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Can Students in Technology Entrepreneurship Courses Help Foster Start-ups by the Unemployed?

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Abstract

Purpose: Evaluates Lehigh University's demonstration program integrating technology entrepreneurship courses with state and federal employment and economic development agencies. Details program goals, activities, resources and structure.

Methodology/Approach: The demonstration involved three stages over 30-months in the context of Lehigh's Integrated Product Development Program. IPD engages students and faculty from business, engineering and design arts. Multidisciplinary student teams worked with unemployed clients with entrepreneurial new product ideas. We report results of several surveys and lessons learned from a comprehensive assessment process.

Findings: One year after participating, compared to a control group of non-participants, clients with student teams had made statistically significantly more progress in launching businesses and generated more economic activity. Family support and market knowledge were the strongest predictors of entrepreneurial progress.

Research Limitations: Sample size is small and follow-up timeframe only one year post-participation. Larger controlled studies over longer periods would be valuable.

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Practical Implications: Findings suggest both students and unemployed early-phase entrepreneurs gain from such academic collaboration. Resources were substantial in the context of curriculum. Partnerships with economic development agencies were instrumental.

Originality/Value: Despite a large literature on the value of multidisciplinary and project-based experiential learning, there is little empirical evidence about the extent of commercial benefits to client companies, particularly early phase entrants. Specifically lacking is evidence on the utility to start-up entrepreneurs of working with student teams. This paper begins to fill that assessment gap.

Keywords: Entrepreneurship, New Product Development, Inquiry-Based Learning, Project-based Learning, Multidisciplinary Teams, Collaborative Learning.

Type of Paper: Research Paper.

Introduction

This paper discusses and evaluates a 2½-year demonstration program, funded by the US Department of Labor, integrating technology entrepreneurship courses with state and federal career and employment agencies. The demonstration was carried out in the context of Lehigh University's Integrated Product Development (IPD) Program, in which student teams from business, engineering and design arts work on a wide range of industry-sponsored new product and process design projects. The program consisted of three stages over 30-months. The first involved recruiting and selecting from among 212 applicants. Second, each of the 11 selected participants worked with multi-disciplinary IPD student teams in a year-long sequence of related courses. In the final stage, interested participants received assistance from the Technology Business Development Program at Lehigh's Small Business Development Center and pursued ideas further with Pennsylvania's Ben Franklin Technology Partners center at Lehigh.

This paper's objectives are to 1) evaluate the feasibility and impact of an integrated partnership of academic, government and private entities for economic development based on new companies started by the entrepreneurial unemployed; 2) explore whether multidisciplinary student teams can help emerging entrepreneurs; and 3) draw lessons-learned about the structure, process and resource implications.

Cross-disciplinary curricular integration and experiential project-based learning have both seen considerable growth and attention in the last two decades (e.g. Tubbs, 1985; Eppinger, Fine, & Ulrich, 1990; Hamilton, McFarland & Mirchandani, 2000; Ochs, Watkins & Boothe, 2001; Barber, Borin, Cerf & Swartz. 2001). In technology entrepreneurship, this trend accelerated in the early 1990s when the importance of active, project-based, collaborative experiences and interdisciplinary teaming was a constant theme in many reports on design education (e.g. Dixon,

1991; Nevill, 1992), including from the National Research Council (1991) and National Science Foundation (1993). In business and management there was a parallel flood with remarkably similar emphases (e.g. Stinson, 1990; Foster & Gilbert, 1991; Usher, Simmonds & Earl, 1991, Wagenheim, 1992, Wagner, 1992, Kimber, 1996, Watkins, Ochs, Boothe & Beam, 1998). Indeed, the literature on the value of multidisciplinary collaborative project-based curricula dates back at least 35 years (Fletcher & Przirembel, 1971). As a result, experiential product design courses nationwide now regularly integrate business and entrepreneurial skills, often with corporate clients, and an increasing number of programs now also foster student technology entrepreneurship (e.g at Lehigh (Ochs, Watkins & Mitchell, 2005); Maryland (Barbe & Thornton, 2004); N.C. State (Ohland, Frillman & Zhang, 2004); and Penn State (Bilén, Kisenwether, Rzasa & Wise, 2005)). With the expansion of such programs, an associated growing literature has shown their effectiveness for student learning (e.g. Wagner, 1992; Kimber, 1996; Ohland et al., 2004).

However, there is little empirical evidence about the extent of commercial benefits to the client companies, particularly those who are in the earliest phase as completely new entrants. Specifically lacking is evidence on the utility to start-up entrepreneurs of participating with student teams. This paper attempts in part to fill that assessment gap.

