-up procedures for testing and refinement of the model or intervention strategy.

BENEFITS TO STUDENTS

The program's benefits to students have been numerous. Direct benefits derived from participating on applied research teams include learning to work well with others in a team centered work group, improving personal organization and planning skills, honing verbal communication and presentation skills, and acquiring confidence in one's personal abilities and the value of one's contribution to communal efforts. On projects involving structured research methods, team members learn how to utilize appropriate research techniques, such as questionnaires, focus groups, and observations, to clarify problem parameters and identify forces driving undesirable outcomes. Student researchers

also learn how to develop and utilize various analysis techniques to isolate and delineate variables contributing to unwanted outcomes and to design intervention strategies to mitigate their effects. Research team leaders develop higher-level skills by assuming responsibility for a research team's activity. In this capacity, they are responsible for developing the research design for the project, initiating and fostering industry partner relations, scheduling team and research activities, developing team member skills, providing necessary training, promoting team cohesiveness, and keeping the project performance on-track and productive. This requires that student team leaders refine and optimize their organizational, interpersonal, communication, problem solving and project management skills.

Students wishing to focus on improving their presentation and written communication skills beyond those offered by preparing the project deliverables to industry partner upper managers are encouraged to co-author journal articles and conference papers. The demonstrated ability of students to address and creatively solve industry based problems and to work with all levels of personnel, including upper management and vice presidents, has resulted in considerable interest on the part of industry partners to maintain contact with the students for future recruitment. This has resulted in over 50 paid internship opportunities for students during 2000, alone.

Establishing applied industry research partnership opportunities has been a tremendous success for students. The exposure and experience gained by student researchers through these opportunities has proven invaluable in preparing them for their future careers in the aerospace and air transport industries. Although student participants are generally not paid for their participation on the research team, the rewards for their efforts are invaluable. Students gain practical experience along with opportunities to gain a competitive edge over their peers. Many students enrolled in the Purdue University Aviation Technology program have not had any previous work experience in the aviation industry prior to working with a team. The research projects give students the opportunity to interact with mechanics, ramp servicemen, customer service representatives, cabin servicemen, fuelers, pilots, flight attendants and others and to gain a global perspective of aviation commerce. Some of the team members have even had an opportunity to assist in ground handling and taxiing large aircraft such as Boeing 777's, 747's, 767's, etc. Being able to work in a "live" operational environment salient to their academic studies allows students the chance to apply the knowledge they gain in classroom environments.

BENEFITS TO INDUSTRY PARTNERS

One obvious benefit for industry partners of participating in applied research projects is the expanded opportunity to address troublesome problems in their operational environments. Often industry partners find themselves

challenged to provide adequate staff to address all of the problems confronted in today's dynamic aviation work settings. Additionally, the interdisciplinary nature of the applied research team provides a rich diversity of knowledge and skills often unmatched by resources within the partner's workforce. The involvement of an unbiased "third party" in the evaluation and mitigation of problems is often a pivotal influence in providing innovative and effective solutions. Because of the nature of the student/faculty mentor relationship of the research teams, industry partners can often avail themselves of subject specific expertise beyond those intrinsic within their workforce. The combination of these factors often results in a highly innovative and effective solutions that would have been difficult to match utilizing only the industry partner's limited and constrained resources.

An additional advantage realized through cooperative applied research efforts is that of organizational learning. Partners in applied research projects often relate that their employees and even the organization itself often learn new and more effective techniques for dealing with difficult and persistent problems. The team's strategy of working with partner representatives leaves the industry partner with the knowledge and skills necessary to continue to address the issues salient to the project long after the student research team has discontinued their involvement.

Industry partners also realize a long-term benefit from involvement in that they are effectively establishing a "pipeline" of highly skilled and industry wise future employees. Many partners maintain contact with student researchers by involving them in internships and fellowships throughout the student's remaining academic career. This extended contact and involvement with the student allows companies the opportunity to thoroughly assess the student's strengths and opportunities for improvement while building the student's loyalty and commitment to the company. At the completion of the student's academic career, these companies have a distinct competitive advantage over other companies to recruit these highly sought after talents. The industry partner also has a much better idea of the types of positions and opportunities that best match the individual student's talents, skills, and abilities.

