Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India

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ABSTRACT

Entrepreneurs are essential for creating companies, jobs and growing wealth in communities. Currently, existing entrepreneurial programs start with self-identified entrepreneurs and provide facilities for their growth. However, these programs fail to tap into a whole community of latent youth entrepreneurs. Can more of such youth, with no prior exposure to entrepreneurship, be catalyzed into starting new ventures? If so, how? These questions are addressed in this study with a particular focus on engineering student communities in small town India. By conducting experiments we test the hypothesis that the entrepreneurial attitude of students can be changed through a specially designed learning workshop on innovation, fabrication and entrepreneurship.

The subject of this research is the design of the curriculum for this workshop, and the analysis of the effects of the workshop on two experimental student communities. The students were selected without any requirements on academic performance or entrepreneurial experience and aptitude. The results of the experiments show, overwhelmingly, that a significant change in entrepreneurial thinking can be achieved and indicate clearly that innovators and entrepreneurs can be created from ordinary student populations with the right kind of teaching. This can have huge implications for building entrepreneurship ecosystems in different parts of the world, giving average individuals the opportunity to be entrepreneurs.
Catalyzing Entrepreneurship from the Ground Up:
An Experiment in Small-Town India
ACKNOWLEDGEMENTS

As an inventor and an entrepreneur, the theme of this research is very dear to my heart. I always believed, that the ability to startup ventures is a special talent that is bestowed on a few ‘born entrepreneurs’ and all other less fortunate people, like me, would be employees for the ‘chosen few’. It was only when I started my own company, in an attempt to challenge myself, that I realized that there is no magic to entrepreneurship. It can be inculcated and learned by going through the entrepreneurial process repeatedly. My experience teaching the students, at the workshop on innovation, fabrication and entrepreneurship at the two colleges in India and watching them transform into energetic innovators and entrepreneurs, confirmed this realization.

There were several times when I felt I might not be able to do this work. It was the constant support and encouragement from my advisor, Prof. Charles Fine, that made this involved study real. A very encouraging note from Mr. Ratan Tata gave me the confidence that I was addressing a very relevant social problem in India.

The generous fellowship from MIT-Tata Center supported my student life and provided the research funding for designing and conducting the workshop. This research work would never have happened without this support.

I thoroughly enjoyed my experience in India. Dr. T M George, Principal of Mar Baselios College, made my seven week long stay in Trivandrum a pleasure. I felt I was right at home in Muzaffarnagar, with the generous hospitality extended by Dr. S C Kulshreshtha, Chairman of Shri Ram Group of colleges. I miss our daily long discussions and home-cooked meals. My colleagues, Prashant Patil, Paul Anand and Adithya Pasupuleti, embraced the big mission, dropped what they were doing and joined me for several weeks at Trivandrum and Muzaffarnagar as workshop mentors. These weeks together made us brothers on a mission to infect the youth of India with confidence in entrepreneurship.

I want to thank all my students at Trivandrum and Muzaffarnagar. This was my first experience at teaching. Besides learning a lot, I realized my love for teaching through them. All workshop mentors helped to enrich the workshop experience.

All of this would have been just a dream if not for the support and encouragement, from my family, Shanthi, Lekha and Meera, through my graduate student life, and especially through the long field trips to India, away from home.
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Chapter 1: INTRODUCTION

"What you are is what you have been, and what you will be is what you do now."

- The Buddha

Entrepreneurship is the primary driving factor for the growth of a nation's economy and the creation of jobs. This is especially relevant to nations with large growing young populations. India, for instance, needs to create 1 million new jobs, every month, to sustain its growth [1],[2].

With large youth populations, employment can be the single factor that can gauge the growth of a nation [3], or potential impending social instability [4]. Almost all of the jobs required for growth need to be created by new startups since existing corporations are typically negative job creators [5].

Top down approaches to build entrepreneurship ecosystems with government or industry funded entrepreneurial programs have not shown the expected results in spite of significant financial investment [7]. Other approaches such as incubators, startup centers and accelerators, start with individuals who have good business ideas and assist them in creating startups. Half of these startups fail in the first four years [8], deterring some of them from ever trying again. These approaches do not provide entrepreneurs a safe, hands-on, and trial and error environment to hone their skills before the actual launch of businesses. They get the training ‘on-the-job’ and failure in these circumstances can come at a high cost.

Also, the latter approach fails to address a large population of entrepreneurs who have yet to recognize their potential because of numerous factors like, lack of exposure, self-confidence, poor ideation of solutions, and lack of training. For every entrepreneur who is accepted into these current programs there are several innovators, with equal or more latent entrepreneurship talent that are not. How do...
we ensure that, in the current educational system, there are better chances of promoting these innovators by enabling their entrepreneurship skills?

With the large share of its young population still in towns and villages, the entrepreneurship ecosystem in rural India needs to be built, from the ground up, to have the desired job growth. One part of the youth population that is best suited to be specially trained for entrepreneurship is the engineering student community because they already have exposure to the design of technical solutions. This is not to say that the broad approach taken by this research will not work for other student bodies, but this research focuses on the engineering community in India and technical entrepreneurship.

