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Title: "Practical Applications as part of Interdisciplinary Entrepreneurship Training: the IRL-EPICS Practicum"

Abstract: Purdue's Innovation Realization Laboratory (IRL) offers a program that trains participants in fundamental aspects of commercializing innovation and brings teams of 2 MBA students and 1 science/engineering Ph.D. student together to explore commercial possibilities in the Ph.D. student's dissertation topic. A recent extension of the IRL curriculum has MBA-Ph.D. student teams "consult" with teams from Purdue's EPICS (Engineering Projects in Community Service) Program to analyze commercial possibilities in the public service products developed and delivered by EPICS teams. The resulting interaction allows science/engineering Ph.D. students to apply their IRL-based business training in a context that is independent of their own research.

Introduction

The favorable environment created by the Bayh-Dole Act[1] and, all too often less than favorable budget circumstances have combined to promote university involvement in the application of innovations by commercial and/or nonprofit enterprises.[2] Some of this involvement takes striking new forms, one of which is the rise of the university-industry science park. But university promotion of innovation has also taken the form of innovative educational programs, clearly in line with the traditional higher-education function of the university but extending that functions to new areas.

The commercialization of innovation involves expertise in disparate fields – scientific disciplines, human resource management, intellectual property law, accounting, finance, management, among others. There is thus an inherently interdisciplinary aspect to education programs that aim to prepare students for careers in innovation-intensive sectors of the economy. Such an interdisciplinary approach is central to Purdue

[1] The Patent and Trademark Law Amendments Act of 1980, amended in 1984.
[2] See, generally, the November 2003 (Volume 21, Issue 9) special issue of the *International Journal of Industrial Organization* on the Economics of Intellectual Property at Universities.

University's Innovation Realization Laboratory (IRL),[3] which is based in the Krannert School of Management but involves Ph.D. students from Purdue's Schools of Agriculture, Science and Engineering along with MBA students.

IRL Structure

Traditional Ph.D. training in science and engineering has in common with Ph.D. programs generally that it is structured, first and foremost, to prepare students for careers in academia. It may well be that science and engineering Ph.D.s who make careers outside academia are well served by such a preparation, but that is not to say that the large[4] number of such Ph.D.s who find research careers in industry could not be better served by a program that that acquaints them with the basics of innovation in a private-sector environment. In addition, today's tenure track faculty must be conversant with business and product language in order to obtain research funding from corporations, and increasingly, government agencies and foundations, that request a commercialization path or market relevance assessment as part of the grant proposal.

MBA programs typically include some exposure to principles of human resource management. While individual MBA students often come to the MBA program with prior training in science or engineering, MBA programs have not in the past specifically addressed topics associated with the management of research personnel.[5] Yet it is increasingly the case that making a successful career in business, with a start-up or in a

[3] The IRL welcomed its first cohort of students in Fall 2000. It has received generous financial support from a National Science Foundation IGERT grant and important supplementary support from the Lilly Endowment, Inc. It was established by Prof. Marie Thursby, now of Georgia Tech University and supervisor there of the TI:GER interdisciplinary innovation education program (http://www.dupree.gatech.edu/tiger).

[4] See NSF (2001): "At the beginning of their doctoral programs, 61.0 percent of the 114,800 employed recent S&E doctorate holders recalled most wanting to work in a college or university upon completing their degrees… In April 1997, 47.8 percent actually were employed in academia, with 14.4 percent as postdocs."

[5] See the undiplomatically titled Glen (2003).

Fortune 500 firm, requires working with research operations. Communication across cultural, gender, and racial differences is a necessity in today's workplace. The IRL screens for a technical background in the MBA students who join the program, yet our experience with the program demonstrates that the factors leading one individual with, say, a B.S. degree in Engineering to pursue an MBA degree, while another from the same program elects to pursue a Ph.D., also create tremendous differences in perspective, ability to communicate, and inclination to collaborate in a team environment.

The IRL combines faculty lectures, presentations by outside speakers, and interdisciplinary team projects to supplement traditional Ph.D. and MBA training in a way intended to meet the needs identified above, while not affecting the graduation schedules of the MBA and PhD student participants.

