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# University-Industry Alliances: A Foundation for Innovative Business and Science Education in Emerging Professional Graduate Programs

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*Industry has an increasing need for a professional workforce with multiple competencies. The Professional Master's programs address this need by adding specific professional training to multidisciplinary academic education. North Carolina State University is situated close to the Research Triangle Park, a hotbed for biotechnology. This environment has spurred new synergy between academics and industry professionals. The logistics of building alliances between the two parties and the dynamics of these alliances are described. Examples of the utilization of these alliances to integrate business and science in state-of-the-art cases for professional graduate students are presented.*

**Key Words:** University-industry alliances, professional programs, graduate workforce

**Disciplines of interest:** All business and science disciplines

Abbreviations: PSM = professional science Master's, MMB = Master's in microbial biotechnology, GMP = good manufacturing practices, GLP = good laboratory practices, CEO = chief executive officer, HT = high throughput, CDA = confidential disclosure agreement, FDA = food and drug administration, RTP = Research Triangle Park

## INTRODUCTION

Traditionally, universities have produced employees for both academic and industry work environments. The industry work environment has changed dramatically during the last two decades and the skill set needed in industry today is very different than the skill set needed in academia. More than ten years ago the National Academy of the Sciences addressed the rising need in industry for an improved graduate workforce. Graduates need a high level of technical skills, multiple professional competencies and an interdisciplinary, collaborative, highly adaptable and globally-oriented attitude [National Academy of Sciences 1995]. The necessity of organized professional development of the workforce has long been stipulated and universities have been encouraged to support new and experimental

education [Handelsman *et al.* 2004]. Bridging the gap between industry and academia has the potential to create valuable synergy and cross-fertilization both in education and with other types of collaboration [Kennedy 2003].

In an effort to meet the need in industry, the Alfred P. Sloan Foundation has provided initial support to multiple professional Master's programs [Professional Science Master's 2005, revised]. The programs add a component of professional training to the academic curriculum and the programs have variable levels of interaction with industry. The professional Master's program in Microbial Biotechnology (MMB) [Hamer 2005, revised] at North Carolina State University employs multifaceted interaction with many industry professionals in the Research Triangle Park. The program integrates academic and professional training in business and

**Table 1. Skills in High Demand in the Biotechnology and Pharmaceutical Industries**

Competency Category	Discipline
Academic	Science Business Integration of Science and Business Analytical Thinking
Practical Experience	Internship Bench and Office Work
Technological	Research and Development Process Manufacturing Process Clinical Trials Process
Specialty	Intellectual Property Regulatory Knowledge GMP/GLP Exposure Project Management Introductory Finance
Soft Skills	Leadership Mentorship Teambuilding Conflict Management Expectation Management Change Management Ambiguity Management Communication Skills
Mindset	Context-oriented Thinking Out-of-the-box Focus Entrepreneurship Global Orientation

science. Students learn work-force related skills through industry internships, via industry mentors, and in a new course: Industry Cases. The course is interdisciplinary and encompasses a variety of business and science disciplines. The Industry Cases course serendipitously utilizes components of the action-based case-method [Harvard Business School, revised 2005] and context and problem-based learning [Wood and Gentile 2003] by involving cutting-edge unresolved projects and teamwork. This course is currently one-of-its-kind because it is tailored specifically to the biotechnology and pharmaceutical

work environments in the RTP. Industry professionals from a variety of small, medium-size and large biotechnology and pharmaceutical companies participate in this enterprise. The focus of this paper is the description of 1) a method of alliance-building between academics and industry professionals 2) design, format and model examples of cases, 3) initial assessment of success of alliance-building and 4) future trends in professional Master's education.

**METHOD OF ALLIANCE-BUILDING BETWEEN ACADEMICS AND INDUSTRY PROFESSIONALS**

Educational Needs Assessment.

