An Information Technology Program for a Small Liberal Arts College: An Interdisciplinary Approach

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Abstract

Juniata College, a small liberal arts college, has recently developed an Information Technology program in an interdisciplinary manner. The college encourages students to customize a unique program of study across multiple disciplines called a "Program of Emphasis". The design of the IT program retains this concept by combining existing courses from cooperating programs. This collaborative approach relies on the support and coordination of three long-standing programs in computer science, business administration and communication, along with ancillary disciplines such as environmental science, biology and criminal justice. The cornerstone component of the program is a three-semester team-based local industry project experience. The result is a program that is attractive to a wide range of student interests.

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1. BACKGROUND

In 1998, Juniata College, a small, rural, four-year liberal arts school in Pennsylvania with an enrollment of 1300 students, was challenged with an endowment to develop a unique Information Technology (IT) program that is fitting for the existing liberal arts program of the college. The initial goals of the IT program were to:

- be interdisciplinary by building on the liberal arts tradition of the college and collaboration among existing departments
- combine communication, business, and problem solving skills with a solid technology background in our graduates
- ensure significant industry experience into the program
- develop management skills for success in leadership roles
- develop an entrepreneurial mindset so that a student could create an information technology product or service and successfully market it
- eventually integrate information technology into all programs of the college

An aspect of the curriculum at Juniata College is that students do not follow majors *per se*, but instead, each student develops a program that is unique to him or her. This is called a Program of Emphasis or POE. The students design and follow their individual POE under the guidance and approval of two faculty advisors, one in their major area of interest and one outside their area. Nearly all departments do, however, designate what courses must be taken in order to claim a program with certain, well understood, key words or phrases in their POE title. For a student to graduate with "Computer Science" in their POE title, for example, a certain set of computer science and mathematics courses must be completed.   Such is the case for the Information Technology program that is described below.

Initial Development
Determining what the phrase *Information Technology* was and what such a program would consist of for a small liberal arts school was our first hurdle. IT tends to represent the conglomeration of related disciplines in computer science, management information systems, information sciences, etc.   Obviously to adequately cover all these areas would be impossible for a student in a four-year undergraduate time frame. We set out as our task to best achieve the initial goals set forth above, while remaining within the context of our liberal arts education, to prepare graduates for successful careers and leadership in the IT fields. Faculty members from the Accounting, Business and Economics department, English and Communication department, and Mathematics and Computer Science department along with interested student representatives met as a task force over the course of 18 months to devise a plan for the development of the IT department and its curriculum.

One challenge in developing an Information Technology program is that it be distinct from the existing computer science program, and remain true to a liberal arts college. The computer science program has existed since 1980, is based on the Computing Curricula '91 (Turner 1991) and is guided by the liberal arts model from ACM (Walker 1996).   The desired outcome for our IT graduates is for them to become industry leaders and entrepreneurs who benefit from the broad based liberal arts education at Juniata rather than having had too much focus on current technology, that will likely be obsolete shortly after graduation.   We wanted to distinguish ourselves from local two-year colleges that offer such focus, seeing such vocational training as being contradictory to our mission of providing a liberal arts education.

As a context for the development of the IT program, the computer science program at Juniata College primarily focuses on software development and analysis with a foundation of mathematics. Computer science I and II, software design, computer organization and architecture, operating systems and programming language paradigms courses, along with discrete mathematics, calculus, linear algebra, probability and statistics form the core of the program.   The program does not emphasize particular current technologies except to implement or test concepts from the classes to keep in the liberal arts tradition.   While team projects are common in many of the computer science courses and internships are encouraged, intentional connections to industry for application of classroom theory is not made.

The task force began by consulting with a number of industry leaders and a network of alumni working in the IT field to provide guidance in terms of what industry would like to see in our graduates. This interaction has since led us to form an advisory board that continues to meet one or two times per year to advise the IT department on trends in the industry. Another function of the board is to provide an internship and job placement network for our students.

The primary message from our advisory board is for the IT program to produce graduates with a solid technology skill set, but also combined with communication and business strategy and management skills. Of course, this is not surprising news to educators in the information sciences and information technology fields. This message did encourage the three departments represented on the task force to collaborate and devise a program that effectively uses existing courses within each department to support the program. In some cases courses were revised to better support the new IT program.   The college could not afford e a new IT department replicate any courses that existed in other

departments to simply be specific for IT, e.g. a software development course for IT majors that would be similar to Computer Science I and II courses. To do so would not be in the spirit, or resource constraints of the small liberal arts setting.

