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A3IR-CORE at Purdue University: An Innovative Partnership Between Faculty, Students, and Industry

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A Reexamination of Institutional Roles

The difficult economic realities of the years immediately following the beginning of the Great Recession in December of 2007 have forced many public institutions of higher education to reexamine the roles that they play with respect to the overall educational process and the support of that process from a financial perspective. This reexamination has been focused along two particular lines of interest, among others: that of the practical funding mix between public and private sources of revenue, and that of a more philosophical nature regarding the balance of the preparation of the student between a broad-based education and a more specific vocational focus. While partnerships between academia and industry for both educational and research purposes have existed for many years, Reinhard, Osburg, and Townsend (2008, p. 1) noted that “sponsoring activities of higher education institutions by companies is more and more common and represents a significant part of the yearly budgets for universities.” Concomitant with this trend towards increasing involvement and sponsorship of educational programs by industry comes a natural posing of the question, “for what should we, as faculty at institutions of higher education, be preparing the student?” In other words, should a portion of the collegiate preparatory process that is undertaken by postsecondary institutions assume a greater focus on graduate employability, and, if so, should potential employers be given a significant stake in that process?

The Advanced Aviation Analytics Institute for Research (A³IR-CORE), a university-level center of research excellence that is housed within an aviation technology department at a large Midwestern university, is focused on the dual mission of addressing operational challenges within the aviation industry and facilitating positive educational outcomes for students by actively involving both graduate and undergraduate student researchers working closely with

faculty mentors in a highly-collaborative multidisciplinary environment. A key goal of the Institute is that of improving graduate employability and placement rates, which aligns with the strategic goals of the university and college in which it resides. The Institute is sponsored by industry partners, and a portion of the research performed is done so in conjunction with those partners. The research agenda of the Institute is concentrated primarily in the area of operational assessment and improvement of global aviation enterprise processes through the utilization of data collection and analysis.

The Institute employs an innovative structure, described in greater detail later in this article, that consists of faculty mentors guiding graduate students in their supervision of teams of undergraduate student researchers engaged in industry-sponsored projects. This structure is an important factor in ensuring that positive educational outcomes are achieved by the participating students.

The current research attempts to examine the apparent need for engagement between academia and industry with specific regard to student educational opportunities in a research context and to show how A³IR-CORE facilitates this engagement, with a goal of increasing the employability of graduates.

A Need for Growing Relationships with Industry

Recent research has brought to light an expanding disparity between employers' expectations of skills possessed by the college graduates they are hiring and the actual skillsets of those graduates. According to Teixeira, Rungo, and Freire (2013), graduate employability is affected by this disparity, which is found primarily in the area of systemic competencies, or those skills that are relative to systems and which require a combination of understanding, sensitivity and knowledge that allows one to see how the parts of a whole relate and come together. These

researchers noted the necessity that universities change their traditional focus and “make a special effort to help their students to develop those competencies that best foster employability” (p. 287).

Smith (2010) identified three mechanisms for enhancing employability in this context: identity work, training and networking, and laboring in unpaid and marginal paid positions. A separate study by Gracia (2010) suggested the use of supervised work experience (SWE) to embed employability into the undergraduate curriculum. The employability benefits of supervised work experience are well documented (see, for example, Ball, 2009), and include an understanding of the practical application of knowledge and of organizational cultures, which results in increased self-confidence for the student. Supervised work experience can consist of a year-long placement that occurs somewhere between the second and final years of study, or a shorter period that is interspersed within the academic program. The example of external applied research described in the present study actually places students working on industry-sponsored projects in “micro-SWE” periods that consist of from one to several days in length.

Regarding the transfer of learning that occurs when students participate in supervised work experience, Gracia noted that:

Students displaying the more common ‘technical’ conception construct SWE as an opportunity to develop technical, knowledge-based expertise and abilities that prioritize product-based or cognitive learning transfer. Students with an ‘experiential’ conception were found to construct SWE primarily as an experience through which the development of personal skills and abilities beyond technical expertise are prioritized using process-based or socio-cultural learning transfer. Further data analysis

suggests that these two learning transfer approaches have differing impacts on students' employability development (Gracia, 2010, p. 51).