An effective way to identify immediate training needs is to ask professional employers which kind of skills graduates should have in order to obtain employment. The North Carolina Biotechnology Center has recently predicted the future need of employees and skill set in demand in North Carolina [North Carolina Biotechnology Center 2003]. This prediction was based on a survey of the need for future employees and the preferred skill set of such employees in the major biotechnology and pharmaceutical industries in North Carolina. Although this work mostly focuses on training below the graduate level several need-based skills transcend educational levels. Another method is the creation of an inventory map of employers, their field of expertise, technology, market, size and predicted growth in a particular area. Using a compilation of these methods a list of highly desirable skills for graduate-level employees has been compiled (Table 1). Many of these represent large challenges for universities. In order to create effective training in these areas a high level of interaction with professional experts is necessary. The interaction can attain many formats such as internships, guest instruction of projects/cases, guest lectures and mentoring.

Establishing Contact.

After the determination of educational needs and resources, key people from industry must be identified. The process involves research of individual

**Table 2. Company Size and Rank of Contact Person**

Industry Professionals: Contact Person	Company Size
Team Leader	Large
Manager	Large
Director	Large
Vice President	Large
Director	Medium
Vice President	Medium
Vice President	Small
CEO	Small

industry professionals, their positions and responsibilities, fields of expertise, and level of interest and skills in curriculum design and teaching. Phone calls and visits must be made and often followed up by numerous meetings to discuss scope and length of the interaction, necessary resources and format. The interaction must be initiated at the correct level. The industry professional should have the flexibility to make the decision to interact with academia without jeopardizing company interests. As an example it is more likely that a CEO from a small (less than 50 employees) or medium (50–200 employees) size company will be responsive to a request of interaction rather than a CEO from a large company (more than 200 employees). This is a reflection of responsibilities and resource constraints. Table 2 lists various industry professionals who interact with the MMB program according to their position and size of the company in which they hold employment.

#### Marketing Incentives.

Clearly describing the advantages of collaborative teaching is essential for alliance-building. As examples, industry professionals have an opportunity to obtain 1) resources through student work and new ideas, 2) opportunity to train students in skills of importance for industry, 3) opportunity to evaluate students for future employment and 4) access to potential employees. By interacting with industry professionals, academics have the potential to access

new technology, interdisciplinary thinking and know-how, as well as to gain a professional network.

#### Obtaining Committal.

After spurring initial interest, reciprocal goal setting needs to take place. Flexibility must be displayed in any of the following areas: timing, length of project, participating instructors, specific deliverables, intellectual property matters, and geographical logistics among others. Intellectual property is often a matter of great concern for both parties. Universities typically want to protect students and faculty from signing unnecessary contracts of restraint as well as to limit the length of the contract. Industry professionals, on the contrary, have a duty to protect the intellectual property and trade secrets owned by the company in which they are employees. Agreements that provide for non-confidential interaction are easier to manage but the outcomes are limited by disclosure restrictions.

#### Alliance Dynamics.

Many factors influence the dynamics of the interaction. If the interaction is deemed positive, it is likely to continue and it becomes an opportunity for further development and an asset for both parties. External factors play an important role and can be cause for change. Examples may include sudden travel arrangements, unforeseen audits, termination of employment, relocation, company reorganization, altered priorities caused by market forces, lack of resources, promotions, mergers and acquisitions and personal reasons. Success and maintenance of an interaction between industry professionals and academics are dependent on such changes and the ability to quickly adjust to alternative strategies when change happens.

### **DESIGN, FORMAT AND MODEL EXAMPLES OF CASES**

The broad scope of intellectual exchange defined by the alliances becomes a useful platform for innovation. Due to the synergistic nature of the interaction new education not normally employed at universities are being created; an example being the

