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Andrew Czuchry
East Tennessee State University, czuchry@etsu.edu

W. Andrew Clark
East Tennessee State University

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Technology Based Business Incubators: Living Laboratories For Entrepreneurial Students

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W. Andrew Clark and Andrew J. Czuchry
East Tennessee State University, Johnson City

Abstract

Those teaching entrepreneurship to engineering and technology students are faced with the challenge of converting theory into learning opportunities that provide real-world-practical experience. Although the literature stresses the need for experiential learning through group and field projects and case studies, the potential of capitalizing on technology-based business incubators as living laboratories has not been fully utilized. The purpose of this paper is to suggest a conceptual framework for closing this gap. This framework is based upon our experience working with graduate student teams on projects with the Oak Ridge National Laboratories Center for Entrepreneurial Growth and East Tennessee State University's (ETSU's) Innovation Laboratory. Both are high-technology business incubators striving to commercialize technology developed in university or government laboratories. High-technology business incubators present an excellent experiential learning opportunity for engineering and technology students faced with the challenge of translating theory to practice. Our experience, gained through personal observation and via a benchmarking study conducted in 2002, indicates that incubators routinely utilize MBA students as at-large business counselors for the fledgling technology based businesses. In addition, businesses founded by university professors tend to attract recently matriculated technology graduate students, many of which served as advisees of the founding professor, as new hires in these startup ventures. However, the use of technology business incubators as training ground for engineering and technology students seeking entrepreneurial business opportunities has not been fully exploited. New technology business ventures generally have strong research experience and intellectual property but little marketing and management experience. These businesses, many of which are cutting-edge technology, present the entrepreneurial student with "real world vision" in seeing hurdles these new technology ventures must face and overcome. We have found that diverse student teams comprised of graduate students majoring in technology, business, digital media and medicine offer unique solutions to problems and insight into opportunities for technology businesses. This paper presents a practical step-by-step conceptual framework for using technology-based business incubators as living laboratories for students studying entrepreneurial leadership. Lessons learned are underscored to suggest mitigation practices to avoid potential problems such as patenting issues, disclosure of confidential information, and liability.

Introduction

The technology-based business incubator has proven to be an excellent vehicle for the commercialization of intellectual property residing in universities and federal laboratories and in

fact many of these facilities are managed by and located adjacent to universities. University Managed Technology Incubators (UMTI, 25%) are located in close proximity to government facilities and/or federal research laboratories (FRL, 16%), are associated with economic development organizations (15%) or are private entities located in technology rich areas (16%). Phillips[1] reported that technology based business incubators associated with universities help to promote the retention of university faculty, maximizes the use of university facilities, establish a living-laboratory for student employment and instruction and promote the formation of high-technology businesses that contribute to the region's economic viability. The success of UMTI's may be dependent on several factors. Mian[2,3] reported that companies located in UMTI's benefit from various value-added aspects including association with university image, access to laboratories and equipment, close proximity to faculty consultants, use of undergraduate and graduate student employees and the collaboration and interaction with other incubated companies. If there is a strong connection between the incubated company's mission and that of the university's research objectives then this further promotes the symbiosis between the two entities. Smilor[4] reported that incubators assisted start-up companies through the development of credibility, shortening of the learning curve, a quicker solution to problems and access to an entrepreneurial network.

Although the literature stresses the need for experiential learning, the use of the business incubator as a learning laboratory for entrepreneurial students has not been fully exploited. Results of a benchmarking study of eleven business incubators conducted in 2002 and located on the eastern seaboard[5,6]; indicate that most university and many privately managed technology-based business incubators use students from MBA programs to assist their client companies. For example, business students from Lally School of Management (MBA) at Rensselaer Polytechnic Institute are required to perform a field project with clients residing in their UMTI. These students may rewrite business plans, develop marketing plans, write technical brochures or manuals, perform specific marketing research programs, and create advertising plans or other business related issues[7]. The benefits to students learning in this type of environment are multi-fold. Tovey[8] states that students involved in internship-type projects that subject the student to real-world situations at operating businesses benefit from building a stronger resume, create job prospects, gain knowledge of how organizations work and adapt to challenges and gain a new understanding and appreciation of collaborative work. Students trained in highly technical fields (both graduate and undergraduate) are often utilized by technology-based business incubators as laboratory workers or scientists involved in directing the research. Businesses founded by university professors based on research conducted in their own university laboratories may hire recently matriculated technology graduate students, many of which served as advisees of the founding professors, as new hires in these startup ventures.