We begin by describing the program, including the institutional context and the interdisciplinary new product development courses involved. To assess impact, we present results of a survey of the early phase business progress of the participating entrepreneurs one year after the program, and statistically compare them to the progress of a control group of applicants who were not selected. We also describe the step-by-step process involved and results of the comprehensive assessment tools used to evaluate the program, including an original

survey to identify key selection characteristics predictive of entrepreneurial success and how those predictors correlate with post-program outcomes. Finally, we discuss the assessment feedback from each segment of involved groups, and reflect on lessons learned. Given the early stage of these entrepreneurial companies, assessing longer-term economic impact is beyond our scope, as the clients continue to pursue funding and follow through on business plans.

Institutional Context and Resources

Lehigh University, in Bethlehem, PA, 75 miles west of New York City and 50 miles north of Philadelphia, is private, co-educational and non-denominational. It serves ~4,600 undergraduates and ~2000 graduate students across four colleges: arts and sciences (45% of undergraduates), business (25%), engineering (30%) and a primarily graduate college of education. Lehigh is considered "highly selective" with median SAT scores of 1300, and is consistently among the top 40 US national universities in *US News*'s annual rankings.

The program ran within Lehigh's Integrated Product Development (IPD) Program (Ochs, et al., 2001), which began in 1994 in response to a need for college graduates prepared to work in group settings as multi-functional, self-directed and team-oriented professionals. IPD engages students, faculty and courses from the colleges of business, engineering, and arts and sciences. In the IPD capstone courses, multidisciplinary teams from business, engineering and design arts collaborate with external clients to develop products and business plans to commercialize them. The student teams, with faculty advisors and clients, devote the first (spring) semester to market research, customer needs analysis, concept generation and selection, system specification, and financial projections. In the second (fall) semester, the students revisit design details, fabricate

prototypes, design and perform tests, plan for production, and revise the business plan and financial models. Annually, approximately 150-200 students from 20-30 majors participate.

A major goal was to show whether academic, government and private agencies can work together to spur economic development. This was done by assisting dislocated or new entrant workers in their attempt to become self-supporting through start-up companies. IPD coordinated efforts with three outside agencies to recruit eligible applicants, provide services to those not selected, and help the selected participants pursue their business plans after the coursework.

First, the Lehigh Valley Workforce Investment Board is located in Allentown, PA. A committee chartered by the LVWIB connects employers with qualified job seekers. A second associated agency was the Small Business Development Center, located in the College of Business and Economics at Lehigh. Services include financial, marketing, production, technology development, organizational and human resource assistance. Third, the Ben Franklin Technology Partners of Northeastern Pennsylvania (BFTP) provides funding and services to technology entrepreneurs with high-growth potential for the region's economy.

Resources applied during the demonstration program were substantial compared to typical academic curricula. Over the 30 months, US Department of Labor grant funds of $556,000 covered: 1) faculty project director's one month summer support; 2) outreach manger for 18 months, responsible for interactions with clients; 3) two graduate students, one each in business and design arts, 4) computers, laptops, projection systems and office supplies, 5) recruitment publicity in regional newspapers, 6) 40 copies of the Entrepreneurial Quotient questionnaire from Wonderlic Inc. for part of the participant selection process; 7) student team prototyping, travel and other project expenses; and 8) assessment costs, including an internal evaluator (co-author here) and an external evaluator, who did four semi-annual evaluation reports. In addition

to DOL funding, the 11 faculty advisors for the student teams were from regular teaching loads in academic departments, funded internally, as was a third graduate assistant in engineering. Other internally funded IPD resources include a Program Manager responsible for budgets and facilities; an Academic Administrator responsible for the capstone course; and an Administrative Coordinator for secretarial support and office management.

Evaluating Entrepreneurial Outcomes

Eleven entrepreneurs, recruited and selected through a procedure discussed below, were each assigned either one or two student teams. All 11 were males and unemployed at the time. Three attended some college, five graduated college, two attended graduate school, and one completed all requirements for a Ph.D. except dissertation. Seven had some business training. The majority characterized their most recent jobs as managerial, technical, or other professional positions. Two had been in sales-related positions. Seven had previous entrepreneurial activities, such as in landscaping, consulting or newspaper delivery. Three had been self-employed, and five had parents who owned businesses. For the duration of the demonstration, all 11 supported themselves through temporary jobs, savings or investments and support from others.

The entrepreneurial ideas generally involved product improvements rather than radical innovations. The 11 projects tended toward higher (but not highest) technologies, and were: improved microwave telecommunications filters; an epoxy-and-Kevlar hoof coating to replace horseshoes (the most radical innovation of the group); an improved outdoor volleyball net system; an improved wildlife trapping system; a redesigned hoof-cuff for the meat processing industry; an override safety device for boats; an improved Ob/Gyn speculum; a digital table

display for casinos; an improved monitor to track cardiac function; a novel hydraulic impact drill; and an improved handle and installation process for refurbishing lockers.

