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How Universities Can Build an Entrepreneurial Mindset in STEM Students

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The University of Minnesota's MIN-Corps program shows how customer discovery, mentoring and commercialization training can help STEM innovators become entrepreneurs.

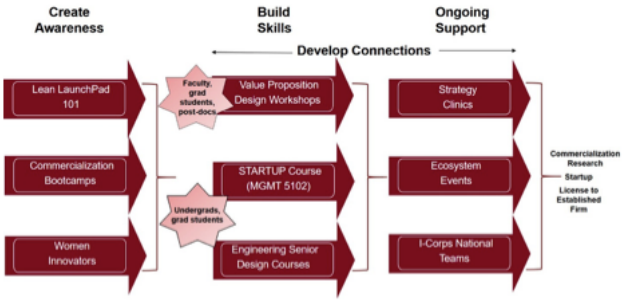
The University of Minnesota MIN-Corps is one of about 100 sites of the National Science Foundation National Innovation Corps (I-Corps) program, which began with great fanfare in 2011 [(1)]. The purpose of I-Corps is to "grow and sustain the national innovation ecosystem" by providing educational programs for scientists and engineers to learn "to identify valuable product opportunities that can emerge from academic research, and gain skills in entrepreneurship through training in customer discovery and guidance from established entrepreneurs" [(2)]. All sites share the Lean LaunchPad curriculum(https://venturewell.org/wp-content/uploads/Educators-Guide-Nov-2015-Final.pdf) emphasizing customer discovery in conjunction with iterative product design to achieve product-market fit, but customize their offerings to fit the needs of their institutions.

Since 2014, the University of Minnesota I-Corps site has delivered education and coaching to about 220 innovation teams and 1200 participants, producing 16 startups and more than $11 million in commercialization and equity funding. Following are the lessons we've learned about building an entrepreneurial mindset and skill set in STEM students, staff and faculty.

Program Goals

At MIN-Corps, we adopt McGrath and McMillan's (2002) definition of entrepreneurial mindset to mean the "ability to sense, act and mobilize under certain conditions [(3)]." We define entrepreneurial skill set to include core Lean LaunchPad elements, such as customer discovery through interviewing and observation, the development of minimum viable products, iterative value proposition design to achieve product-market fit and business model canvas development. We also address market sizing, competitive assessment, pitching business concepts to non-specialist audiences, team formation and resource mobilization, including startup funding.

The MIN-Corps program design is based on a four-part theory of change, which emerged from benchmarking other I-Corps sites, customer discovery within our own institution, and trial and error. We **create awareness** of commercialization opportunities and considerations, **build skills** in commercialization and entrepreneurship, **establish connections** with external entrepreneurs and industry experts, and **provide ongoing support** during the commercialization process. Following is a summary of our program offerings:



Awareness

When MIN-Corps launched, we incorrectly assumed that we had pent-up demand among STEM students, staff and faculty for entrepreneurship training. It quickly became apparent that, before our target audience would consider expending the time and effort required by commercialization, we needed to initiate what Shepherd

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et al. (2009) refer to as "entrepreneurial spirals," feedback loops whereby organizational actions help individuals perceive both the desirability and feasibility of engaging in entrepreneurial activity [4]. The resulting awareness-building programs include:

- Lean Startup 101 - two-hour lunch-and-learns that introduce the NSF I-Corps program and core Lean Startup concepts.
- Innovation Commercialization Bootcamps (https://mincorps.umn.edu/programs) - six-hour sessions that introduce participants to Lean Launchpad concepts, intellectual property/technology transfer, and the broad range of roles that academics can play in commercialization and startups.
- Our annual half-day Women Innovators Conference for female scientists and engineers, which features successful women STEM leaders as keynote speakers, and includes panels where speakers share their personal experiences and advice on career development.

The awareness-building programs are designed to encourage the development of an entrepreneurial mindset by framing entrepreneurial activity as both feasible and desirable for STEM innovators. While they do include conceptual content, the more important feature is that participants see that people that they identify with – their reference group – are engaged in productive and rewarding entrepreneurial activity. Therefore, Lean Startup 101 and the bootcamps are offered in three different versions (Medical, Agriculture & Environment, Science & Engineering), with specific examples drawn from those disciplines. We also include panels of people who can share their commercialization experiences that reflect each audience in terms of role (student, staff, faculty), academic discipline and demographics.

Skills

When MIN-Corps began, we assumed that our business school undergraduate Lean LaunchPad course could simply be offered more broadly. However, enrollment did not grow as much as expected, so we regrouped to expand our offerings to accommodate the varying interests and schedule constraints of STEM undergrads, graduate students, post-docs, research scientists and faculty.