Our experience at East Tennessee State University (ETSU) suggests that technology-based business incubators are an underdeveloped resource for teaching entrepreneurship to multi-disciplinary groups of students majoring in engineering technology, digital media, medicine, business management and administration, as well as other diverse fields of study. The formation of consulting teams consisting of cross-functional disciplines provides solutions to problems seen in UMTI's that differ from a typical MBA student approach. For instance, a team consisting of MBA, engineering technology, digital media and medical students may approach evaluation of competitive landscape using their own individual sets of educational lenses,

collating the information and formulating a solution that optimizes their heterogeneity in academic training. These solutions may not have been possible if the team consisted of a homogeneous blend of MBA students alone.

Since new technology business ventures generally have strong research experience and intellectual property but little marketing and management experience, interdisciplinary approaches may create mutually beneficial partnership opportunities. Faculty teaching technical entrepreneurship can further enhance the experiential learning for their students while contributing to the economic development of their regions by capitalizing on these opportunities. This paper presents a practical step-by-step conceptual framework for establishing these partnerships and for using technology-based business incubators as living laboratories for students studying entrepreneurial leadership. To provide the context for implementation, our experience in teaching entrepreneurship and experiential learning at technology-based business incubators is briefly reviewed.

Teaching Entrepreneurship

ETSU has developed a program where students obtaining a Masters Degree in Technology or a Masters of Business Administration (MBA) can select coursework with an emphasis in entrepreneurial business practices and concepts. Faculty members from both the technology and business colleges form an interdisciplinary team to help coordinate offerings for students. To help facilitate cross-pollination between diverse fields of study many of these courses are dual listed in both the MBA and Technology curriculums. In addition to the master degree programs, an Entrepreneurial Leadership Graduate Certificate Program has been implemented to provide non-traditional students an opportunity to learn entrepreneurial business concepts that can be applied directly to their careers. Coursework offered at ETSU to facilitate innovative entrepreneurship learning is listed in Table 1.

Two of the classes in the innovative entrepreneurship curriculum provide the student with frequent and constructive interaction with regional entrepreneurs. This interaction and dialog with entrepreneurs from diverse technologies provide students an opportunity to observe entrepreneurs from numerous market segments. The graduate course “Innovative Entrepreneurship” provides the student with the opportunity to develop a unique business plan for an innovative product or service. The business plan is developed throughout the semester as students attend relevant lectures and meet regional entrepreneurs and learn from their experience. Presentation of the final business plan to a panel of area entrepreneurial business owners and receiving their critique is the culminating event of the semester. In the sequential semester, students are encouraged to further develop their business concept into an operating entrepreneurial business through further definition of the business plan and the acquisition of venture capital funding (Strategic Experience). Students not interested in moving their business plan forward have the option of participating as a member of a cross-functional consulting team. These consulting teams assist regional businesses in further defining their business plans, performing strategy development or others areas critical to establishing a business. The “Strategic Experience” course develops a mutually beneficial relationship with regional businesses as the businesses gain the expertise of graduate students with current entrepreneurial business techniques and the student gains valuable real-world experience.