2. THE IT CURRICULUM

Overall Structure
There are four components to the IT program as shown in Figure 1. The first component is simply the introductory course, Principles of Information Technology. This course is one of the few IT designated course offerings of the department. It is the only core course from the IT department and is described in greater detail below. The second component is the set of courses from the pre-existing computer science, business, communication, and mathematics programs. The third component is a set of *Areas of Concentrations* from which a student can choose to study further in depth or apply their IT background to. Finally, the fourth component is a capstone sequence of courses called "Innovations for Industry" that places students into teams of two to four to work on IT projects from local businesses and other organizations.

The IS '97 curriculum model was not used explicitly as a guide, but the resulting curriculum described herein is a reasonable implementation. Each of these program components is discussed further in the subsections below.

1. Principles of Information Technology (3 credits)
An introductory course to IT
2. Core Courses (42 credits)
Computer Science program (5 courses)
Communication program (4 courses)
Business program (3 courses)
Mathematics program (1 course)
3. Areas of concentration (9 credits)
Business   Digital Media
Communication Media
Entrepreneurship
Computer Science   Hardware
Criminal Justice
Bioinformatics
4. Innovations for Industry (12 credits)
Industry experience in teams of students
Three semesters, 4 credits each

Figure 1. Structure of the IT Program

Principles of Information Technology
Principles of Information Technology is an overview of the large field of information technology. The course addresses IT not only in its content, a review of hardware components, software applications, software development techniques, Internet applications, IT

careers, etc., but also in its process. Students are exposed extensively to the use of educational technology in this course as well.

The course is delivered with a hybrid approach of weekly class meetings, externally developed, web-based course material for enhanced learning, and electronic communications and discussions among students and faculty. We currently use on-line content developed by Penn State (PSU 2001) for their similar introductory course in the School of Information Sciences and Technology that is delivered on the web and managed by the course management system WebCT®. Students must use the web to access the material for the course as well as respond to discussion questions in a threaded discussion list. Small liberal art colleges are typically known for their personal interaction among faculty and students, thus the reason for the hybrid approach: personal contact between faculty and students is not lost, but students gain experience in the learning methods and course delivery that they will likely encounter when continuing their education during their IT career.

Collaboration in teams is also required in this course. Students are expected to work in teams that involve systems analysis and planning for IT projects. They collaborate on solutions, often by email and chat rooms, share in the writing of the reports, and orally present their results using presentation technology (e.g., PowerPoint) to the class. This approach provides gives the students early in the curriculum an understanding of the type of skills they will use and need to develop to have a successful career in the IT field.

Core Courses
The core courses develop the breadth of communication and business skills expected of graduates, as well as the depth of the technical skills from computer science needed in an IT graduate. Thirteen courses for 42 credits from four programs define the required core courses in addition to the above Principles of IT. Figure 2 lists the courses from each of the programs by title.

There are five courses comprising 17 credits from the **computer science** program. Computer Science I and Computer Science II cover the rudiments of software development, data structures and programming in an object-oriented language, currently Java. Exposure to PC and Unix platforms, visual and command line development environments are also objectives in these courses. Software Design covers the topics within software engineering and requires students to design a larger software system. The courses, Network Management and Database Management, offer the theory, design, and management practices of networks and databases, respectively.

Program/ Department	Courses contributed to core
Computer Science	Computer Science I Computer Science II Software Design Network Management Database Management
Mathematics	Discrete Structures
Communication	Art of Public Speaking Professional Presentations indiv@metaverse.com Technical Writing
Business	The Management Process Behavior Analysis of Organizations Senior Seminar in Business

Figure 2. Program contributions to the core

The Discrete Structures course is being developed by the *mathematics* program first offered this fall (2001), for freshmen to provide students appropriate mathematics background that can be built upon in the sophomore level courses in computer science. This course is offered in place of any calculus requirement. "Discrete Structures" is also an example of a course that was developed for the IT department. Statistics is not prescribed in the core course set, but is part of the general education requirements of the college and students have a number of options to fulfill this requirement.

Four courses are offered from the *communication* program. The "Art of Public Speaking" is the introductory oral presentation course. This is followed by "Professional Presentations" which focuses on advanced public speaking techniques and the appropriate use of presentation technology. The third course also is a course specifically developed for the IT program called "indiv@metaverse.com". It challenges students with the past, present, future analysis of technology's impact on society. Finally, the "Technical Writing" course addresses the various styles of writing necessary in a number of disciplines as well as IT.

Three courses from the *business* program round out the core requirements. Two sophomore level courses, The Management Process and Behavioral Analysis of Organizations, prepare the student with management skills and understanding of planning, organizing, controlling and leadership. The Senior Seminar course considers corporate strategy formulation from a CEO viewpoint. This last course contributes to the initial entrepreneurship goal of the program.