DEPARTMENTAL BENEFITS

Benefits to the Aviation Technology Department at Purdue University of participating in applied research partnerships with industry have gone well beyond the obvious benefit of experiential education opportunities for its students. Participation in the assessment and solution of contemporary industry problems has allowed faculty members to maintain their currency with the state and challenges of the aviation industry. This has resulted in course and curriculum contributions which foster a much more effective educational foundation for preparing tomorrow's aviation professionals. Faculty members have also enjoyed the

opportunity to attend many industry-training courses and receive educational material from research partners. In one case, the industry partner has formed a strong bond with the Department in providing material and financial support for educational activities. This has included providing faculty and student travel to national and international conferences, aircraft and components for laboratory coursework, and financial gifting to support program development and to provide for a Graduate Assistant position for the Department.

TECHNICAL SUPPORT

No Aviation Department can teach a quality program without the support of an Industrial partner. United Airlines supports the Aviation Department in many ways, and in return the air carrier is assured that future employees are properly trained and prepared for the tasks ahead. In the following paragraphs we will briefly discuss the ongoing activities.

COURSE WORK DEVELOPMENT

The Aviation Technology Department of Purdue University works closely together with the Aircraft Maintenance Department of United Airlines, one of the world's largest air carriers. Through this cooperation faculty members have access to the large number of technical documentation and maintenance manuals and they could use these to improve their coursework materials. The last few years, faculty members and United Airlines managers and maintenance engineers have organized workshops for the students. During these workshops students are exposed to state of the art hardware and materials, and are taught the latest maintenance techniques used in modern aircraft maintenance operations. Normally, these materials and hardware are far too expensive for schools to purchase. The industry is happy to provide these resources, because they have a need for better-trained personnel and this will eventually reduce their training effort.

AIRCRAFT DONATIONS

For many years the aviation industry has encouraged aviation maintenance programs to introduce large modern aircraft maintenance technology in their curriculum. Due to the high costs of both the aircraft and parts, most schools have passed the opportunity. The Aviation Technology Department has been able to introduce these new concepts due to the help and support of their industrial partners. The last few years United Airlines donated two Boeing aircraft to Purdue University. The Boeing 727 and 737 are used to teach many aspects of large aircraft maintenance. The aircraft enable the faculty to teach real world aircraft maintenance technology. In addition to the donation, United Airlines supports the maintenance on the aircraft and frequently, mechanics work closely together with students to maintain these aircraft.

Industrial training opportunities

The airline industry has changed rapidly over the last decade. The introduction of new aircraft like the Boeing 777 and the Airbus A330/340 with their advanced systems, electronics and “glass cockpits” has created a need for the faculty of the Aviation Department to receive continuing training. Several Industrial partners have offered their maintenance training courses and resources to faculty members of the Aviation Department. This has enabled the faculty to stay abreast of the rapidly changing technological requirements, and improve their course material to reflect the current technical requirements.

Student Interaction

Many students who enroll in an Aviation Technology program do not really have a good idea about the job opportunities after graduation. This could lead to a low student retention rate. The Aviation Department realized this and has organized tours and job shadowing activities for freshmen students in their first year of study. The students will tour the United Airlines maintenance facilities in Indianapolis. The tour guides are the managers and faculty who also participate in the workshops during the same semester. The students have plenty of time to interact with technicians and engineers and ask questions about their jobs and opportunities in the company and the airline industry. The students have the chance to see many aspects of aircraft maintenance and students experience this positively.

Globalization effort

The aviation industry has become more global the last decade, and many companies realize that they need to prepare their workforce for working in an international environment. Purdue University and United Airlines have joined forces to develop student foreign exchange programs and programs to introduce United Airlines managers to the global environment. So far, a joined team of faculty and United personnel has visited the Netherlands, France and Great Britain and collected data that will be used to develop a globalization course for both students and air carrier managers.

One of the main objectives of this new initiative is to develop joint engineering course work in which students from engineering and technology programs work together in teams in an international environment.

SUMMARY

Purdue University’s applied research partnership program with aviation industry companies has proven to be highly successful at engendering advanced knowledge, skills, and abilities in Aviation Technology students while providing valuable industry experience and perspective. It has also provided industry partners with pivotal assistance in solving

persistent and difficult operational and safety problems. Besides producing highly skilled future professionals for the aviation industry, the program has also contributed significantly to the understanding of critical operational and safety issues and problems and developed numerous pragmatic strategies and products to assist industry in solving persistent problems and operating more safely and efficiently.