One of the major lessons learned during the past eleven years of teaching technical entrepreneurship is that the entrepreneurial skill set is equally important to those in existing businesses that are responsible for product innovation and for those involved in new business development. This has in some cases, given our students experiential learning opportunities by conducting consulting projects for existing technology based businesses in our region. The Strategic Experience course at ETSU has assisted over eighty businesses in the eleven-year existence of the class. Over the past few years several regional technology incubators have been established within a one hundred mile radius of ETSU. The existence of these incubators provides a self-renewing source of embryonic technology-based businesses for ETSU graduate students to interact with through the course of their study in technology driven entrepreneurial innovation. ETSU established a technology based business incubator (Fall 2002) and is in the second phase of accepting new client companies with an emphasis on technology-based innovation (software and biotechnology). Having an incubator within walking distance from the university campus provides the platform for increased faculty and student involvement through consulting and/or employment opportunities.

Experiential Learning at Technology-Based Business Incubators

The innovative entrepreneurship program at ETSU encourages students to develop unique solutions to problem sets they address in various graduate classes. This program unites students from diverse backgrounds to develop products (business plan, business strategy, technology strategy, entrepreneurial finance, business communication and digital animation) needed by regional businesses to enhance their operational efficiency and penetration of the market. The ETSU experience suggests that innovative technical ideas alone do not result in successful business ventures. Technical contributions must be customer focused and market driven before technical innovations can be of commercial value. Nowhere is this concept more evident than in the technology-based business incubator. Our experience through benchmarking[5] and working with technology-based incubators associated with university and federal laboratories indicate that many times these new technology businesses have a significant advantage in technology and intellectual property, supported by cutting-edge research, but lack experience in marketing, management and business principles.

The UMTI and FRL incubators provide an experience not typically observed when consulting with established businesses. The problem of equipping students with both textbook knowledge and practical "real world" experience is a challenge for most university programs. Cooperative programs where students gain experience in an industrial environment provides an excellent platform for application of theory to practice but extends the time required to graduate. In addition, university cooperative programs in engineering are typically developed with well-established industrial corporations and students are assigned tasks that border on the mundane. For example, the first author in his experience at Eastman Chemical Company noted that engineering interns were given assignments that related to data collection, writing of processes or other tasks that did not allow them to fully utilize their engineering training. In this circumstance both the company and the intern fall short of an ideal match. The student does not gain a true appreciation of how their engineering skills might be utilized once they graduate and the company served underutilizes a resource that is skilled in engineering but not constrained with

the paradigms imbedded within the company. An ideal learning experience for students might be established through several short-term assignments with embryonic technology based companies. For many business segments, true "out-of-the-box" innovation occurs in entrepreneurial companies where the founders aren't hindered with the research paradigms established by mainstream businesses. Slywotzky and Morrison[9] caution that tomorrow's competitors may be in businesses dramatically different than yours and may currently provide products or services that currently reside in radically different markets. The UMTI provides an excellent forum for students to apply theoretical concepts to businesses that are at the cutting edge of technology.

Our experience at the ETSU Innovation Laboratory (ETSU's technology-based business incubator) and the Oak Ridge National Laboratory Center for Entrepreneurial Growth indicates that students gain a unique educational experience when consulting with startup businesses at these locations. As Dr. Slywotzky[9] indicated in his book "The Profit Zone", new businesses that change the way business is conducted, within discreet market segments, are not typically found on the list of current competitors but find a way to satisfy customer needs through new and unforeseen formats. These types of businesses create new challenges for our diverse graduate student teams in formulating solutions to business problems. For instance, defining the competitive landscape can be very challenging when there are no direct competitors in the marketplace and the new technology itself has yet to be proven beyond an experimental stage. However, definition of the competitive landscape and expected retaliation from companies currently serving the market is needed for developing a list price for the new product, creating marketing and advertising plans and attracting future funding for new research avenues, manufacturing facilities and operating capital. In business consulting situations such as these, student teams need to expand beyond their current textbook and case study knowledge and extrapolate from information gleaned from other markets or from different experiential bases. It is here that the diverse teams of technology, business, medicine, digital media and other disciplines demonstrate their full potential.

We have also found that the diverse team approach improves the communication with the high-technology incubator client. The inclusion of engineering technology and medical students to the teams allow for "techno-talk" between company founders/scientists and the consulting team. The ability to understand the technical direction through understanding the science (engineering, biotechnology, medical equipment, etc) helps to create a trust between the client scientists and the consulting team and develops a knowledge of the technology foundation that is critical for the integration of business principles in business and technology strategies, marketing and sales plans, advertising, and web site development as well as others.