The research questions here are,
- What are the factors that can enable a technical student from engineering colleges with little exposure to entrepreneurship to startup companies?
- How can these factors be developed in these students?

Research hypothesis:

If a group of students without prior entrepreneurial exposure or culture, are given experiential training in the fundamentals of innovation, fabrication and entrepreneurship, their entrepreneurial attitude can be changed, increasing their propensity for starting up businesses.

As part of a fellowship from MIT Tata Center, two experiments were conducted in India to test this hypothesis, with a specifically designed experiential curriculum and a selected field for problem solving. The first experiment was a two-month long workshop, focused on Healthcare, at Mar Baselios College of Engineering and Technology in Trivandrum, Kerala State. The college was chosen specifically because Trivandrum is significantly smaller than other major Indian metropolises and the college itself is not one of the nation’s top-tier academic institutions. The second was an eighteen-day workshop, focused on the local industries and rural problems, in Shri Ram Group of Colleges in Muzaffarnagar, Uttar Pradesh. This college will see its first batch of graduates in the summer of 2014. The population of Trivandrum is 1 million and that of Muzaffarnagar is about 500,000; in comparison, the population of other major cities in India varies from 5 million to 13 million.

Students learned to identify and evaluate problems/opportunities with societal impact and financial gain, ideate and fabricate solutions, and develop and pitch business plans. This process was repeated to develop team chemistry and confidence in the innovation process and their entrepreneurial capabilities.

In the first case, fifty-three students from all engineering disciplines and academic years attended the workshop with almost equal number of males and females. Before the workshop, almost all the students desired campus placement after graduation. Entrepreneurship was not one of their career options. Many of the students attended the workshop just to get a certificate that can be used for job placement. Upon
completion of the workshop, two-thirds indicated that they want to take on entrepreneurship in the future. They pitched their final projects to local entrepreneurs and investment communities. Out of the ten teams, six continued with their startups after the workshop. All this, in a college that had one student entrepreneur in the last twelve years.

In the second case, fifty-one students attended from all engineering disciplines with 40% female students. The college was chosen because Muzaffarnagar is an agriculture based small industrial town with students primarily from rural communities. The time and the repetition of the workshop’s entrepreneurial cycle was reduced to test for effectiveness. The basic format of the workshop was essentially the same. Two third of the students have changed their attitude to entrepreneurship and are planning to startup ventures in the next year and a third of the students have already started their ventures.

The hands-on curriculum was specially designed as part of this research. The experiential aspects were emphasized with interactive real world problem identification, cross discipline engineering exposure, business and social impact opportunity evaluation, solution design and development, rapid prototyping, field validation, business plan creation, and finally, pitching these ideas to established investment and business communities. The design included a component to emphasize that the fabrication process is inherently necessary for effective learning of the innovation process.

As already stated, existing entrepreneurship programs identify people with entrepreneurial intent and provide them the framework and training to actually start their businesses. In the workshops held in Trivandrum and Muzaffarnagar, the focus was to start with any technical student irrespective of entrepreneurial intent, capability or experience, and train them to become innovators and entrepreneurs. It is important to note that these workshops focused on incubating entrepreneurs while most current programs incubate companies that are started by self-identified entrepreneurs.

Three critical factors have been identified as enabling entrepreneurs:
- **Empathy**: the ability to understand, identify and connect with potential customers
- **Maker-skills**: the technical skill to develop and fabricate products
- **Self-efficacy**: the confidence or the belief in one’s capability to handle any situation in spite of lack of resources or experience

An average technical student in India has little exposure to the innovation and entrepreneurship processes. We conclude that entrepreneurship in youth is more prevalent than is currently recognized. There is the need for training to identify entrepreneurial capabilities and the motivation to develop these skills. With empathy to identify potential opportunities, maker-skills to enable innovation of better solutions and self-efficacy, an average person’s attitude to entrepreneurship can be positive. To create the million jobs a month that India needs, there is a necessity to
bring entrepreneurship programs to the 'common student' and work from a more fundamental level.

The suggested approach in this research is ideally suited for creation of entrepreneurs from bottom up. The hypothesis was tested in India with focus on technical students. But, the method can be suitably adjusted to support all forms of entrepreneurship, in any age group, in any country.
Chapter 2. LITERATURE REVIEW AND BACKGROUND

"'Who is an Entrepreneur?' Is the wrong Question"
– William B. Gartner

The entrepreneur has been the subject of classical socio economic research and many historians have tried to describe the main traits of the entrepreneur. Obviously the word itself has French origins. Early writings of entrepreneurship are attributed to the French economist Richard Contillon in the 18th century who introduced the notion of the entrepreneur as someone who engages in exchanges for profit by exercising judgment in the face of uncertainty [9]. Subsequent historians have added and modified this description based on economic studies. For instance, during the industrial revolution, John Say [10] distinguished “scientific” and “entrepreneurial” skill as evidenced by the production skills in the textile industry. Joseph Schumpeter, in the early 20th century, was instrumental in introducing ‘innovation’ as a key attribute to entrepreneurship. Innovation that brings ‘new combinations’ of products, processes, export markets, and sources of supply to create new businesses causing ‘destructive’ economic changes, sweeping out old ways for doing business with new ways. His claim was that this dynamic nature of entrepreneurship laid the seeds for capitalism as well. McClelland [10] emphasized achievement as a key attribute of entrepreneurship.