Gracia (2010) concluded that institutions of higher education may “need to consider how best to collaboratively engage with their students to an experiential, process-based conception of workplace learning amongst those students, where the technical and personal components of learning are integrated” (p. 62). This concept aligns with the premise of Teijeira, Rungo, and Freire (2013) that faculty should assist their students in developing systemic competencies, which are essentially fostered by those technical and personal competencies. These studies indicate that faculty should focus not only on the integration of supervised work experience into the curriculum, but on the expectations of students who participate in that experience, as well.

Darwen and Rannard (2011) examined the state of student “volunteering” in the United Kingdom. Such volunteering can be linked closely to “learning within the curriculum, through voluntary or community placements that complement, or are a part of, students’ academic work” (p. 177). These researchers conclude that volunteering is at a critical juncture due to “funding considerations, a shortage of robust evidence of its impact” (p. 187), and the lack of commonality of partnership approaches across sectors. They do note, however, that volunteering makes a valuable contribution to student employability.

University faculty are beginning to seek “a more active learning methodology to improve the education of students to prepare them for the real world,” even as industry moves toward a more open innovation structure that encourages engagement with academia (Lucia, Burdio, Acero, Barragan, & Garcia, 2012, p. 15). In describing the Student Projects with Industry program at the University of Tennessee, Sawhney, Maleki, Wilck, and Hashemian (2013) noted that the simulated work experiences provided by that program enhance participating graduate

students' leadership, critical thinking, technical, organizational, and social skills, which, in turn, leads to measurable improvements in graduation rates, publications, and the breadth of their network of potential sponsors.

A model of practice-based learning that has been deployed very successfully in the United Kingdom over the last two decades, and one that was used to guide the structural development of A³IR-CORE, is that of the knowledge transfer partnership (UK Companies, 2005). A knowledge transfer partnership is a relationship formed between a company and an academic institution, known as the knowledge base partner, which facilitates the transfer of knowledge, technology and skills to which the company partner currently has limited access. Each partnership employs one or more associate, generally a graduate student, to work in the company on a project of strategic importance to the business, while also being supervised by the knowledge base partner. Projects typically vary in length between 10 weeks and 36 months. Harris, Chisholm, and Burns (2013, p. 174) suggested that this model “be extended to undergraduate education to provide sustainable practice-based learning that fits well with the strategies and ideologies of government, employers and academia.” The KTP model has an average placement rate of approximately 75% in the UK (KTP Online, n.d.), meaning that 75% of participating associates are offered permanent positions by the sponsor companies.

Institutional research centers such as A³IR-CORE have a significant impact on the success of academic-industry partnerships. In a 2010 longitudinal study, Ponomariov and Boardman noted that affiliations with such centers by faculty and students are “effective at enhancing overall productivity as well as at facilitating cross-discipline, cross-sector, and inter-institutional productivity and collaborations” (p. 613). Similarly, Cyert and Goodman (1997)

examined academic-industry alliances from the perspective of the research center, and concluded that:

by providing a mechanism linking the university's researchers with a corporation, the center becomes a potential conduit for change in both organizations. For the corporation, this change may be in terms of new products, application policies, or practices. For the university, it may be in terms of a new research agenda, new curricula, or better ways to train students (Cyert & Goodman, 1997, pp. 45-46).

Regardless of the precise structure of the academic-industry partnership, the relationship among the stakeholders must be reciprocal in nature such that mutual benefits are derived. Such a partnership must "involve deep learning transfer and practitioner reflection and reflexivity as opposed to training" (Henderson, McAdam, & Leonard, 2006, p. 1437). Desired outcomes should be stipulated from the beginning of the arrangement, if at all possible, so that difficulties that arise from differing and incommensurate outcomes are minimized. Doing so will ensure that the partnership will produce a successful range of outcomes for both the academic institution and the organization over the period of the partnership.