Did the program and student teams help these entrepreneurs? Approximately one year after participation in the capstone, the client entrepreneurs received (by both mail and email) a questionnaire that included key tasks (Table 1) associated with various stages of building a business. After a series of attempted telephone and email contacts, seven of the 11 participants (64%) responded. For a control group, the questionnaire also went to individuals who applied but were not selected. Nine of 41 (22%) returned it.

Table 1 shows that the client entrepreneurs completed more tasks and are more likely than applicants to have completed each task. Despite the small sample size, most of the differences in proportions are statistically significant. All of the client entrepreneurs who responded created a new product design, and all but one created a marketing strategy, compared with only five of the nine non-participants. Five of the seven participants reported fabricating and testing a prototype, creating a marketing plan, forming a legal business entity, and establishing an office. Four of the nine non-participants created a prototype, but only two were able to test it. Three created a marketing plan, but none established a business entity or office. Five client entrepreneurs demonstrated their product to potential customers, and three established paying customers. Only one non-participant completed these tasks. Two client entrepreneurs reported hiring employees, positive cash flow and profit, compared with none of the non-participants.

In addition, one of the non-responding participants received a provisional patent. The hoof-cuff team continued their project after the two-semester IPD sequence through independent study. Based on the students' work, the client entrepreneur received a provisional U.S. patent. Another non-respondent said by telephone that although not now pursuing further development

of the IPD team's product, he is working on other aspects of the business he created through the demonstration. The other two non-respondents gave no feedback. There is no reason to believe they progressed beyond the initial development process.

Note that one client who reported profit does not attribute success to his participation. On the other hand, another respondent believes that his company would not exist without the demonstration. He has since received over $400,000 in start-up grants from BFTP, and $550,000 in first round venture capital funding, and has begun production of a different product, much of the progress through contacts he developed by participating. The IPD product is in abeyance until the launch of the new product. To quote David Bonner with his permission:

> I cannot emphasize enough the significance and importance of this program to both Thor Power and the students. The IPD Program, supported by the DoL, for developing entrepreneurs, is the wave of the future. Without it, Thor Power probably would not exist. And, as a teacher as well, integrated thinking and teamwork are essential for the students.

Another respondent is now developing the product with a larger company, and another will continue development as cash is available. One participant is seeking funding so he can devote more time to the project and acquire supplies. Another is continuing to build the business, working on a different prototype, not the product developed by the student teams. Still, the participant describes working with the students as "a wonderful experience and very informative," and due to the students' research is exploring introducing the product into markets other than originally envisioned. By contrast, only one unselected applicant plans to pursue the idea further, trying to find a parts fabricator.

By these measures, participation by entrepreneurs with student teams in IPD was clearly, if moderately, helpful in enabling more rapid progress in the key steps towards starting a business. Given capstone course deliverables, each participant should have received market and technical

research results in the final reports, a business plan, a marketing plan, and one or two working prototypes (depending on the number of teams assigned to the project in the fall semester). That there have not been additional profitable ventures yet is likely due to several factors, not least of which is the sheer difficulty and overall high failure rate in starting any business. More specifically, the students' research did not produce results as favorable as expected by some clients, leading them to pursue other options. Second, where projects produced workable prototypes, some clients decided against assuming the risk associated with starting a business.

In sum, one year after participation, the economic impact of the demonstration was positive but limited, as expected given the short period. Three client entrepreneurs reported that they are working 40 or more hours on their businesses. Two others are devoting 5-10 hours per week, and another characterized the hours as "many." Two individuals had hired employees, and one is currently advertising for a Program Controller position. Two were profitable and one received a provisional patent. By contrast, the control group of non-participants had no substantive increase in economic activity, and only one continued to pursue the business at all.

Evaluating the Selection Criteria

We now move to reviewing the selection process we used, following the Service Model and selection steps shown in Figure 1. The Figure also shows the numbers of applicants progressing at each stage, from 212 total initial applicants to the two positive cash-flow businesses noted above. We discuss each stage and our assessment of the effectiveness of the criteria used.

Survey. Early in planning this demonstration, we reviewed the entrepreneurship literature and interviewed individuals involved with entrepreneurship to identify characteristics associated with success. We developed and sent a survey to 22 entrepreneurs, 64 professors (the majority

with personal experience as entrepreneurs) and 19 professionals who deal with entrepreneurs. Fifty (48%) responded by rating 32 characteristics on five-point scales from "no influence" to "extremely influential." We factor analyzed, grouped and ranked the items (Table 2) according to level of influence as scored by these experts. This informed the development of selection instruments, discussed and assessed below, used in the application process.