This historical study of entrepreneurship continued for the next two decades. Building on Schumpeter, research proposed that the traits and qualities of the entrepreneur were largely defined by relevant social and economic context. There was also research that indicated entrepreneurship contributing to growing capitalism. There was a shift in scholarly research to the role of organizations rather than entrepreneurs as the agent of change as propagated by Chandler [10].

However even as business historians shifted focus from entrepreneurs to organizations there was a large body of social research that investigated the key qualities of entrepreneurship in modern societies. Audretsch [11] gives a comprehensive study of entrepreneurship and why entrepreneurship has become more important. For the first time also research explored other countries for social and economic factors of entrepreneurship. History was widely accepted as providing the insight to define a single set of ‘traits’ for the entrepreneur, even though contemporary research itself proved that these varied based on the different nations and economies [10]. David Birch’s [12] influential work identified new and small firms as the primary job creators and high growth firms caused regional differences in economic development. Baumal [12] was instrumental in putting the entrepreneur in the center of economic theory, and added insights into venturing, and the importance of institutions for productive, unproductive and destructive activities (recall Schumpeter). Gartner [12] recognized how the entrepreneurs find and identify opportunities.
There was research by Shane and Venkatraman [12] that drew the distinction between entrepreneurs and the nature of entrepreneurial opportunities. This study introduced the notion of the entrepreneur being able to recognize possible industries and markets and identify opportunities. Shane’s investigations covered major aspects of the entrepreneurship phenomenon – the individual(s), the opportunity, the organizational context, the environment, and the entrepreneurial process. The study of big American business and entrepreneurship is a whole treatise in itself but a good summary can be inferred from Peter Drucker [13].

Recent research has recognized the institutional, social and regional influences on entrepreneurship and there have been attempts at quantifying entrepreneurship, defining entrepreneurial indices and attitudes in these treatises. [14], [15], [16].

The entrepreneur has always been a key factor in determining economic success. So there is desire to ‘define’ the entrepreneur. Today more so than ever this is true. There is no single definition of the entrepreneur only some characterizing traits. Research studies are filled with inconsistencies [17], [18], [19], [20]. The personality traits approach to entrepreneurship has been criticized by Gartner [18] as being unsatisfactory and questionable in defining entrepreneurial behavior and performance. In fact, he does a comprehensive listing of the traits of the entrepreneur over several research publications and comes to the conclusion that there is no consistency in definitions. There have been various discussions disputing the traits of entrepreneurs. For instance, Martin [20] claims that the risk-bearing propensity is not necessarily a trait of the entrepreneur since the burden is on the investor, Brockhaus [20] found no significant risk-bearing traits on comparing entrepreneurs and managers.

The characteristics of an entrepreneur still remain largely general and unspecific. This is not surprising, in an age when entrepreneurship is the rage, given the success stories of the likes of Bill Gates, Steve Jobs, Mark Zuckerberg and more. Leadership, Creativity, Business Acumen, Intelligence, Risk taking, Delinquent Associations, Locus of Control, Acceptance of failure [21] are some of the common traits used to describe these professionals [18][20]. Clearly there is no norm to prioritizing these or even giving a comprehensive list of these qualities. While the characteristics have defied narrow definition, there is a plethora of research, literature and discussion, both educational and social, on the classification factors influencing the entrepreneur [22],[23], [14],[15],[16]. Factors range from general social factors like government policies, education, funding, mentorship, media, etc., to individualized attributes like attitude, drive, tenacity, and, faith. Surveys show that in industrialized societies there is a preference for self-employment as a means of living but this is more common when preceded by generous family funding or large inheritances [24] [22].

Recent research has included other kinds of economies especially fast growing ones like India and China. This research is particularly interesting since the social environments in these economies are significantly different from the western economies [25]. In particular there is research on social and economic influencers on
entrepreneurship in India [26], [23], [27], [28]. Factors include family, investors, academia, entrepreneurial support network, market, government and media [29]. Some other key factors influence the individual entrepreneur like access to mentors, funding, technology, education and inspiration. So clearly attempts at changing the entrepreneurial ecosystem include both individual and collective efforts [30]. Social issues from education to poverty alleviation can be addressed by current and would be entrepreneurial actors [31].

Collectivistic cultures like India and China have a greater social stigma against failure and are known to be less conducive for entrepreneurship [32], [33], [34]. In fact the greater tolerance for business failures in the US has been sighted as the reason why Indians in the Silicon Valley have been more successful than entrepreneurs in Bangalore India. Risk taking is essential for doing good business. Risk profiles are highly varied and some of the common known facts are given in [35]. For instance, men have higher financial risk tolerance while women social. A common misconception is that teams are dangerous risk takers, and there is also 'cold' and 'hot' risk taking, basically a single decision versus sequential decisions, and more. [35]

Entrepreneurs might be the best job creators in any economy [5]. The nature of businesses started by entrepreneurs can change economies significantly; for example a small non-technical business may contribute less economic impact than a idea-driven high tech company [36]. The environment, government and political institutions play a large part in growth [37].