- *Value Proposition Design Workshops* (https://learning.umn.edu/public/category/programStream.do?method=load&selectedProgramAreaId=1593519&selectedProgramStreamId=1593527) are non-credit seminars targeted to doctoral students, post-docs, research scientists and faculty. This is a "Lean LaunchPad Lite" program that focuses on initial customer discovery and determining an innovation's market feasibility. The VPDW series is composed of four three-hour working sessions each separated by two weeks to allow for customer outreach:
  - *Product-Market Fit* (the value proposition design canvas)
  - *Customer Discovery* (conducting customer interviews and in-situ observations)
  - *Pathway to Commercialization* (identifying milestones and inter-dependencies regarding product development, market development and business resource mobilization)
  - *Market Assessment* (competitive differentiation and market sizing)
- *STARTUP: Customer Development & Testing (MGMT 5102,* our original flagship offering) is a two-credit, 15-week, experiential course open to both undergraduates and graduate students across the University who submit an application (https://carlsonschool.umn.edu/faculty-research/gary-s-holmes-center-entrepreneurship) describing a specific business concept that they intend to explore. Course content includes the topics from the Value Proposition Design Workshops, as well as minimum viable product development, business model design, securing intellectual property and startup funding.
- *Engineering Senior Design Courses* in Biomedical Engineering as well as Electrical and Computer Engineering have been revised to incorporate customer discovery (problem interviews) and customer feedback (solution interviews) into their capstone projects.

Two considerations drove the expansion of our skills development offerings beyond the STARTUP course. First, as discussed earlier, many doctoral students, post-docs, research staff and faculty expressed reluctance to invest significant time in an experiential education program unless it is tailored to be relevant and productive. Our Value Proposition Design Workshops

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are offered in the same three versions as the bootcamps (Medical, Agriculture & Environment, and Science & Engineering), led by instructors with extensive commercialization experience and include specific topics (e.g. on regulatory considerations) and case studies relevant to each area. Second, scheduling was a major consideration: the workshop participants simply did not have the time for a full-semester course that meets weekly, and engineering students have highly structured academic schedules that may not allow for many non-major electives.

Connections

While they may be well-embedded among their academic peers, STEM students, research staff and faculty also need to build connections to commercialization and entrepreneurship expertise, startup funding and operational resources. In other words, they require access to the local entrepreneurial ecosystem. We adopt Spigel's (2015) definition of entrepreneurial ecosystems as "combinations of social, political, economic, and cultural elements within a region that support the development and growth of innovative startups and encourage nascent entrepreneurs and other actors to take the risks of starting, funding, and otherwise assisting high-risk ventures" (5). MIN-Corps' focus is on helping our participants to develop social ties to the ecosystem through our mentorship programs, which tap a pool of over 150 mentors to work with our innovation teams. We have found mentors through the following sources:

- Judges and mentors for the Minnesota Cup (https://carlsonschool.umn.edu/mn-cup) (https://carlsonschool.umn.edu/mn-cup) venture competition
- The business advisory group to the UMN Technology Commercialization (https://research.umn.edu/units/techcomm/startups/external-entrepreneurs) office
- University corporate relations and development staff seeking engagement opportunities for local employers and major donors

However, it has been challenging to develop a mentor pool that better reflects the demographics of our program participants. We are working to expand our mentor pool through outreach to women and minority leadership networks, professional associations and entrepreneurship groups.

Support

Customer discovery and business model design are only the beginning of a months or years-long commercialization process. As Shepherd et al. observe, amplifying entrepreneurial spirals require enduring feedback loops: while one-off educational programs may start the spiral, repeated organizational reinforcement for entrepreneurial action is required as well. Therefore, we also offer monthly Strategy Clinics (https://mincorps.umn.edu/programs) , which are co-facilitated by MIN-Corps and UMN Technology Commercialization staff. These dinner sessions address the practicalities of commercialization and startups. They also build a sense of community among our academic entrepreneurs and create touch-points for staff coaching and intervention, if necessary.

Success Story: Dose Health

At the time he took the STARTUP course in Fall 2014, Paul Hines was a fourth-year medical student also pursuing a master's degree in health informatics. His business concept was an internet-connected pill dispenser that could help caregivers better manage their loved one's medications. Paul teamed with two friends to develop a prototype, then used the course to get feedback from patients, their caregivers and other healthcare system players. The course also connected him to mentors with extensive experience in health care and health insurance. The combination of customer outreach and industry expertise helped Paul refine his commercialization strategy and pinpoint his initial target market.