Recruitment. Our initial plans targeting dislocated workers from recently downsized firms in our region proved of limited value, resulting in only 15 inquiries. The Lehigh Valley Workforce Investment Board assisted by providing a list of downsizing companies, and inviting the Outreach Manager to join their presentations to dislocated workers and to participate in a LVWIB-supported job fair. To reach a wider audience, two of this paper's co-authors publicized the opportunity on *Job Quest*, a Lehigh Valley television program, leading to five inquiries.

By far the most successful (and time-efficient) publicity was ads in four major newspapers, in the Lehigh Valley, Philadelphia, Reading and Wilkes-Barre. This led to 181 inquiries. Eleven additional inquiries came through Lehigh connections, for a total pool of 212 individuals.

Screening and Selection. Based on the survey of experts, we developed two instruments for the application process, a seven-page, 47-question Tier I form, and 72 additional questions for Tier II. Together with a preliminary informational interview, these instruments formed three screening stages. As shown on Table 2, our survey of experts in entrepreneurship produced six major factors associated with successful entrepreneurs. In order of perceived influence, they were: 1) Passion/ Commitment, 2) Knowledge of the Market, 3) Product Characteristics, 4) Characteristics of the Entrepreneur, 5) Skills of the Entrepreneur, and 6) Personal Conditions. Questions regarding the most influential factors were included on the Tier I instrument and the remaining factors on the second tier.

The first screening stage was an initial informational discussion with Outreach Manager, a previously successful entrepreneur. Interested individuals contacted him and he discussed their ideas and explained the application and IPD course process. He used two sets of criteria in determining whether their business idea fit the program. The first set dealt with the product idea, that is whether it: was a product rather than a service; size-appropriate; required only resources readily available at Lehigh; contained business, engineering and design arts components; and whether students could complete it in two semesters. The second set dealt with the individuals: whether they were self-supporting for the duration; were willing to make the time commitment; and had sufficient expertise in the product area. When the project fit, the individual moved to the second stage and received the Tier I application. If not, the individual was referred to the Small Business Development Center where they could meet with counselors to explore feasibility and get guidance on next steps. From the pool of 212 inquiries, 106 received Tier I applications, of which 53 (50%) were returned.

Though there was no systematic follow-up of non-respondents, reasons cited for non-responses included the absence of a non-disclosure statement and lack of a signed contract agreement. We also suspect self-selection due to the content of questions, including realization of the level of product knowledge needed and work involved.

After receiving the completed Tier I applications, the graduate student consultants interviewed each of the 53 applicants in person for approximately an hour. They judged four criteria: Did the project fit the IPD model? What were the applicant's expectations and could they be met in the context of the capstone courses? Would they work well with the student teams and have enough knowledge of the market to provide appropriate guidance? How committed were they to their product idea?

In the third stage, the Outreach Manager and graduate student consultants invited promising candidates to complete the Tier II questionnaire and Wonderlic's Entrepreneurial Quotient questionnaire, which measures entrepreneurial potential. From these, we selected 11 projects most likely to benefit from the capabilities of the students in the IPD Program.

Given the survey of clients one year after the program, we are able to assess the degree to which the screening questions were effective in predicting entrepreneurial progress. We correlated principal factor scores (normalized from 0 to100) from sets of related questions on the Tier I and II questionnaires and the Entrepreneurial Quotient with a variable that reflects the highest stage of business development reported on the post-IPD-participation survey discussed above. Scores on two characteristics in Table 2 were significantly related to business progress. Family support was significant (r=.554, p=.02) when participants and unselected applicants were considered jointly, and also significant (r=.916, p=.004) for the client entrepreneurs subgroup considered alone. In retrospect, we might have increased our attention to this criterion when screening applicants, because it was not the principal metric used.

The other characteristic was market knowledge, which was in fact one of the main selection criterion. This metric was only significantly related to business progress (r=.565, p=.02) when the joint sample was analyzed, but not when the sub-groups were analyzed separately. This result is most likely due to the combination of small sample sizes and the fact that the client entrepreneurs were chosen specifically because of their knowledge of the market. Their scores on this market knowledge factor were significantly higher than those not selected (89.3 vs. 72.8 respectively), and by being accepted into the demonstration they completed more tasks through their association with the student teams.

Thus, the applicants' market knowledge and family support appear to have been effective predictors of entrepreneurial progress and reasonable screening criteria. These correlations are based on a small number of cases and short timeframe, so they suggest further study.

Other Lessons Learned

Throughout the program we also did assessment surveys of participating faculty and students. All 11 advisors completed a survey, as did 108 of the students who participated. The forms contained 48 items, across ten categories: Overall Objectives, Engineering Objectives, Business Objectives, Instructor Effectiveness, Course Work, Advisor Issues, Sponsor Interest, Sponsor Input, Productiveness in Labs, and Value of IPD Staff. Given space limitations, we report only a few select results from those surveys.