There is a strong social impetus for entrepreneurship in recent years -the economy. Let us look at developing countries like India. India needs to create 10-15 million jobs a year to sustain its young population [2], [27] and avoid social unrest [3]. “India’s entrepreneurial growth can be accelerated by creating more conducive conditions – a catalytic government, regulatory environment, adequate capital flows
(both debt and equity), support from businesses and society, and availability of appropriate talent and mentoring” [1], [38]. There is a necessity to facilitate investment, cash flows, venture incubation programs, debt offerings and more. Large businesses in India have not contributed to jobs to sustain this growth. It has been stated that startups are the single largest job creators and developing economies need to create jobs to sustain growing population [5]. Recent studies by the Kauffman institute for entrepreneurship have shown that in US in the recent recession startups were stable jobs creators, while existing firms were sensitive to business cycles and contributed job losses more than job gains.

New facets are added to entrepreneurship almost everyday. Social Entrepreneurship is another rapid growing trend where the power of entrepreneurship is applied to solving big social problems and this is changing old business ways. Bill Drayton [39] was a big proponent of the idea and started the Ashoka Foundation. The foundation has identified Empathy as one of the key traits for social entrepreneurship [40].

Business schools currently offer educational programs with some entrepreneurial focus. The various programs are neutral and equal in the broad entrepreneurial skillset they offer. Surveys of students enrolled in these schools show that there is still hesitation to going into entrepreneurship as a career without some industry experience [41].

So what are the major factors that promote the starting of a business by an entrepreneur [23]? Obviously the ability to recognize good business opportunities ‘early’, the acceptance threshold for failure as a possible outcome of a business, the perceived self abilities of current skills and the ability to acquire what is needed, making decisions based on partial information and, most of all, the optimism and willingness. This brings us to the notion of self-efficacy [42].

Self-Efficacy, as defined by psychologist Albert Bandura is one’s belief in one’s ability to succeed in specific situations. This is particularly important in the context of entrepreneurship since this single quality facilitates many of the other entrepreneurship traits [43], [44].

The Kauffman Foundation identifies entrepreneurship as being a mindset more than an academic discipline and proposes that traditional academic teaching methods are inadequate for teaching entrepreneurship. Some of the common challenges are changing mindsets, varying entrepreneurial attitudes across regions, needing to localize content, and necessity to build proper internal and external systems [45]. Some research investigates experiential learning where students are exposed to activity-driven learning with exposure to entrepreneurial skills [46]. The student completes the program with an entrepreneurship “portfolio” as representation of these experiences.

Almost all current entrepreneurship programs such as, competitions, accelerators and incubators work with candidates who have already shown the ability to startup ventures. These are the innovators who possess the self-efficacy and take the next
step into entrepreneurship. What about the potential entrepreneurs who lack the confidence? Can self-efficacy be developed? This question parallels the age-old question of, “Can an entrepreneur be created?” [47], [48]

This study aims at presenting a methodology to create entrepreneurs through a packaged experiential curriculum. The program can be summarized as teaching Innovation, Fabrication & Entrepreneurship to develop Empathy, Maker-skills and Self-Efficacy.

While this study focuses on a technical curriculum, the idea is expandable to other fields, such as, social sciences and arts.
Chapter 3: KEY FACTORS IN ENTREPRENEURSHIP

“People with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided.”
-Albert Bandura

Entrepreneurship is fundamentally described as recognizing a problem faced by a community or an individual, developing a solution for the problem and then reaching it to the customer in a profitable manner. Engineers start most technology companies. Today, only a small percentage of engineers actually become entrepreneurs. However, if these engineers are trained in understanding the market need, developing effective solutions, and creating business strategies, a larger percentage of them can become entrepreneurs.

This study has identified three skills that are critical in training a student to be an innovator and an entrepreneur.

Empathy

Bill Drayton, a leading social entrepreneur introduced the concept of empathy to entrepreneurship [39]. Social entrepreneurship provides for a more sustainable model of business in the future economy. There is a major shift in today’s economy from a hierarchical model to a ‘team of teams’ model. In this environment, every person needs to be a ‘changemaker’. It is becoming increasingly important for business leaders to understand and ‘feel’ the needs of the consumers. Drayton’s organization Ashoka Foundation has identified empathy as one of the key factors for social entrepreneurship and for building sustainable businesses. In developing countries, with increasing population, social entrepreneurship is evermore important for a growing economy.

Interestingly, empathy was noted as one of the qualities that is most lacking in entrepreneurs [49]. The workshops of this research chose the empathetic aspect of entrepreneurship, most importantly for the following reasons

- To empower the students and build their leadership qualities
- To improve quality of the solutions through better understanding of the problem
- To provide culturally sensitive technology solutions to existing social problems.

Design processes like IDEO’s ‘Human Centered Design’ and Stanford Design School’s ‘Design Thinking’ teach us how empathy is critical to understanding the causes of the problem and the roles of stakeholders in the initial phase of problem definition. Further, IDEO’s empathetic design emphasizes the process of understanding people’s unspoken latent needs through observation, data collection, analysis, repetitive prototyping, and addressing them through design [50], [51].