Areas of Concentration
Several sets of courses were defined as areas where students could either study further in depth or apply information technology. Essentially, an area of concentration is a set of three courses or a group of courses from which a student selects three. We intend to add to these areas as student interest or industry demands dictate. This component is another means for the IT department to collaborate with other departments at the college. Without giving the details of the courses, the areas of concentration currently available are:

- Bioinformatics
- Business
- Communication
- Communication Media
- Computer Science
- Criminal Justice
- Digital Media
- Entrepreneurship
- Hardware
- Individualized—a student may define his or her own unique area of concentration with approval from the department

Innovations for Industry
Our cornerstone, and in many ways the capstone, of the IT program is a three course sequence called "Innovations for Industry" (I4I). Beginning in the junior year students in the courses are grouped into teams of two to four and are assigned an IT project from a local, partnering organization. The students in I4I practice project management, teamwork and the various roles therein, and utilize various applications of technology while producing a solution for the client organization. The prerequisites of the first I4I course essentially include the first two courses of the business program, the first two communication courses, Computer Science I, and junior standing. Most students have had substantially more technology courses by this time.

The I4I course sequence is viewed as an alternative to the traditional internship experience. The projects and student interaction are in a much more controlled environment than is typical in an internship. Students invest 12 credits of their undergraduate career to the I4I sequence, which is equivalent to the credits earned in a full time internship. The I4I experience is spread over three semesters, rather than a concentrated in a one-semester internship permitting experience with a wider variety of organizations, project and team management situations, and technologies. This structure also allows for closer faculty guidance.

There are some recognized disadvantages to this approach. Some of our IT advisory board members have argued the value in the immersed experience of a full time internship. We offer and encourage the opportunity for students to schedule such an experience, but we don't require it. We instead offer to "notarize" a full-time summer internship with zero credits on their transcript if the experience is significantly IT related. In

fact, we promote the summer internship to occur at least once during their undergraduate years and encourage the partnering clients to offer such paid experiences. Another disadvantage is the faculty time that is involved. Faculty sponsorship of an I4I is equivalent to 1½ credits of the teaching load per semester, making delivery of the course very labor intensive. We believe this unique personal contact and involvement by the faculty and students is worth the cost.

Significant collaboration occurs at many levels for the I4I course sequence. Students must collaborate in teams of two to four to develop useful solutions for industry clients. The student teams must collaborate with their assigned industry clients. In many cases one or more employees represent the client. The I4I courses are taught by a team of four to five sponsoring instructors who collaborate in the design, delivery and review of the I4I courses. Each instructor sponsors one or two teams of students and collaborates with them as well as the client. The result is an interaction and coordination of many people (as many as 10 in our experience so far) representing three constituents across multiple locations.

As students progress through the three I4I courses, they will work with students from different levels of the course sequence. All three courses of the sequence meet at the same time and location as teams are composed of students from the different levels. Team composition is determined by the faculty based on students' different skill sets, I4I level and past experiences. A student who is in his or her third semester of I4I will often serve as project team leader. Students normally do not specify what project they prefer to work on or which peers to have on their team. Given the credit load and team size the productivity available to the client varies from one half-time to one full-time equivalent employee.

The projects vary widely from web site construction and intranet development, to remote data entry via wireless handheld computers, to paper-to-paperless workflow analysis. The accepted project from a client is not expected to fit neatly into a 15-week semester. Rather, we prefer that a project spans over the academic year and possibly into a second year with the prospect that a student, hopefully from the assigned team, works as a paid intern during the summer. Ideally, a student will work for no more than two semesters on the same project to assure a wider range of experiences; that is, a student may work the first two semesters on one project but then be reassigned to another, or switch after the first semester to another project that they may remain working on for two semesters.

I4I students are not necessarily expected to have all of the particular technical skill sets at the beginning of the project to which they have been assigned. In fact, it is better that they don't since one goal of the sequence is the development of skills in "learning to learn" and students to become "fearless learners." Students are expected to secure the necessary background in order to sufficiently address the problem or problems to be solved. We take a just-in-time approach by providing a variety of training materials, both printed and on-line, as needed. There is a sufficient budget to purchase manuals if not available from the library or sponsoring faculty collections. Often the client supplies the necessary materials for learning the technology, as well as the software and hardware of the technology. Students have access to the comprehensive on-line training resources available from NETg® (National Education Training Group, Inc.).

3. OBSERVATIONS AND CHALLENGES

Initial goals
The design of the curriculum has been built around the direct collaboration of three initial departments. The core courses, except "Principles of Information Technology", all come from these pre-existing departments. While a full four-year interdisciplinary Information Technology program has been created from the cooperating departments, conversely all involved departments have devised within their programs (computer science, business, communication) an Information Technology minor. Other programs of the college have also begun collaboration with the Information Technology department, namely Environmental Science, Criminal Justice, and Biology, to create interdisciplinary programs as well. A direct effect across these departments is an increased enrollment and in some cases increased demand for faculty.