Facutly Advising. During the program, 11 faculty members advised 22 teams. Each faculty advisor who had not previously participated in IPD paired in apprentice fashion with an experienced IPD advisor. Apprentice advising is a one-time duplication of resources, with two advisors for some teams, but is especially useful where academic backgrounds bring little business or design and prototyping experience, or little experience with multidisciplinary team projects. Our experience in more than 10 years of IPD is that this has substantially reduced inter-advisor variation in expectations, since all students would ideally be treated similarly. All students attended common lectures once per week, were required to meet their advisors once per week both terms, and to meet on their own as a team at least one additional time per week. All teams had common deliverables. Before both semesters, the Outreach Manager and graduate students met with each faculty advisor to overview of the course, answer questions, and offer assistance at any time during the semester. With handouts they provided examples of how team

advising and meetings might be organized. This and the new-advisor apprenticing aimed for some consistency in team management.

Our post-course survey of faculty advisors asked how helpful they found each of these resources on a scale from 1 (not at all helpful) to 4 (extremely helpful). Table 3 contains the average ratings for the entire group (All), and compares faculty with previous experience advising IPD teams to those advising for the first time.

Table 3: Average Usefulness Score for Course Preparation Resources

Resource	All N = 11	Experienced N = 7	New N = 4
Pre-semester meeting	3.0	2.6	3.8
Handouts	2.9	2.6	3.5
Course Info web site	2.8	2.6	3.3

Code: 1 = Not at all helpful; 2 = Slightly; 3 = Moderately; 4 = Extremely helpful.

While in retrospect perhaps this is obvious, we were surprised by how useful the introductory meetings and handouts were to new faculty and have since become significantly less ad hoc about it. While experienced faculty found the resources only moderately helpful, new faculty advisors in particular found the pre-semester meeting extremely useful. This suggests first-time advisor meetings should clearly be held. Meeting experienced advisors appears to be unnecessary unless discussing new course features.

Another reason we have redoubled efforts in preparing advisors and standardizing the process is that advising variation is clearly the main driver behind variation in student satisfaction and in learning outcomes. On a scale of 1 (disagree strongly) to 5 (strongly agree) for the principal factor that combined six questions about the advisor, the mean was 3.7. However

across the 22 teams, the team means ranged from 1.9 to 4.9, and the students' assessment of the degree they learned from the course had the strongest correlation (r=0.675) with this factor.

Project Fair. To begin the two semester IPD sequence, all students attended a Project Fair. Each client entrepreneur set up a station to demonstrate their product ideas, distribute materials, and answer questions. We also provided refreshment to make the session as inviting and enjoyable as possible. After the fair, the students completed a form to indicate skills, interests and ranked four projects that interested them. Based on the students' preferences, expertise and outside interests, the IPD staff assigned them to the various projects.

The chaotic energy during the Project Fair is high and stimulating, as nearly 200 people mingle and converse, making this day among our favorites in the yearlong sequence of activities. Moreover, assigning teams based on preferences informed by the Fair appears to work reasonably well. There were few complaints about team assignments. Nevertheless, in the assessment survey at the end, a small number of students voiced disappointment that their teams were not as multidisciplinary as others, or about issues with the client, faculty advisor or other team members. While this level of dissatisfaction is probably likely in any course involving teamwork on diverse projects, we also think the complaints from students about the limited degree of multidisciplinary skills on their teams is a healthy sign that they have understood its value, compared with functional silos.

Support Staff. Through both semesters, in addition to the faculty advisors, the Outreach Manager, Academic Coordinator and graduate students played supporting advisory roles to the teams. They attended lectures, team meetings, and suggested and marshaled resources to promote teams' progress. Course evaluations reflected a great deal of variation in the extent to which teams valued this input. Some fully agreed that they served a valuable role in the team's

progress, and others believed that they were not helpful. Approximately a quarter of the students agreed or strongly agreed that the Outreach Manager played a valuable role in the spring, while a more robust 44% did in the fall, the semester in which most of the hardware prototyping took place.

Because these results were weaker than we had hoped, given the cost of these full-time resources, to better leverage these resources for students, we have since changed our process, giving the Outreach Manager, Academic Coordinator and graduate students significantly more direct interaction with teams. A newly renovated 17,000 square-foot building, designed entirely to support student design teams, allows us to have all teams meet at the same time and place. The staff, and other resources such as reference librarians, now meet informally and regularly with all the teams by circulating within in that single space, and students know they will be checking in periodically.

That said, behind-the-scenes planning is not readily appreciated by students. These individuals were extremely valuable for the IPD Director, who was able to keep abreast of the teams' progress through the bi-weekly staff meetings. Also, the staff is vital in organizing course activities. The importance of these roles in supporting the teams should not be underestimated.