To enable empathetic experiences, each workshop conducted in India had a specific theme. For Trivandrum it was Healthcare and Medical devices. For Muzaffarnagar it was Sugar/Paper Mills and Agriculture. Both workshops included extensive field visits and...
interactions with all stakeholders and industry experts in their respective business areas. In the first workshop, the students' interaction with patients, their families and hospital care providers at city and village hospitals created a lasting impression. This was also true in the second workshop where they connected with farm laborers, factory workers and administrators. In both situations, it gave the students the drive and reason to address some of the critical problems. In some cases the students were predisposed to consider problems that they had already empathized with in their social circles.

IDEO- Human Centered Design process was roughly followed during the problem identification phase. The students were trained to observe and conduct interviews during field visits. Back in the classroom, they analyzed their observations and identified causes for field problems. In some cases they validated their observations and analyses at a later time in the workshop with industry experts.

The hospitals, farms and factories were familiar environments in some of the students' day-to-day lives but this empathetic approach gave them a fresh perspective on the problems existing in these places.

**Maker-Skills**

Design and development of technical products requires skills in multiple engineering fields like electrical, mechanical, software and hardware design, and various networking technologies. Computer programming has become more common amongst youth because of the availability of the tools for programming - the laptop and software. The development platforms for software are available freely as easy downloads enabling the possibility of writing 'apps' - needless to mention there is a market for these. Developing apps has become more commonplace because 'the lab' is on the laptop. There are many success stories of teenage app developers as entrepreneurs [52].

Product design however requires the understanding of multiple modules and the engineering know-how of putting these modules together. The average student lacks easy access to physical design tools and hence hardware design is more daunting than software design. It is necessary to make design and fabrication a part of any innovator's toolkit so that the prospect of building product comes as easily to him as the making of furniture to a carpenter, or the writing of songs to a musician. Until recently product development was not an indigenous process. It required significant cost, time and manufacturers to build certain products. It required significant cost, time and manufacturers to build certain products.

Today design and fabrication infrastructure has been significantly reduced in complexity by the introduction of free mechanical and electrical CAD design software such as Sketch-Up and Eagle, software development platforms such as Arduino and Eclipse, and fabrication equipment that is affordable, portable, and easily programmable such as desktop CNC machines, 3D printers, and vinyl cutters. This has made it possible to bring the industrial fabrication process, which was previously beyond the reach of average students, to the classroom. Familiarity with this process enables frequent prototyping, and easy testing, to accelerate and improve product development.
It is important to mention here that there is a whole new growing 'maker culture' that is growing out of the DIY (Do It Yourself) movement triggered by easy access to tools, design information and collaboration and it includes the notion of ‘making’ in an informal and fun setting. The technology extension of this is the Fab Lab, which is a standardized fabrication lab developed by the Center for Bits and Atoms at MIT. This platform was selected for the fabrication component of this experiment.

The fabrication component was designed to familiarize the student with product making. For good technical product design, the entrepreneur has to be a master in the craft of product making before he can be the innovation artist.

**Self-Efficacy**

Empathy and maker-skills are creative enablers for an entrepreneur. But, product innovation is often not as risky as the startup process. Self-efficacy is a critical factor in launching an enterprise or venture. As mentioned before, self-efficacy is the confidence of an individual to achieve success without the required resources or training [42]. Self-efficacy improves coping behavior in the face of obstacles and aversive experiences. Of all the traits of an entrepreneur this is the trait that handles the risk taking and required tolerance of ambiguity and is perhaps most instrumental in the actual launch of the startup for an entrepreneur.

The workshops here provided the students opportunities for the four major sources of self-efficacy: self mastery through hands-on independent learning; vicarious experience by allowing individuals to gain confidence through peer experiences; verbal persuasion through mentoring, coaching and peer appreciation; and emotional arousal by challenging them in areas where they lacked training and ability [42].
Chapter 4: THE EXPERIMENT

"Entrepreneurship is the pursuit of opportunity beyond resources controlled"

- Howard Stevenson

The main focus of this study is catalyzing entrepreneurship. This is achieved by testing a hypothesis through an experiment in small-town India where entrepreneurship is not prevalent. While this study is specific, the hypothesis and the basic framework of the experiment are relevant irrespective of country, geography or economic and social environments.

Hypothesis

*If a group of students without prior entrepreneurial exposure or culture, are given experiential training in the fundamentals of innovation, fabrication and entrepreneurship, their entrepreneurial attitude can be changed, increasing their propensity for starting up businesses.*

An experiment was designed to test this hypothesis and conducted on two sample groups. It was conducted in the form of a specially designed experiential workshop on innovation, fabrication and entrepreneurship. It was conducted in one engineering college each in two towns in India, as part of a fellowship from the MIT-Tata Center for Design and Technology.

About fifty undergraduate students were accepted to each of the two workshops. The students were from all academic years (first through fourth) and all engineering disciplines. Students were selected through an application process. The students were asked to make a one-minute video about why they should be selected for the workshop. This was done to push the students out of their normal comfort zone, to gauge drive and interest level. In other words, the ideal candidate was anyone who expressed some interest to learn to be an innovator or entrepreneur but had little to no prior exposure or experience.