An early study of the effects of corporate sponsorship on academic projects (Gluck, Blumenthal, & Stoto, 1987) raised concerns that such sponsorship could lead to students producing fewer publications and perceiving that constraints (real or otherwise) were placed on their work and the discussion thereof. A more recent and extensive study involving graduate students in engineering programs at six domestic universities (Behrens & Gray, 2001) attempted "to inform the debate about benefits vs. costs of cooperative research by examining the impact of source of funding: industry, government and no external sponsor, and form of funding: single

source, consortial, or unfunded on a variety of research processes and outcomes for a particularly vulnerable population — graduate students; it also involved the development and evaluation of a measure of ‘climate for academic freedom’” (p. 179). The results of this study failed to show that industry sponsorship of academic research projects can negatively impact student outcomes.

A³IR-CORE: A Mechanism for Student-Industry Engagement

The Advanced Aviation Analytics Institute for Research was founded as an institutional-level center of research excellence. The original mission of the Institute was to serve as a clearinghouse for scholarship related to global policy analysis in the area of air transportation (Bowen et al., 2011). However, as time progressed, the Institute’s interim director came to the realization that the scholarship piece was merely a subset of the potential activities that could occur within the research center framework. Subsequently, the Institute was reorganized and provided with a broader mission: that of serving as a structure to facilitate both graduate and undergraduate academic research-oriented projects related to the operational aspects of the air transportation industry, with the goal of improving employability of the host institution’s graduates.

The organizational structure of the Institute falls along three lines: internally-funded projects, externally-funded projects, and scholarship. The scholarship line encompasses the functions of both the internal and external projects, and consists of two primary means of disseminating scholarly activities: the *Journal of Aviation Technology & Engineering* (JATE), and the university’s e-Pubs system.

The *Journal of Aviation Technology & Engineering* is an open access, refereed publication serving the needs of collegiate and industrial scholars and researchers in the multidisciplinary fields of aviation technology and engineering. A key focus of *JATE* is to

promote the bridging of these fields by publishing scholarly articles related to the integration of theory and application in the Design/Build/Test process. This process generally consists of various constituencies working toward a common goal of an end product which is properly designed through theory and made practical through application. *JATE* publishes both quantitative and qualitative research articles. Topics include air carrier and general aviation flight and ground operations, the technological aspects of airport operation, aviation maintenance and engineering, aviation human factors and applied training research, and significant developmental and historical topics related to these areas.

The e-Pubs system benefits faculty, graduate, and undergraduate researchers at the university by providing online publishing support for original publications as well as hosting for university-affiliated articles, reports, conference proceedings, student scholarship, and more. Together, the *JATE* and e-Pubs provide a solid platform with wide accessibility for the dissemination of scholarship resulting from the functions and research activity of the Institute.

A³IR-CORE's internally-funded projects are related to the development and operation of the Operations Center. This facility is designed to be the operational focal point of the university's flight operations, which include flight training and executive transportation. There are a number of data sources related to flight operations that produce large amounts of data; examples include scheduling and dispatch, maintenance, ramp control, air traffic control, and weather. The goal of the Operations Center is to collect, archive, and analyze this data, thereby facilitating improved managerial decision making as related to flight operations. The Operations Center is similar, on an albeit smaller scale, to systems operation control centers employed by major air carriers. With appropriate transfer of learning, students who gain operational experience in the Operations Center will be better prepared for similar positions in industry.

Externally-funded or sponsored projects are generally aligned with operations research and process improvement projects with companies in the aviation industry. For example, the Institute has recently engaged with two major U. S. air carriers to conduct projects related to staffing models and human factors initiatives at those respective organizations. Funding has been accomplished in the form of general gift contributions to the Institute, which is possible in cases in which no deliverables in the form of intellectual property are transferred to the sponsors.

The administration and faculty involved with the Institute envisioned a smooth progression in multiple respects with regard to student learning experiences. The first progression envisioned was with respect to project involvement. The expectation is that students will typically be brought in to work on an internal project under the supervision of a faculty member. Such projects are generally unfunded, and are completed in the context of an independent study course, with a specified deliverable, for which credit is granted. Departmental programs are such that a certain amount of elective credit fits within the curricula and is encouraged by the faculty. Students who successfully complete an internal project would then be invited to continue their involvement with the Institute by working on a sponsored research project in either an undergraduate or a graduate capacity. This suggests a second aspect of continuity and progression: that of providing a smooth pathway for undergraduate students who wish to enter the department's Master's program. Students who are involved with the Institute in their undergraduate programs are clearly afforded such a pathway, in that they are already part of the research organization and are generally working on projects that may be extended to serve as required capstone projects in the Master's program.