Conceptual Framework

With the above discussion as a backdrop, a conceptual framework for utilizing technology based incubators as living laboratories for entrepreneurial students is given in Figure 1. The partnerships established using this framework are based upon the strengths and improvement opportunities identified for each of the participants as identified in Exhibit 1. A three-phased approach for implementation is offered in Exhibit 2. The framework and implementation approach are briefly discussed below.

Universities having a technical entrepreneurship curriculum often have faculty and students with complementary and synergistic business and technology skills. However, they seek enhanced ways to provide experiential learning and for conducting applied research in technical entrepreneurship. (See Exhibit 1). To capitalize on the potential relationship with technology-based incubators they must identify mutually beneficial objectives. (See Exhibit 2.) Our experience suggests that managers of these incubators have excellent technology based business coaching experience and a strong venture capital network, but lack sufficient human resources to provide detailed support in implementing their clients' business plans. This creates a partnership opportunity for the university to provide these resources as shown in Figure 1.

However, to structure a deal the university must identify a mutually beneficial relationship between several stakeholders. Figure 1 provides a systems approach for accomplishing this objective. The technology based businesses residing in the incubator have detailed knowledge of a specific technology, but often have difficulty explaining the technology and its market potential to investors. Investors on the other hand need to understand the technology and marketing ramifications before they can make strategic investment decisions that balance the risk equation. Guided by the framework shown in Figure 1, the faculty can implement the three phased approach suggested in Exhibit 2. For example, digital media skills can be used to provide a short animation explaining the core technology. Detailed marketing analyses, developed by the cross-disciplinary graduate student teams, can provide an enhanced linkage between the technology and its associated markets. The animation and improved linkage to the marketplace can be used by the incubated company to seek additional funding from potential investors. Experience gained with the Oak Ridge National Laboratories Center for Entrepreneurial Growth suggests that this framework has merit. It should be underscored that using digital media technology is only an example. The essential ingredients of the partnerships are that the student project should be strategic in nature and must assist the technology-based incubated company in approaching its customers, investors and other stakeholders.

A three phased implementation approach is suggested in Exhibit 2 to shed some light on a path that others may choose to follow. Phase one concentrates on planning to find mutually beneficial objectives. Entrepreneurship faculty meet with the technology based incubator management team to identify incubator client companies that would benefit from more detailed strategic planning and market analysis efforts. During this phase non-disclosure agreements are refined to ensure that the client's company's intellectual property (IP) will be protected. Ground rules for marking and handling the IP are discussed in some detail. Often it is helpful for the faculty, incubator manager, and the client company's CEO to meet and discuss the broad scope and timeline. For example, projects should be strategic in nature and must be completed within a sixteen week semester, so students can receive their grade. Client companies should define a representative as the students' point of contact and should agree to provide required information in a timely manner to ensure project completion within the semester. This establishes the broad project scope that will form the basis for detailed negotiations between the students and client companies.

Faculty then meet with students and select students with skills best suited to client projects. This initiates Phase two. Faculty then move into a coaching role and facilitate an initial student-

incubator manager-client company meeting to detail the refined project scope, schedule and ground rules. Since students negotiate the final project scope this establishes student "buy-in" and commitments. Generally, students are expected to work ten hours per week on these projects. Further, client companies recognize the importance of the project to the students and often move into a mentoring role that accelerates student learning. Students sign non-disclosure agreements and document project requirements in an engagement letter signed by the faculty, representing the university, and the incubator manager who serves as the university's client for the project. The engagement letter is the project contract and becomes an important reference throughout the semester project. Although students and faculty receive no compensation for their efforts, it is important to document in the engagement letter other costs (such as travel, reproduction, and mailings) that the client will cover.