Academic performance levels and financial status were not at all a consideration in the selection process. There was some effort to try and keep a near equal balance of males and females.

The entrepreneurship attitudes of students were recorded before and after each workshop through an online questionnaire. These questionnaires are shown in Appendix C & D.

Design Factors

*Engineering Students as Sample Groups*

The word 'students' in the hypothesis can be replaced with any social group for its relevance. However, college students are most appropriate for this kind of study.
They have the maturity to understand the entrepreneurship process. They are already thinking of appropriate career choices and can be most receptive to the addition of entrepreneurship as another career option. These students have the freedom of learning entrepreneurship without the consequence of taking it up as a career choice. In particular, engineering students were most appropriate for this study because they are already trained in technology and design.

Selection of Towns
The workshops were held in two cities with different social and demographic characteristics. Table 4.1 compares the two cities. It is clear that as a city Trivandrum is more advanced than Muzaffarnagar. One notable difference that is not illustrated by this table is that more of the Muzaffarnagar students came from rural environments and had much less exposure to English as a spoken language. The medium of instruction for the workshops at both towns was English.

<table>
<thead>
<tr>
<th></th>
<th>Trivandrum</th>
<th>Muzaffarnagar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>1 Million</td>
<td>0.5 Million</td>
</tr>
<tr>
<td>Economy</td>
<td>Tourism, Govt offices (Capital of Kerala state), IT center, Film</td>
<td>Sugar, Steel and Paper industries and Agriculture</td>
</tr>
<tr>
<td>GDP per capita of state</td>
<td>Rs 69,360 ($1,150) (Kerala)</td>
<td>Rs 26,051 ($435) (Uttar Pradesh)</td>
</tr>
<tr>
<td>Literacy Rate</td>
<td>97.5% (Kerala)</td>
<td>75.2% (Uttar Pradesh)</td>
</tr>
<tr>
<td>Unemployment</td>
<td>11%</td>
<td>8.2%</td>
</tr>
</tbody>
</table>

Table 4.1. Comparison of the two towns selected for conducting workshop

Selection of Students and Teams
Students were selected as follows:
1. In order to create entrepreneurial impact through peers it was necessary to have a sizeable group of students in these workshops with prospects of extended interaction. There was a conscious decision to hold each workshop in a single location thus creating a critical mass for the entrepreneurial activities to sustain themselves even after completion of the workshop.

   It is reasonable to assume that ten students will sustain an initiative in a college setting. With this idea, the aim was to enroll twenty students. Fortunately the interest was overwhelming and there were about 50 students in each of the workshops.

2. Students from all engineering disciplines were selected to attend with the intention of providing technical diversity. Both colleges had undergraduate degree programs in Civil engineering (CE), Mechanical engineering (ME), Electrical engineering (EE), Electronics & Communications engineering (ECE), and Computer Science (CS).
3. Students were put into teams of five members each with at least one physical engineer (CE, ME), one circuit engineer (ECE, EE), and one logic engineer (CS). The motivation for this was to provide sufficient engineering diversity to handle any kind of technical projects. Students stayed in the same team for the entire duration of the workshop. The distribution of the disciplines of students selected for the workshop is shown in Table 4.2.

<table>
<thead>
<tr>
<th>Type of Engineering</th>
<th>Discipline</th>
<th>Number of Students at Trivandrum</th>
<th>Number of Students at Muzaffarnagar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Engineering</td>
<td>Civil Engineering</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engg</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Circuit Engineering</td>
<td>Electrical Engineering</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Electronics &amp; Communications</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Logic Engineering</td>
<td>Computer Science</td>
<td>18</td>
<td>14</td>
</tr>
</tbody>
</table>

*Table 4.2. Distribution of students and their engineering majors at the two workshops*

4. The selection process allowed students from all years to participate in the workshop to ensure teams with various levels of experience and to sustain this activity in the college. The distribution of students according to academic year is in Table 4.3. The teams were adjusted to have very similar average ages.

<table>
<thead>
<tr>
<th>%age of Students per Year of Study</th>
<th>Trivandrum</th>
<th>Muzaffarnagar</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year (Freshmen)</td>
<td>12%</td>
<td>14%</td>
</tr>
<tr>
<td>Second Year (Sophomores)</td>
<td>34%</td>
<td>20%</td>
</tr>
<tr>
<td>Third Year (Juniors)</td>
<td>50%</td>
<td>48%</td>
</tr>
<tr>
<td>Fourth Year (Seniors)</td>
<td>4%</td>
<td>18%</td>
</tr>
</tbody>
</table>

*Table 4.3. Distribution of students according to their year of study*

5. There was an effort to ensure near gender balance, as shown in Table 4.4, in the final group of selected students and also in the teams.
<table>
<thead>
<tr>
<th>%ge of Students vs Gender</th>
<th>Trivandrum</th>
<th>Muzaffarnagar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>44%</td>
<td>42%</td>
</tr>
<tr>
<td>Male</td>
<td>56%</td>
<td>58%</td>
</tr>
</tbody>
</table>

*Table 4.4. Gender distribution among students at the two workshops*

**Theme for the workshops**
To facilitate synergy and working across teams, the workshops each had predefined business areas as themes. With a single theme it was convenient to provide industry and relevant subject experts as a common resource to all teams. It also allowed the students to better collaborate. The Trivandrum workshop had 'Healthcare and Medical Devices' as the theme since they are relevant social problems and the Muzaffarnagar workshop had the theme ‘Sugar/ Paper industries, and Agriculture/Rural living’ since these were the predominant industries in the area.