**Table 3. Examples of Cases and Case Formats**

Case	Topic	Competency Category (see table 1)	Duration	Student Deliverables
1	Gene Expression	1, 2, 3, 6	3 weeks	Individual Presentations Individual Reports
2	HT Diagnostics	1, 3, 5, 6	4 weeks	Individual Presentations Team Reports
3	Modified Crops	1, 3, 4, 5, 6	4 weeks	Team Presentations Team Reports
4	Bioremediation	1, 2, 3, 5	4 weeks	Team Presentations Team Reports
5	Technology Development	1, 3, 4, 5, 6	4 weeks	Team Presentation Team Report
6	Quality Assurance cGMP Training	1, 2, 3, 4, 5	7 weeks	Team Presentations
7	Biomarkers	1, 3, 4, 5, 6	4 weeks	Team Presentations Team Report
8	Communication Skills Conflict Management	5, 6	2 weeks	Individual and Team Presentations and Reports
9	Intellectual Property	1, 3, 4, 5, 6	4 weeks	Individual and Team Presentations and Reports
10	Product Assessment	1, 3, 4, 5, 6	4 weeks	Team Presentation Team Report
11	cGMP Training FDA Audit	3, 4, 5	2 weeks	Individual and Team Presentations and Reports
12	Business Development	1, 3, 4, 5, 6	11 weeks	Individual and Team Presentation
13	Project Management People Management	1, 3, 4, 5	4 weeks	Individual and Team Presentations and Reports

industry cases. Industry professionals and faculty discuss matters concomitantly from both an industry perspective and a university point of view. They decide topics, process and teaching methods, duration, geographical location, resource allocation, deliverables and target audience for final presentations. They discuss and resolve legal matters and may agree to publicize the interaction with academia and the students in press releases or other media [Leith 2004]. Table 3 displays a summary of cases and the different formats of these as they were created and performed in the period of August 2003 (program launch) – May 2005. All cases target the core competencies listed in Table 1 and involve the study of a forefront issue in science and/or business.

Example 1: Technology Development.

Case #5 focused on the manufacturing of enzymes and was performed at a large biotechnology company. Students learned about the process of enzyme production and were tasked to create methods to minimize fouling on membranes by microorganisms (the occurrence of so-called “bio-film”). Students worked to comprehend a variety of issues in the areas of microbiology, biochemistry, molecular biology and engineering. They suggested a mix of physical, chemical and biological barriers as a means to reduce bio-films. The students finalized the project with a report and a presentation for the employees at the plant. The case gave the students an opportunity to 1)

**Table 4. Measures of Success (As of August 2005)**

Proportional Unit	Success Rate (in %)
Alliances Established /Total Alliances Requested	95% (18/19)
Alliances Maintained/Alliances Established	89% (16/18)
Cases Established/Total Cases Requested	94% (16/17)
Advisory Board Members/Total Members Requested	100% (16/16)
Industry Mentors/Total Mentors Requested	100% (10/10)
Graduates In Jobs and Continued Education/Total Graduates	100% (7/7)

work as entrepreneurs on an important problem in industry, 2) work inter-disciplinarily, 3) practice teamwork, 4) improve oral and written communication skills, and 5) present their ideas to a large heterogeneous group of industry professionals including laboratory staff members and executive officers.

**Example 2: Product Assessment.**

Case #10 took place in a medium-size biotechnology company. The focus was the analysis of a confidential new product. Students were divided into two teams, a business team and a science team. The business team was tasked to perform a market analysis, investigate prior art and intellectual property status, develop a budget and predict the profit margin. The science team developed protocols, proposed a time-line for production, assessed the development costs and considered compliance issues. Together the teams developed a business plan and gave their recommendation. Students developed an understanding for 1) the challenge of science and business teams working together, 2) components in a business plan, 3) taking responsibility for a product assessment, 4) defending the assessment to an executive management team, and 5) professional conduct while working with a confidential project.

**Example 3: Business Development.**

The goal of case #12 was innovation and marketing of new products containing antioxidants. This study was carried out in a large pharmaceutical company. The students performed a cost benefit analysis and a market analysis including identification

of the current competition. They studied a variety of antioxidants and compiled and summarized large amounts of data on the biochemical pathways involved including toxicological and pharmacokinetic aspects. The students decided to present product ideas useful for both prophylaxis and treatment of selected conditions for the management team. During the process many product ideas were deemed not profitable and, therefore, rejected. This study gave the students 1) an opportunity to comprehend the amount of business and science information that is necessary to analyze a new product idea, 2) learn that often projects are changed and flexibility is a necessary skill, 3) to design a new product, 4) to market their product idea in a corporate forum, and 5) discuss their product idea with a professional management team.