Successful implementation and continuous improvement are the objectives for the third phase. It is important for students to develop detailed sub-project plans clearly defining their individual tasks and responsibilities. This avoids future misunderstandings and helps to avoid a student team becoming dysfunctional. In addition, students should be mindful of the time burdens placed on client company executives and incubator managers. Monthly project reviews with faculty help keep the project on schedule. To maximize student learning our experience suggests that faculty remain in a coaching role. One of the most difficult challenges for us has been to accept that the project is the students' and that our professional reputation does not mandate that we take charge and control outcomes. However, in some cases these relationships can result in faculty consulting and/or applied research opportunities. In these latter cases, after the students complete their projects, faculty assumes full responsibility for outcomes of faculty research and/or consultation. An important final step of phase three is to review the lessons learned and discuss improvement opportunities that can be implemented on future projects. In some cases projects can extend over several semesters if care is taken to ensure a smooth transition between project teams. After celebrating the successful completion of a project and implementing plans to realize improvement opportunities, the three phases are repeated with another student team in a subsequent semester.

During phase three the importance of a mid-term review with the faculty, incubator manager and Client Company's management team is underscored. Significant mid course corrections are often necessary to avoid client disappointment with the end results. Another lesson learned is that a dry run of the final student presentation is absolutely essential. During the dry run the faculty provides coaching points to help the students polish their presentation content and delivery, and anticipate typical client questions.

Faculty review a grading copy of the students' final report and makes improvement suggestions. Students make these refinements and provide the client with a written final report at the time of their final presentation. At the project conclusion the incubator manager provides a written evaluation of the project and offers improvement suggestions for future projects. Faculty members discuss these suggestions with the incubator manager and the three phases of the implementation approach are repeated for a future project conducted by another student cross-disciplinary team.

Concluding Remarks

Although the literature stresses the need for experiential learning through group and field projects and case studies, the potential of capitalizing on technology-based business incubators as living laboratories has not been fully realized. Perhaps this is due in part to the lack of a systematic approach to establishing mutually beneficial partnerships between the institutions of higher learning and all of the stakeholders. Our experience suggests that these partners should include the client company and their investors as well as the management of the business incubator. This paper provides a practical conceptual framework with a step-by-step guide for implementation and continuous improvement. Hopefully, this represents a modest contribution that others teaching technical entrepreneurship will find useful.

Guided by this framework, our experience suggests that technology-based business incubators can play an important role in innovative entrepreneurship education. Not only do these incubators enhance the success probability of the faculty and student led technology start-ups, but they also provide students with the opportunity to consult with these dynamic businesses to gain considerable practical knowledge of what is required to make a technology start-up venture successful. Further, results of students' projects have, at least in one specific case, helped a client company achieve second round venture capital funding.

Cross-functional teams provide the opportunity for students to gain a perspective for the value of each other's expertise. In addition, team based learning experiences helps prepare students for the challenge of managing businesses with rapidly changing technologies. Innovative entrepreneurship at ETSU stresses the importance of cross-functional teams to multiply the individual's effectiveness in solving complex technical and business problems and in delivering unique solutions not probable with homogeneous teams. We hope that the framework described in this article will help others avoid some of the pitfalls that we have encountered on our journey. We welcome suggestions that will help us continue to improve our program and that will make more effective use of technology-based business incubators as living laboratories for our entrepreneurial students.

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W. ANDREW CLARK is a nutritional biochemist with diverse experience in academics and industrial research. He received his Ph.D. in Nutrition from North Carolina State University in 1980 and served as Assistant Professor of Nutrition at South Dakota State University (1980 to 1983). From 1983 to 2001 he held various positions in research, management and business at Eastman Chemical Company. Dr. Clark is an Associate Professor of Entrepreneurial Business at East Tennessee State University.

ANDREW J. CZUCHRY received his Ph.D. from the University of Connecticut in 1969 with a concentration in guidance and control engineering systems. He has more than twenty years as a professional manager in technical innovation and electronics manufacturing. Dr. Czuchry has been the holder of the AFG Industries Chair of Excellence since joining East Tennessee State University in 1992. He holds a dual appointment as a tenured professor in the Department of Management and Marketing and the Department of Technology.