Tack Board and Poster Fairs. At the end of each semester, each team displayed a poster (36" x 48") of their business and technical results and their design concepts. Client entrepreneurs also attended the poster fair, as did representatives from the associate agencies, and team members stood by and responded to questions. A workshop by an adjunct professor in Design Arts provided design tips to make posters attractive and informative. For feedback, during each poster fair all students and faculty advisors completed evaluation forms on three assigned posters.

During the spring poster fair, we detected higher-than ideal variance in progress among the teams. So, in the spirit of continuous improvement, in the fall we added two mid-semester tack-board sessions. These additional due-dates stimulated progress, and encouraged the teams to focus on substantive content and on getting mid-stream feedback on that content, without concern for more formal or aesthetic poster design issues. Faculty advisors and classmates provided constructive critique at each session to improve the quality of the final solutions.

Posters and tack-boards proved useful high visibility deadlines and immediate feedback. They are also useful as communication exercises for students in identifying and displaying their chief results. Indeed, we have since expanded the poster workshops. The full-sized posters were put on display in various campus buildings to help promote IPD to visitors and potential students. Public display of the posters has also created expectations for succeeding classes. We believe the quality has been therefore successively better each year. While worthwhile, managing the posters displayed in public spaces is a minor logistical burden, and we recommend regular rotation and culling. Ad hoc feedback we get suggests that posters tend to lose their appeal after a year or two. To reduce the logistical issues given the volume of posters annually, we have also since installed two multiple-poster hanging rack display systems. We continue to use the tack board sessions, which proved very valuable. These are community building moments for IPD. At the same time, they help teams gauge where they are relative to others, get early feedback from multiple viewpoints, and see the variety of problem solving approaches in other teams. Together with the initial Project Fair and Poster Sessions, which are also high-energy, these structured-chaos, community sessions have become our favorite activities in the capstone courses.

The posters have other utility as well. The final posters reduced to an 8½" X 11" format were provided to clients, who have used them in presentations to potential funding sources. The

Outreach Manager also uses similar reduced versions in recruitment to demonstrate to potential project sponsors the type of work produced by student teams. Students too have used small versions during job interviews.

Oral Presentations. End of term oral presentations by each team lasted from 35 to 50 minutes. The audience included other teams, other faculty and other clients. Students had to attend at least three other presentations and give peer feedback. The spring presentations included business and technical research, design concepts and preliminary recommendations. To conclude in the fall, teams displayed prototypes and discussed testing and results. In our survey, clients were between moderately and very satisfied with the student presentations.

In addition to informing the client of the work done, the presentations require that the students work together as a team to develop the content and decide how to present it, reinforcing the teamwork aspects of technical businesses and improving communication and speaking skills. The client entrepreneurs asked questions and heard comments and questions of the other attendees. One improvement we have added since, to significant positive review, is setting up private discussion sessions among each team and client immediately after the presentations. This allows more time for in-depth conversation than the formal public presentation sessions, engaging the clients far more fully in feedback to the teams. We now wish we had thought of this straightforward approach years earlier.

Written Report. If they followed the syllabus, the teams developed final report content through a series of regular homework assignments. These roughly paralleled the suggested sections of the final report: Introduction, Market Opportunity, Customer Needs, Competitive Analysis, Target Specifications, Aesthetics and Ergonomics, Technical Concept Generation and Selection, Final Design Description, Prototype Fabrication and Testing, Production Plan,

Financial Models, and Conclusions and Recommendations. Along the way, the teams did three preliminary drafts for advisor feedback. The final reports went to the client entrepreneurs. In our feedback survey, the participants were moderately satisfied with the final reports both semesters. Writing skills clearly needed greater development, so we have since instituted a report editing process using adjunct writing instructors who help the teams improve report clarity and focus.

The final reports are the most important deliverable for the class. They provide a full accounting of team accomplishments, document the entire development process, justify design decisions and provide the results of market research and financial analysis. Collective responsibility for a substantial, multidisciplinary document going to an external client is an important learning process for the students. When done well, many sections can be in the client's business plan for potential funding. Our experience suggests that the external client creates significantly greater intrinsic drive for the students to perform well than any faculty-created grade incentive ever could. Students also regularly use the reports during job interviews.

Post-Program Protocol. In retrospect, we believe we could have been more useful to clients had we had an explicit protocol for post-IPD collaboration. The spring after the program, clients discussed the status of their business plans with a graduate student business consultant, who made suggestions and helped participants access additional SBDC and BFTP resources and programs. Yet, this ad hoc approach also had drawbacks. First, the consultant completed his work on the demonstration three months after the program concluded, and left the University. Afterwards, no specific member of the project staff was assigned to follow up on the participants' progress or provide further guidance. The Academic Coordinator responded if problems arose, but the participants would have benefited more by having an individual responsible for continued periodic assistance. Another drawback was that participants did not

receive consistent information on available resources. In order to leverage fully the valuable services available through the SBDC and BFTP, we should have explicitly documented resources available to clients after collaboration with the students.