With some annual variation, each year the IRL Realization Laboratory admits a cohort that normally consists of 6 MBA students and 6 Ph.D. students to a two-year program. All students enroll in courses totaling two credits per semester. MBA students begin their association with the IRL at the beginning of their MBA studies. Ph.D. students come into the IRL after having completed coursework and after having formulated a dissertation topic that is acceptable to their research supervisor.

The weight that is given to faculty lectures, outside speakers, and projects has evolved with experience, and in a way that gives greater weight to outside speakers and to practicums in which MBA-Ph.D. teams apply their skills.

One purpose of the IRL is to expose Ph.D. students to basic structural aspects of innovation outside a university environment. While these topics can be presented by regular university faculty members, and a certain amount of this is part of the IRL

program, such lectures overlap with material that is part of the standard MBA program. Inviting venture capitalists to talk about capital markets for new ventures, patent attorneys to lay out the basics of intellectual property law, patent examiners to teach patent search techniques, and other expert practitioners in the field of new venture team development, commercialization planning, and others, allows the IRL to give Ph.D. students a foundation-level acquaintance with material they would not otherwise see, while offering MBA students a practical slant on that same material that is over and above what they would otherwise get. Unlike many, perhaps even the typical, "executive in the classroom" programs, speakers invited to participate in the IRL are given specific content deliverables and are apprised of where their presentation fits in the overall design of the IRL program.

At the beginning of the two-year program, each Ph.D. student is paired with two MBA students.[6] The first exercise in applying the material presented by inside and outside IRL speakers is to have each team of MBA students analyze such commercial possibilities as are inherent in the Ph.D. student's dissertation topic. This analysis involves at a minimum a survey of the intellectual property terrain, an assessment of the size of the potential market and who the main competitors in that market would be, and the laying out of possible commercialization plans, such as setting up a start-up company to bring a product to market, or licensing technology to an established firm. Interim steps such as creating a working prototype, identification of scale-up issues and remaining

[6] Thus, MBA students A and B are paired with Ph.D. student C. Under the standard model, the same number of MBA students and Ph.D. students are admitted in each cohort. MBA students A and B are, therefore, also paired with another Ph.D. student, D. As far as the initial team structure is concerned, there is no team association between Ph.D. student C and Ph.D. student D. Human nature and the pressure of graduate education programs being what they are, a common pattern is that MBA student A will work primarily with Ph.D. student C, while MBA student B works primarily with Ph.D. student D.

scientific hurdles to clear prior to the creation of a production prototype are also considered and quantified. "Commercialization" plans might also include the conclusion that a technology will not really fly on a for-profit basis, but that it might underpin products or processes that could be useful in the public sector.[7] The first semester of the four-semester IRL program ends with presentations of a preliminary version of this team assessment, and the first year of the program ends with presentation of a more fully developed version.

It became clear from the experiences of the first IRL cohorts that much of the value-added of the program lies in the team interactions. Some of this value-added arises in doing the things that are discussed in classroom presentations. It is one thing to hear that it is possible to sign on to the internet and do a patent search; it is another thing to actually do it. Much more of the value-added lies in mastering the art of interdisciplinary communication. Even MBA students with a technical background – a differentially high share of IRL MBA participants – typically need to make an investment to acquire enough of the right vocabulary to understand what it is a Ph.D. student is working on. Ph.D. students often have little patience with MBA students who are slow to pick up on things the Ph.D. student regards as obvious. MBA students (most of whom have some, or even more than some, experience working in business), often have little patience with Ph.D. students who don't meet deadlines or appreciate the pressure-cooker environment of the MBA program. Yet working with research personnel who give little priority to deadlines or other kinds of operating constraints is something successful businesspeople need to be able to do; explaining research goals and the path that needs to be followed if they are

[7] Of course, private-sector and public-sector applications are not mutually exclusive.

met to intelligent laypeople is something the successful private-sector researchers needs to know how to do.

Curiously enough, most of the time the team-interaction process works. There have been personality clashes, but most of them have been overcome. A change in dissertation topic did disrupt the work of one team, but the team managed to segueway from one topic to another. It is impressive just how many times three people who had little in common at the end of August manage to put together a coherent team presentation, first at the end of December and in more depth at the end of the following May.

More Practicums

The value-added generated by the team approach seemed so evident that we have made an external practical commercialization exercise part of the second year of the IRL program, requiring MBA-Ph.D. teams, often reshuffled and often with more than three members, to evaluate the commercialization possibilities of a technology that is not based in the dissertation topic of an IRL student.