Table 1. Innovative Entrepreneurship Coursework offered at ETSU

Course Name	Credits	Course Description
Small Business Management	3	Teach skills necessary to establish and run a small business. A focus will be placed on technology-based businesses such as information technology, digital media and biotechnology. Lecture, discussion, teamwork, and presentations.
Entrepreneurial Finance	3	Provides the fundamentals for managing an entrepreneurial venture from the financial perspective. Topics include identifying financial and fund-raising strategies, managing cash flow, obtaining venture and growth capital, long term value creation and basic accounting principles. Lecture and exam.
Innovative Entrepreneurship	3	Focus on new business creation based on technology innovation. Provides the innovative prudent risk taker with a practical approach for converting brilliant ideas into wealth. Lecture with emphasis on teamwork, team exercises, and presentations.
Strategic Management of Technology and Innovation	3	Provide the student with a sound, basic knowledge and understanding of technological innovations to include forecasting, strategic implications, implementation of technology strategies, and new product development.
Strategic Experience/ Entrepreneurial Experience	3	Student consulting projects allow graduate standing students nearing the end of their program to apply knowledge and skill in a real-world business and industry environment. The projects also provide opportunities for the university to support the business and professional communities and the regional economy. Consulting teams are staffed by selected graduate students that are under the supervision of faculty. Student teams are comprised of both technology and business college members. Teamwork and presentations.
Leading Continuous Improvement*	3	A study of the skills and knowledge necessary for business and industry to enhance competitiveness in the global arena. Focus on customer driven quality and strategic implementation. Lecture with emphasis on teamwork, team exercises, and presentations.
Leading Empowered Problem Solving Teams*	3	A course designed to provide graduate students with practical, hands-on experience enhancing their ability to work together solving complex business and technical problems as a cohesive team. Lecture, discussion, teamwork and presentations.
Project Management* *indicates elective, students select one of the above.	3	A study of contemporary project management. The course focuses on the development and/or enhancement of the ability to successfully plan, schedule, budget, monitor, and control the execution of projects. Lecture with emphasis on teamwork, team exercises, and presentations.

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Exhibit 1: Strengths and Improvement Opportunities

Technology-Based Businesses

Strengths

1. Excellent knowledge of a specific complex technology
2. Entrepreneurial spirit and drive

Improvement Opportunities

1. Ability to explain the complex technology to customers and investors
2. Enhanced business skills including strategic planning and marketing
3. Additional funding support from investors

Technology Based Business Incubators

Strengths

1. Technology based business coaching knowledge
2. Venture capital network

Improvement Opportunities

1. Additional human resources
2. Simplified methods to explain complex technologies to potential investors

Venture Capitalists, Angels, and other Investors

Strengths

1. Understanding of technology business plans and success criteria
2. Financial resources

Improvement Opportunities

1. Better ways to understand complex displacement technologies
2. Linkages between displacement technologies and the marketplace

Universities Teaching Technical Entrepreneurship

Strengths

1. Academic cross-disciplinary curriculum
2. Faculty and students with complementary and synergistic business and technology skills

Improvement Opportunities

1. Enhanced ways to provide experiential learning
2. Ways to conduct applied research in technical entrepreneurship

Exhibit 2: A Three Phased Approach for Utilizing Technology Based Incubators as Living Laboratories for Entrepreneurial Students

Phase 1: Planning

1. Cross-disciplinary faculty teams establish partnerships
2. Incubator managers identify potential client companies
3. Faculty and incubator manager establish project ground rules with client companies
4. Non-disclosure agreements are established