**Curriculum**
The workshop was conducted outside school hours on weekdays starting at 4:30 - 8:00 PM. The classes ran on weekends from 10:00 AM - 8:00 PM. This was arranged so as not to affect the regular classes at the college. For all students this was an added workload over their regular schoolwork. On the whole there was about 40 hours of face time per week with the students.

The curricula of the workshops at the two towns were designed to offer maximum impact in the time available. The Trivandrum workshop curriculum was designed for seven weeks. The Muzaffarnagar workshop was designed for 18 days. Each curriculum was constructed to focus on intense, hands-on experience within the relevant time frame. Both workshops had 100% attendance till the last day.

The curriculum for Muzaffarnagar workshop was created after very long deliberation to include what was lacking in the Trivandrum workshop and to fit as much of the important training as possible into 18 days.

Some other modifications were made in the second workshop to adjust for the features lacking in the first one. The changes are explained below:

- **Presentation Skills development**: The post-workshop survey conducted at Trivandrum indicated that training in presentation skills was inadequate. The Muzaffarnagar workshop focused on daily presentation sessions primarily for those who were weak in language and public speaking skills. Many of these students who faced problems initially were confident enough to make the final pitch at the end of the workshop.

- **Hands-on Fabrication for Team Building**: The Trivandrum workshop started with mini-projects to provide the students multidisciplinary exposure to mechanical, electrical, and product design. It included CAD design of a flashlight and 3D printing and assembly of prototypes. Since the design and
3D printing is primarily an individual effort, team involvement was limited and did not help team building. The mini-project at Muzaffarnagar was changed to include the sketching of product ideas and hand fabricating the prototype at the school’s mechanical lab as a team.

- **Industry Outreach**: Though the single Healthcare theme of the Trivandrum workshop helped the students work collaboratively, the projects did not make connection with the local markets or industries. To correct this shortcoming the Muzaffarnagar workshop had three themes that were aligned with local industries; Sugar, Paper and Agriculture. This helped the students find relevant local problems with captive customers.

**Method of Teaching**

The experiment was designed to be totally experiential with a focus on three critical factors: empathy, maker-skills and self-efficacy. The reasons for these factors being included in the design of the experiment have already been explained in Chapter (3).

The common ‘sage on stage’ model of teaching was replaced with a coaching model with lots of ‘high-fives and hugs’ to break the distance between mentor and student. Students were asked to call teacher/mentor by first name, which is quite unusual in an Indian classroom.

Each team kept one document that was a collaboration of the individual journals of its members. Each student added to the team journal his/her daily learning from design, problem solving and observations of successful and unsuccessful design attempts. This journal was a collective resource of knowledge not only for the team, but also for the entire class.

Students were encouraged to try new things just to learn through doing. They were encouraged to make one prototype of their product idea each day, even if it meant making a nonfunctional mock up just for getting feedback on their ideas. The mentors did not have experience in the relevant industries/markets and the projects were truly an explorative session for everyone.

**Problem Identification**

Human Centered Design process from IDEO was used to identify problems in the field through observations and interview. During field trips in Trivandrum and Muzaffarnagar, this methodology trained the students to observe certain situation and probe deeper to understand its cause, evaluate the stakeholders, their interests and influence, and develop solutions through ideation. Students followed this process multiple times in their projects. This helped them view the opportunity as a problem to solve than a technology to offer.

**Fabrication Laboratory**

The MIT course ‘How to Make (Almost) Anything’ offered by Prof. Neil Gershenfeld from MIT- Center for Bits & Atoms, was the core of the fabrication training in this
program. CBA streamlined several fabrication processes through unified user-machine interface software called FabModule, use of standard fabrication equipment, and an open list of inventory of electronic components and mechanical devices. The inventory was reduced to an essential list as shown in Appendix B.

**Entrepreneurship Training**
The book "The Disciplined Entrepreneur" where the general entrepreneurship process is simplified into 24 simple steps by Bill Aulet [54] set the guideline for the curriculum. The students learned this process over multiple project iterations.

**Assessment Questionnaire**
The students answered two sets of surveys, one designed as part of this research, and another from Cal4Ino program at University of Cambridge. The questionnaires for both surveys are attached in Appendix C, D. They took these surveys both before and after the workshop. Only the first set of data has been analyzed for this study. Analysis of the data from the second survey is still pending. Chapter 5 gives the details of the analyses of the questionnaire.
Chapter 5: ANALYSIS

The analysis of the survey data:

The survey questionnaire contained sixty-five questions including the following factors that were considered as being possible influencers in entrepreneurial attitudes.