A third aspect of the progression that was envisioned is the tangible benefit to the student in the form of compensation or credit. A student who is interested in the work of the Institute is

generally required to spend a semester serving on a voluntary basis, an effort that aligns with the findings of Darwen and Rannard (2011) and Smith (2010), which indicate that such activities lead to increased employability upon graduation. Volunteers are tasked with activities that are more operational in nature, rather than research-oriented. For example, volunteers may be asked to work on infrastructure-oriented tasks such as database management, entering of fleet operational data, and so forth. The requirement that students serve initially as volunteers tends to eliminate involvement by students who are merely looking for a quick grade or who are uninterested in the work of the Institute. Students who volunteer successfully for one semester are then asked to participate in a project, either internally- or externally-funded, for credit. In subsequent semesters, students may be compensated if they choose to participate in additional work related to the infrastructure of the operations center, or they may be given opportunities for additional credit, which may be the case with respect to continuing sponsored projects.

A hallmark of the structure of the Institute, and an attribute that differentiates it from many other academic-industry partnerships, is that both the external and internal projects are directed by graduate students under guidance from faculty whose research interests align with those projects. The graduate students in turn supervise teams of undergraduate students. The undergraduates are generally sophomores, juniors, or seniors, but efforts are underway to extend project participation to the freshman level, as well. This structure closely follows the knowledge transfer partnership model that was described earlier, with the extension to undergraduate education suggested by Harris, Chisholm, and Burns (2013).

Because the Institute has been operating for fewer than three years, a description of outcomes with respect to students is necessarily somewhat anecdotal in nature. However, the anecdotal outcomes that have been observed by administrators and faculty alike generally align

with those suggested by Sawhney, Maleki, Wilck, and Hashemian (2013), among them leadership, critical thinking, technical, organizational, and social skills. Participating graduate students develop leadership and organizational skills through faculty guidance in conjunction with their supervision of undergraduate students who are working on particular projects. In turn, the undergraduate students learn leadership skills through their exposure to the leadership of the graduate students and faculty. Both graduate and undergraduate students gain critical thinking and technical skills through their hands-on efforts on the Institute's projects. Finally, the students improve their social skills through their interaction with designated employees of the projects' corporate sponsors. One should note that these interactions often occur at a relatively high level of seniority in the sponsoring organization; the designated point of contact for one recent sponsored project was a corporate vice-president, who took an active role in serving as an additional mentor to the participating students.

Placement rates of students upon graduation, again, have yet to be examined statistically due to the current small sample sizes inherent in the nature of a relatively new educational structure; however, one should note that the two graduate students leading one of the current sponsored projects were asked to visit corporate headquarters of the research sponsor to explore potential employment options that might become available upon their graduation, and were subsequently offered positions with that sponsor, while the sole graduate student leading another sponsored project was presented with an employment offer by the sponsor one semester prior to graduating. Hence, the goal of high rates of placement for program graduates appears to be achievable based on the small sample described herein, and the rates are at least on par with those demonstrated by the British KTP model.

Final Thoughts

While the expectation is that A³IR-CORE will continue to engage industry in the partnership relationships described herein and that funding for participating graduate students through the resulting sponsored projects will continue to produce the positive outcomes that were noted anecdotally in the preceding section, quantification of those outcomes will be necessary to facilitate a detailed analysis, thereby allowing the researcher to formally conclude that the mission of the Institute is being accomplished satisfactorily. That dual mission, the addressing of specific challenges facing the industrial sponsors and the facilitation of positive educational outcomes for students with respect to increased acquisition of systemic competencies and improved employability, has been shown to be critical for program graduates from higher education institutions of today, and is one that demands that we as educators are fully cognizant of our responsibilities to both our students and our industry partners, and dedicated to the fulfillment of those responsibilities. Only by achieving those latter two goals will we be wholly effective in properly preparing our graduates to assume their appropriate positions within the industrial workforce.

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