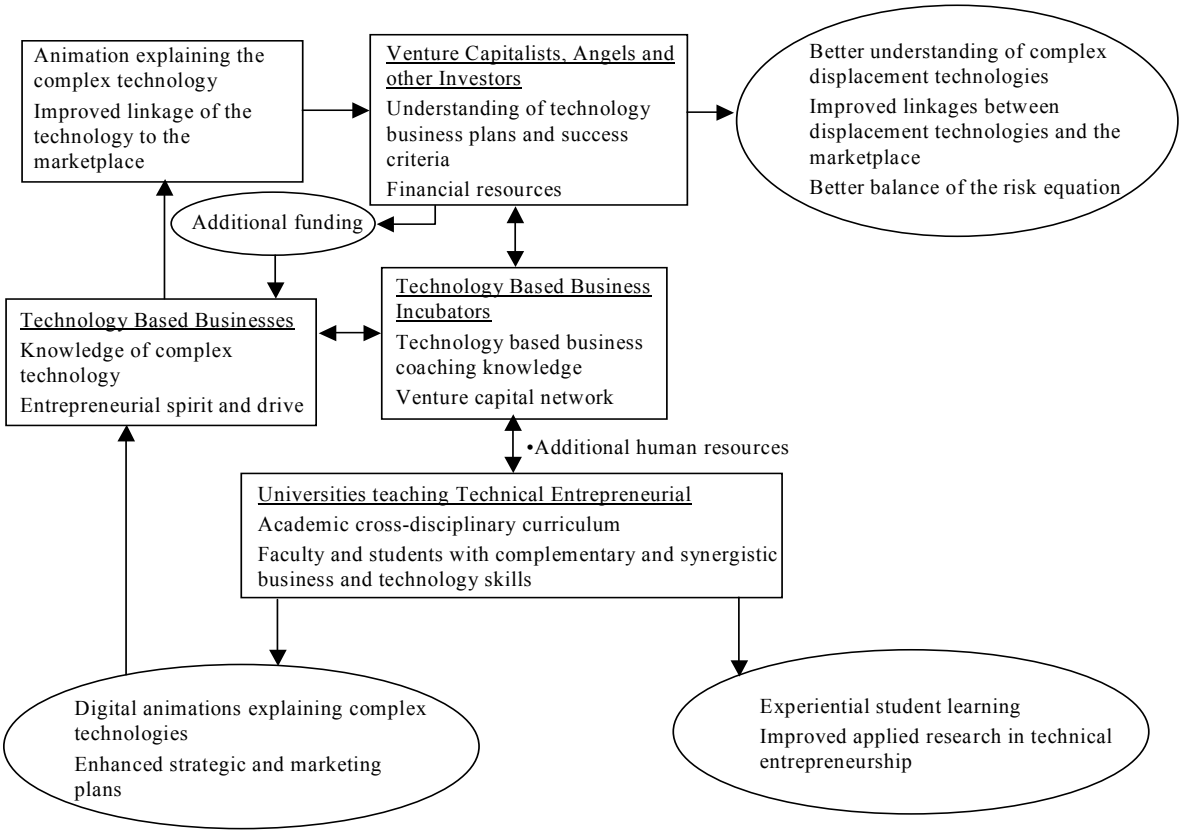
Phase 2: Student-client negotiations

1. Faculty match students to the client's project
2. Faculty facilitate initial student-incubator manager-client company meeting
3. Student negotiate project scope and document in an engagement letter
4. Students also sign non-disclosure agreements

Phase 3: Implementation and continuous improvement

1. Students develop a comprehensive project plan
2. Provision for obtaining needed client information is made
3. Faculty conduct monthly project status reviews
4. Students give a mid term presentation to the faculty, incubator manager and client company executives
5. Mid-course corrections are translated into a revised project plan and implemented
6. Students conduct a dry run of the final presentation with the faculty and provide a grading copy of the final report
7. Students revise the final report and presentation based upon faculty guidance
8. Students make the final presentation to the client and deliver the final report
9. Faculty provide the incubator manager with an evaluation form and ask for improvement opportunities
10. Improvement opportunities are discussed and future projects are identified
11. The three phases are repeated with the next semester's group of entrepreneurial students

Figure 1. Conceptual Framework for Utilizing Technology Based Incubators as Living Laboratories for Entrepreneurial Students



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