Student-Client Interaction & the Outreach Manager. Student teams varied widely in assessing how interested their clients were in the projects and how responsive they were to communication. The mean student response to a factor capturing questions dealing with sponsor interaction and interest was 3.0, but there was wide variation among the teams, from 1.5 to 5.0. Although some indicated positive interactions, by the end of the second semester, many felt their client was no longer interested in the project. This mirrors the feedback from the clients and faculty, so client communication was clearly a trouble spot.

Complaints notwithstanding, comparing our experience with more than 100 similar projects before the Dept. of Labor grant enabled us to hire the Outreach Manager, the communication was an order of magnitude better. In the spirit of continuous improvement, we hope we get better each year as we adjust our processes. Yet the most significant jump in our 12 years in IPD was adding this Outreach Manager, whose primary job responsibility is recruitment of and liaison to clients. He interacts regularly with both the clients and the student teams, which enormously improves the two-way communication. Even so, there remains room for improvement. The process also clearly highlighted for us that finding enough good real-word clients for dozens of student teams is a full-time activity. Doing this on top of a normal faculty load, as we used to do, risks significant headache throughout the process from poor communication and/or projects that are not well suited for student teams.

Conclusions

It will be several years until the real economic impact of the demonstration can be assessed. Most of the client entrepreneurs still have a way to go before establishing their businesses, and even if that occurs, they have to survive a competitive economic environment. The U. S. Small Business Administration reports that 50% of small businesses fail in the first year and 95% fail within the first five years. Still, these 11 unemployed individuals were given a significant entrepreneurial boost. Compared to non-participants, they uniformly made more business progress, and at least two turned profits within a year after participating. Given the long odds in business start-ups, the demonstration can be viewed as a success. Students in partnership with local economic development agencies can help foster technology start-ups by the unemployed.

Moreover, students reported they valued the chance to participate in the entire product development process, to do hands-on work, and to build prototypes for real-world projects. As we mention above, the fact that a number of student teams reported disappointment that their teams were not as multidisciplinary as other teams is a substantive positive sign of learning about the value of multidisciplinary teamwork—a challenging lesson to learn except by doing. We also have ad hoc feedback suggesting high utility for students in job interviews. They are able to talk with authority about experiences with multidisciplinary teaming, technical, business and design issues, and communication and management challenges. Finally, though we believe the investment well worth it given the combination of economic payoff for the region and learning outcomes for hundreds of students, the resources needed are substantial to implement programs like this successfully, and well above the norm of academic curricula.

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Figure 1. Service Model for Self-employment for Dislocated Workers, With Numbers of Applicant Progressing to Each Phase