The goal of developing communication, problem solving, and management skills have clearly been incorporated in the core courses. The direct application of the skills becomes evident in the context of the Innovations for Industry course sequence. Initially, as we piloted the I4I courses, we discovered that students had an insufficient set of pre-requisites other than class standing, and have since required students to have the business and communication skills prior to the I4I experience. These were areas where some background was necessary before additional just-in-time learning. Having included a richer set of prerequisites for the first course has improved the students' comfort in presenting and understanding encountered business practices.

Our initial plan for relying on just-in-time learning for most of the technical skill needs is under re-evaluation. Some of our clients' projects have called for students with greater depth regarding software development skills. While we have support for learning particular technologies, we found some of our students ill prepared in general software development skills and use of development environments. We will require more computer science courses for the second and third semester I4I courses to assure that at least more

members of a team have a significant software design background.

The goal of developing an entrepreneurial mindset is addressed in two ways. First is the Senior Seminar in Business as one of the core courses. The second is making a small business incubator available to students. This is not limited to IT students, nor required, but the basic office facilities and space are made available. The incubator will be available during the 2001-2002 academic year.

A final observation is on the impact on the computer science program. Although the IT program is still only two years in operation, there has not been noticeable changes in the interest level of the computer science program. Clearly there have been increased enrollments in those computer science courses that are part of the IT core courses. In upper level computer science courses where there was concern of reduced enrollments, we have not observer any such decrease. While information technology and computer science students essentially share the first year of courses, students do not seem to have trouble determining which program they wish to pursue: one that focuses on problem solving by developing and analyzing new solutions via software and hardware in the computer science program, or one that builds technology solutions in coordination with industry users in the information technology program.

Using On-line Courses

Students begin their experiences in the Information Technology program with the hybrid on-line and weekly in-person meeting type of Principles of Information Technology course. Our informal student surveys and comparisons to non-on-line sections have shown similar levels of learning. We expect to continue to offer this course in the hybrid style, primarily as a means to expose students to this form of learning. Whether it is determined to be a better form of learning or not, we expect on-line learning will be a common style of learning for our graduates as they need to learn new, emerging technologies.

Our relationship with the Penn State School of IST on-line course development group has benefited us with this learning technology while we provide them with valuable feedback on its use within our liberal arts setting. We have used their course materials for two semesters and will use it for all sections this academic year. One notable drawback is that as the course content is a work in progress, the content sometimes changes unexpectedly. This has not been a significant hindrance, however. The overall success has encouraged us to pilot their Web Development on-line course during this academic year in a similar hybrid style as our offering.

Innovations for Industry

We believe we are doing a number of things right in this experiential opportunity. This is a similar experience as described in the Jensen and Wee paper (Jensen 2000). Their observations regarding benefits to clients and students and lessons learned are compatible with our experiences. Students have remarked on how much they have learned in the course of I4I in their evaluations of the course. This learning occurs at a number of levels:

- The immersion into a real life project with real deadlines
- The necessary collaboration with peers and team management
- Project management with timelines and critical paths
- The necessary communication with employers in its various forms of reports, dialogue, email
- The need to learn or relearn a technology and directly apply it to a solution
- The need to deal with change, as the project evolves in definition by the client

As enrollments grow, staffing, coordination effort, nurturing industry clients and general management of the course will become more of a challenge.

Staffing

The interdisciplinary nature of the curriculum has made staffing the program an interesting prospect. Finding faculty for an IT or IT-related field is a challenge for many schools. Universities offering advanced degrees specifically in IT are few, so the alternative is to hire faculty in related areas. The interdisciplinary nature of the program enables the college to essentially hire faculty in related fields, but who also have interest and training in the various areas of IT. The current IT department staffing consists of one professor, the department chair, one assistant professor, three faculty who have joint appointments in other departments: business, computer science or environmental science, and two faculty whose primary responsibilities are administrative. These joint appointments reflect the interdisciplinary design of the curriculum. Other departments such as the communication closely coordinate course offerings and design to support the IT program.

There are many challenges in this staffing arrangement. Faculty members typically have two department chairs to report to, increased number of meetings and scheduling effort by all, and issues arising with promotion and tenure within this complex management matrix. Fortunately, the college is small enough that communication among all involved is not unreasonably attained.

4. CONCLUSION

We have presented an IT curriculum that is viable for a small liberal arts college. By incorporating courses that

already exist in related departments we were able to define a viable core set of courses. There was no need to replicate similar courses specific for IT. A result is the increased enrollments in these already full programs.

The introductory IT course introduces students to information technology by means of a variety of instructional technology and on-line content. The course gives the students an excellent first exposure to the team oriented problem solving that occurs in IT as well.

The areas of concentration provide a high degree of flexibility for the students to choose areas to explore further in depth and apply their IT knowledge.

The capstone course sequence is a team-oriented, project-based set that provides a controlled, experiential environment for applying the technical, communication and business skills that they acquired in the core courses.

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