**INITIAL ASSESSMENT OF THE SUCCESS OF ALLIANCE-BUILDING**

Many elements should be considered when assessing the success of the alliance-building with industry professionals. Important measures include the success rate with which alliances are created and maintained, the number of affirmative responses to requests for educational interaction through creation of cases, industry participation on advisory boards, and volunteer mentoring of students. A direct result of the education can be measured by the number of graduates who are able to obtain jobs or attend continued education within 1-2 months of graduation. These numbers are found in Table 4. In addition, assessment tools for the program outcomes including student learning are currently being developed.

Stakeholder feedback is an extremely valuable assessment tool. Many industry professionals,

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graduates and students have offered feedback about the alliances and the cases. Below, a series of selected quotations address a variety of needs:

“This (case) course is exceptionally creative and makes good use of existing resources in industry. The curriculum is very flexible and attempts to address many of the general science and business needs in industry. The graduates from this program will have a major advantage in seeking and pursuing industrial careers.” (Michael Stocum, Managing Director, Personalized Medicine Partners, RTP and Vice President of Business Development and Product Strategy, Tricon Pharmaceuticals, RTP. Michael Stocum has served as a case instructor and is currently a student mentor and advisory board member).

“The nature of our work dictates the ability to work effectively in teams working across a broad range of disciplines. The PSM programs provide opportunities to educate students and potential employees on what we do and thereby enable the student to make more effective career decisions.” (Catherine Ricks, Vice President of Research, Embrex Inc., RTP. Catherine Ricks has served as a case instructor, and currently acts as a student mentor and advisory board member).

“I believe that in order for the US Diagnostics/Pharmaceutical marketplace to be competitive and keep in step with the latest technologies and instrumentation that are available we have to have individuals that have practical working knowledge and capabilities to put this technology into practice. I think that is the strength of the (professional Master’s) program.” (Marcia Eisenberg, Vice President of Research, Laboratory Corporation of America, RTP. Marcia Eisenberg has served as a case coordinator, and she is a student mentor and advisory board member).

"With the case class, my public speaking skills have increased and allowed me to have networking opportunities not given to normal masters students." (Rebecca Fitzula, Associate Scientist, GlaxoSmithKline, RTP. Rebecca

Fitzula graduated from the MMB program May 2005).

"The MMB program breaks the mold of traditional science degrees by emphasizing team-based goals and problem solving during our interaction with companies in the RTP area. This unique opportunity aids us in the transition from academia to industrial applications." (Matthew Miller, current MMB student).

## **TRENDS IN PROFESSIONAL MASTER’S EDUCATION**

**Local Trends:** The alliances between academics and industry professionals and North Carolina State University have resulted in the creation of innovative and state-of-the-art cases. Many industry professionals who have been involved in the design of a case also volunteer to be members of the program’s industrial advisory board. Several of these people also serve as mentors for the students. With this trend of increased industry participation at all levels of interaction the program has the opportunity to stay responsive to industry dynamics.

The cases described here are examples of new education alliances, interdisciplinary training and new teachings highly relevant to industry. The exposure to a variety of formats requires students to show flexibility in a context-based manner. In addition, the cases enhance critical and entrepreneurial thinking because there is no ready-made solution to the problems. Students are tasked to work closely with the audience, the company in demand of innovative thinking. Graduates from the professional Master’s program find themselves in a familiar environment when they enter their industry career. Because of their broad education they are likely to consider many perspectives and ideas in future decision-making.

**National Trends:** At this time approximately 100 professional Master’s programs have been established in a number of fields in the USA and more are being developed [Professional Science Master’s 2005, revised]. Several programs enjoy a strong academic home and few are closely connected to surrounding industries. As deemed by the recent Fourth Biennial Meeting of Professional Science Master's Program Leaders there is great interest in establishing

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educational alliances with industry professionals, and bridging science and business disciplines [Council of Graduate Schools, revised 2005], but many academics are unfamiliar with the professional work environment and the process of alliance-building. The method and examples described in this paper may provide useful guidance for new professional curricula development.

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