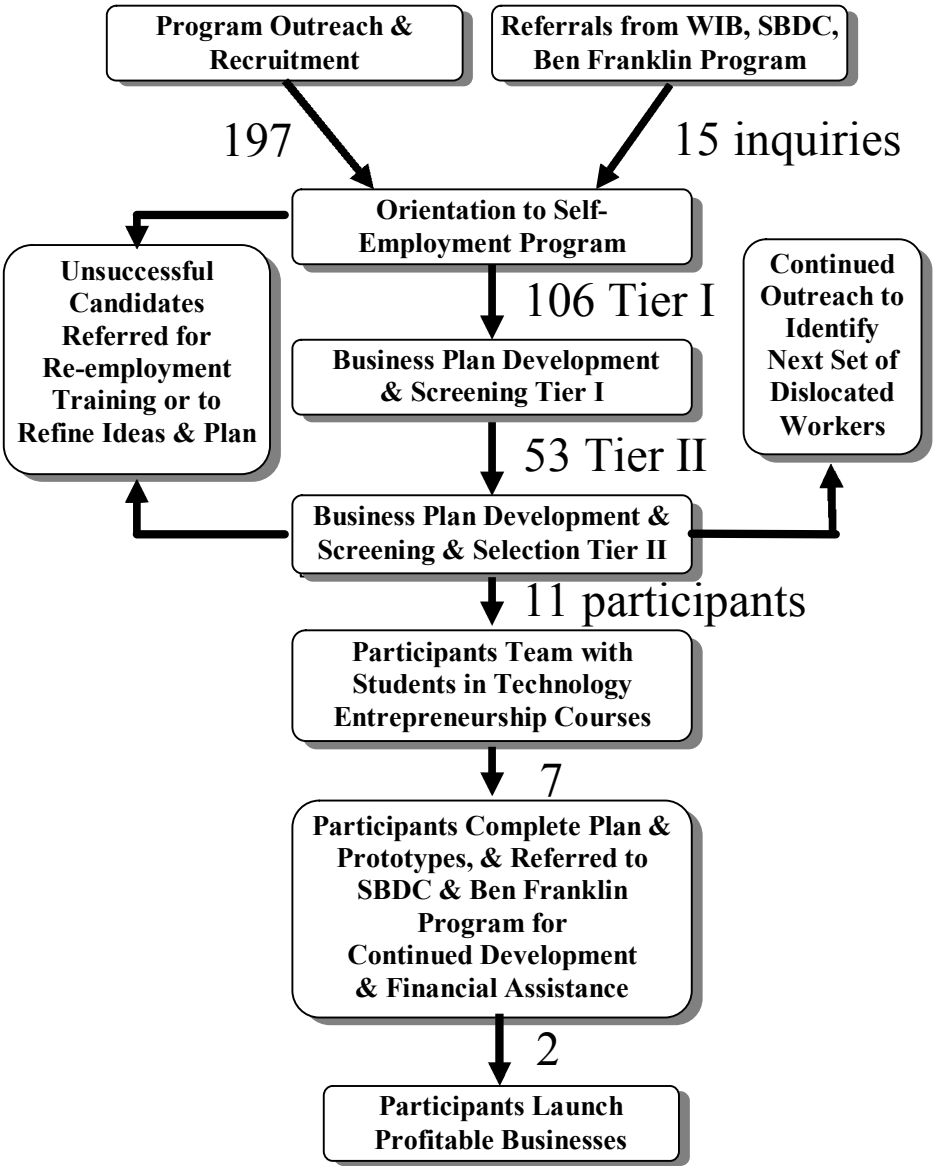

Table 1. Checklist of tasks associated with starting a business

* = statistically significantly lower at p<0.10
** = statistically significantly lower at p<0.05

Task	Percentage of respondents completing the task: DoL Respondents N = 7	Unselected Applicants N = 9	
1. Early Planning Stage			
Created a new product design	100	56	**
Created a financial model	57	22	*
Created a marketing strategy	86	56	*
Created a business plan	57	33	
2. Higher Level Planning			
Had the business plan critically reviewed and defended	14	11	
Created a prototype	71	44	
Tested a prototype	71	22	**
Created a next generation design and prototype	43	11	*
Created a production plan	43	11	*
Created a marketing plan	71	33	*
3. Early Business Activity			
Applied for funding	29	0	**
Formed a legal business entity	71	0	**
Applied for a provisional patent	29	11	
Completed the patent submission process	29	11	
Obtained a patent	14	11	
Advertised to potential customers	57	11	**
4. Business Launched			
Established office (home or elsewhere)	71	0	**
Secured equipment/purchasing supplies	57	0	**
Ramped up a production system	29	0	**
Hired employees	29	0	**
Started producing product	29	0	**
Implemented marketing strategy	29	0	**
Demonstrated product to potential customers	71	11	**
5. Realizing Income			
Established paying customers	43	11	**
Have positive cash flow	29	0	**
Business is showing a profit	29	0	**

Table 2. Results of Survey to Rank the Influence of Characterisitics Associated with Successful Entrepreneurs.

Code: 5 = Extremely Influential; 0=No Influence

Description	Category Average	Average	N	Std. Dev.
Passion/Commitment	4.7			
level of commitment		4.9	50	0.35
passion about the idea		4.6	50	0.70
Knowledge of Market	4.6			
knowledge of the market		4.6	50	0.53
knowledge of customer needs		4.6	29	0.68
Product Characteristic	4.5			
market need		4.7	50	0.62
feasibility		4.4	49	0.89
Characteristics of Entrepreneur	3.7			
goal orientation		4.3	49	0.93
self-discipline		4.2	50	0.90
flexibility		4.1	49	0.66
risk tolerance		4.0	49	1.00
competitiveness		3.8	50	0.98
ethics		3.6	28	1.60
personality type/temperament		3.4	47	1.15
appreciation of the value of a dollar		2.9	29	1.54
internal locus of control		2.8	26	1.52
Skills of Entrepreneur	3.5			
decision-making skills		4.1	50	0.65
oral communication		4.1	50	0.81
leadership		3.8	49	1.03
strategic thinking		3.7	49	0.96
planning		3.7	49	0.93
time management		3.4	50	1.13
creating opportunity		3.3	26	1.47
ease with people		3.3	50	1.14
written communication		3.2	50	1.04
harvesting (conceptually)		2.3	25	1.52
Personal Conditions	3.1			
motivation for choosing entrepreneurship		4.0	49	1.15
work history		3.6	48	0.84
entrepreneurial/leadership experience		3.5	49	1.15
support of family members		3.3	50	1.21
financial status		2.7	49	1.14
educational level		2.6	49	0.89
family/acquaintances in business		2.2	47	1.27