Making such an exercise part of the program requires a certain amount of flexibility. It requires a steady supply of projects for student teams to analyze, and projects do not fit into a common mold. The IRL has put together projects from a number of sources (including venture capitalists with early-stage innovation projects and Purdue's Office of Technology Commercialization, which manages Purdue's intellectual property portfolio). A rich source of projects is Purdue's EPICS Program, Engineering Projects in Community Service (Coyle et al., 2003a):[8]

[8] See also http://epics.ecn.purdue.edu/about/overview_paper.htm.

> EPICS was initiated in the School of Electrical and Computer Engineering at Purdue University in Fall 1995, with 40 students participating on five project teams. … In the 2000-01 academic year, 400 students participated on 20 teams, addressing problems ranging from data management for social services to mitigation of agricultural pollution and from designing learning centers for local museums to developing custom play environments for children with disabilities. EPICS spans engineering disciplines at Purdue and includes students from over 20 university departments.

EPICS has accumulated an inventory of more than 150 projects that were carried out and delivered on a public-service basis. But many of these successful public-sector applications that have been developed may have commercially feasible private-sector applications as well, and the exploration of those possibilities is a natural exercise for IRL teams.

In the first year of IRL-EPICS interaction, IRL teams completed practicums with EPICS teams working on:

- interactive campus maps, showing the optimal travel path between specified locations; a related project,
- a hand-held global position system-based device to permit the visually impaired to navigate an area;
- devices to encourage disabled children to extend their fingers and to maintain a satisfactory posture;
- tutorial programs designed to instruct volunteers with an "affordable housing" program in techniques used to build low-cost, energy-efficient houses.

At the start of the IRL experience, IRL MBA and Ph.D. students enjoy a semi-adversarial relationship. By the time they team up to work with on an outside project, they have a significant common vocabulary and find themselves on the same side of the

fence. IRL Ph.D. students, who naturally enough found the internal logic of their own research projects to be perfectly transparent, find themselves in the position of trying to get a practical understanding of someone else's technology, and to do so subject to time constraints imposed by the deadline they face for their IRL presentation. They also find that they are aware of, and can at least try to explain, things like intellectual property right considerations to EPICS team members. Having to apply the knowledge they gained working with MBA students on their own technology to someone else's work confirms to them (often, it is evident during presentations, to their own surprise), that they had picked up valuable skills from their IRL activities.

The EPICS teams and the Program itself benefit in significant ways from their interaction with the IRL team. In many cases, the interaction with the IRL teams is the first exposure that the engineering undergraduates in EPICS have to the notions and process of commercialization. This experience is particularly enlightening for them because it occurs in the context of a large-scale design project that they are intimately involved with. The report the IRL teams deliver to the EPICS teams at the end of the semester can also be used by the EPICS team to determine if they wish to pursue the commercialization of the products they have developed or are currently designing. The interactions between EPICS teams and IRL teams, in concert with efforts inside EPICS itself (Coyle et al., 2003b) have led to entries in Purdue's Burton Morgan Entrepreneurship Competition by two EPICS teams within the last two years.

Conclusion

Running an innovation-education program is a labor-intensive business. Lining up a steady stream of outside speakers who can convincingly explain what their activities

are and how they contribute to innovation development requires a network of contacts in the community, and it requires an investment in scheduling time. That labor must be provided by the university.

Putting the bits of wisdom from outside speakers into place requires effort on the parts of the MBA and Ph.D. students, who are already committed to the full use of 110% of their time. Ph.D. students, in particular, may begin a program like the IRL not fully convinced of its worth. Interdisciplinary outside applications of program-related skills reinforce the experience of diagnosing the Ph.D. students own dissertation and display, in the most convincing way possible, that the Ph.D. student has gotten more than he or she bargained for out of the program. Setting up a queue of outside projects is a responsibility that falls to program administrators; doing the work falls to IRL students. The outside projects are, however, an effective tool in accomplishing some of the major goals of the Bayh-Dole Act, that is,

> …to encourage maximum participation of small business firms in federally supported research and development efforts; to promote collaboration between commercial concerns and nonprofit organizations, including universities; to ensure that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise without unduly encumbering future research and discovery; to promote the commercialization and public availability of inventions made in the United States by United States industry and labor…

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