At the time of the course, Paul had a strong entrepreneurial mindset, but a limited skill set – his educational background was in biomedical engineering and medicine. Through the course, he learned how to design and operationalize the business model, how to build a startup team, how to develop a sales pipeline, and how to pitch his venture to investors.

After he graduated in Spring 2015, Paul and his partners launched Dose Health(https://dosehealth.com/) , which offers a "smart" pillbox that holds a person's medications and automatically rotates to reveal the correct pills at the correct times, reminds patients to take their medicine, and lets family and professional caregivers know if the patient is complying. Dose Health

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has raised seed financing and has won the 2017 Mayo Clinic Walleye Tank(http://www.walleyetank.com/) life science venture competition and the Securian technology innovation award in the 2017 Minnesota Cup (https://carlsonschool.umn.edu/mn-cup) (https://carlsonschool.umn.edu/mn-cup) venture competition. Most importantly, Dose Health is expanding its product line and growing by targeting Medicaid Home and Community-Based Services Waiver recipients and their case managers.

Success Story: Sironix Renewables



In 2016, Christoph Krumm was a PhD student in Chemical Engineering who had developed a bio-renewable surfactant that delivers superior performance in hard water conditions. Christoph's goal was to build a business around this surfactant, which has many potential applications, including detergents, agriculture, paints and coatings. Christoph participated in the Spring 2016 STARTUP course in order to identify the first commercial application of this platform technology, and to define the business model of what became Sironix Renewables (http://sironixrenewables.com/) . The course also connected him with a business mentor who continues to advise Christoph.

After completing the STARTUP course and defending his dissertation, Christoph (with his academic advisor and a mentor from the UMN Office for Technology Commercialization) then participated in the NSF I-Corps National Teams (https://www.nsf.gov/news/special_reports/i-corps/teams.jsp) program. This intense program of customer outreach (at least 100 interviews) and tough feedback helped Christoph determine that detergents would be his beachhead market and helped him crystallize his value proposition.

Sironix Renewables has attracted a combined $2.7 million from SBIR (Small Business Innovation Research) grants and the Los Alamos National Research Lab. Twenty-six detergent companies have ordered samples of the molecule for testing in their product formulations. And, Sironix Renewables won the Clean Tech Division of the 2017 Minnesota Cup (https://carlsonschool.umn.edu/faculty-research/blog/entrepreneurship/mn-cup-2017-semifinalists) venture competition. In Summer 2018, Sironix participated in the Cascadia Clean Tech Accelerator and is now seeking equity investment.

Additional Considerations

MIN-Corps' initial slow start forced us to follow the same Lean LaunchPad principles that we preach to entrepreneurship students: interview customers, benchmark the competition, and iteratively experiment with minimum viable products in order to achieve product-market fit. Through customer discovery and experimentation, we also learned the following regarding STEM-focused entrepreneurship program positioning and design:

- *Affiliation* – Our website and materials emphasize that MIN-Corps is an institution-wide effort that draws on business school expertise but is not a business school program. The National Science Foundation affiliation is vital for credibility, but it is also important that we have funding and oversight from the College of Science and Engineering and other entities across the University of Minnesota.
- *Terminology* – Our customer interviews revealed that prospective program participants do not typically think of themselves as current or future entrepreneurs. Therefore, they were put off by program descriptors that include words like "startup" and "entrepreneurship." Instead, a more common motivator for undergrads, master's degree students, and some PhD students is for professional development leading to a product research and development role. For other PhD students, post-docs and faculty, a common motivator is to make an impact on the world through their innovations. As a result, while we still title our semester-long course as "STARTUP," our other program descriptions use the terms "Lean LaunchPad" and "commercialization."
- *Location* – None of our noncredit courses are delivered inside business school facilities. Instead, the awareness-building seminars,

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Value Proposition Design Workshops and Strategy Clinics are delivered in classrooms and auditoriums within a 10-minute walk from participants' academic departments.

- *Schedule* – Seminar times and durations dramatically affect enrollment. Through trial-and-error, we learned which programs should be on weekdays, evenings or weekends. As a result, we offer our strategy clinics on Wednesday evenings, but our Value Proposition Design workshops are on Tuesday, Wednesday or Thursday afternoons. We also learned that a concentrated six-hour bootcamp attracted more participation than two-hour sessions spread out over three weeks.

The above considerations have had material impact on our efforts to develop an entrepreneurial mindset and skill set among our STEM students and colleagues. For details about the specific design of any MIN-Corps programs, email pavo0003@umn.edu.

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Additional Search Terms: entrepreneurship courses, teaching ideas, teaching resources, classroom ideas, entrepreneurship classes, business schools, business school classes, entrepreneurship students, professors

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