- Family Background
- Economic Status Of The Family
- Educational Level Of Parents
- Rural Or Urban Upbringing
- Size Of Family
- Gender
- Family’s Exposure To Business
- Entrepreneurial Background
- Authentic Performance
- Social Influence
- Vicarious Experience
- Emotional States

Eight questions collectively address the effectiveness of the workshop. The answers to these questions are influenced by the development of the three key entrepreneurial skills in the workshop; Empathy, Maker-skills and Self-efficacy. Obviously, these questions are most indicative of the changes in entrepreneurial attitudes of the students and were used primarily in the analyses.

The analysis includes the following.

- The changes in attitude effected by each workshop. This is done by comparing responses to the questionnaires done before and after the two workshops
- The influence of gender on the change effected by the workshop
- The influence of income levels on the change effected by the workshop
- Prediction by all the above influencers of the student’s predisposition to entrepreneurial attitude change.

The following are the eight questions from the questionnaire (the answers were scaled from 0= Poor, to 10 = Excellent).

1. How confident do you feel about your capability to estimate the market potential for a product or service?
2. How confident do you feel about your capability to develop a business plan?
3. How confident do you feel about your capability to know if an opportunity is worth investing money in?
4. How confident do you feel about your capability to estimate cost of starting a venture?
5. How confident do you feel about your capability to explain and convince someone of your idea?
6. How confident do you feel about your capability to identify new market opportunities?
7. How is your capability to invent and design new products?
8. How qualified do you feel you are to start a new business?

**Comparison of Results from Workshops at Trivandrum and Muzaffarnagar**
The change in the confidence level, before and after the workshops, for the eight questions are shown in Figure 5.1.

![Bar chart showing comparison](image)

*Figure 5.1. Change in confidence in students that attended the workshops*

The average change in attitude in Trivandrum for starting a business shows a significant increase of about 31% and Muzaffarnagar about 10%. In general in both workshops, there is an increase of about 15-20% in the attitudes of students to estimate market potential, to develop business plans, to gauge investment opportunity, estimate costs of starting up businesses, identify new markets, and design new products. This proves the workshop did have a significant influence on these factors.

The major differences in the two workshops are in Question 5 on the ability to present ideas and Question 8 on the confidence to startup on their own.
The change in Q5 was expected. After the Trivandrum workshop the data showed that the presentation skills had not changed significantly. Therefore, intense presentation training was included in the Muzaffarnagar workshop.

On Question 8, which addresses the students’ confidence on starting up ventures, the difference can be explained by the change in length of the workshop and number of projects completed. The Trivandrum workshop was seven-weeks long and the students did three full projects starting from problem identification to business plan development. In Muzaffarnagar the students had an 18-day workshop and they did only one project.

**Post Workshop Results:**
The following are results from an informal survey done a month after the workshop.

- 60% of the students want to pursue entrepreneurship. Some have already started their ventures, others are planning to start in a year.
- Eight startups have been launched from Trivandrum and Muzaffarnagar. Two have secured seats at local incubation companies.
- Every student indicates a great change in attitude since before the workshop and they claim that they are capable of taking on entrepreneurship.
- They all have seen significant improvement in their ability to
  - Look for opportunities to pursue
  - Ideate solutions
  - Fabricate prototypes
  - Work in teams
  - Startup their ventures
- As of this day Mar Baselios College at Trivandrum converted the workshop classroom to the Innovation & Entrepreneurship Center. Shri Ram College at Muzaffarnagar is in the process of doing the same.

**Gender Based Results:**
The results from Trivandrum were analyzed to see if the female and male students benefited the same way from the workshop. As Fig 5.2 shows, female students gained about 50% more compared to male students. However, the female students started at a lower level and closed their gap with male students to some extent. The change in starting businesses was almost the same. More detailed figures on this study may be found in Appendix-F.
Effect of Financial Background of Family
This study looked at the students according to their economic income levels to study any effect from the workshop. All students showed a near equal improvement on confidence level. Students at the lowest quartile showed a higher change in their confidence level to start new business. Figure 5.3 shows that that family income level has no significant effect on the changes in the entrepreneurial attitude.

Figure 5.3. Change in confidence to startup per family income level
Predicting Potential Entrepreneurs
Can the influencers predict students with significant changes in entrepreneurial attitude? Two MIT graduate students Andrew Radin and Ellen Chen took up this analysis as their final project for the course The Analytics Edge (15.071). Their report is included in Appendix G.

The data from the pre-workshop survey was used to predict change in students' confidence as shown by the post-workshop survey. The change in score for the question "How confident do you feel about your capability to start a new company?" was set as the dependent variable. Several statistical modeling techniques, such as, regression, CART, random forest and clustering were used to identify potentially predictive variables. The accuracy of these models was relatively low.

Given these factors, it is concluded that there are no clear patterns in the data that would allow accurate prediction of whether a student would have a significant change in confidence or not.
Chapter 7: CONCLUSIONS AND FUTURE STEPS

The conducted experiments indicate clearly that innovators and entrepreneurs can be created from ordinary student populations with the right kind of teaching. This can have huge implications for building entrepreneurship ecosystems in different parts of the world, giving average individuals the opportunity to be entrepreneurs.

This research includes the study of the change in entrepreneurship attitude of the students, design of a workshop to effect these changes, and the general methodology for conducting the workshop. As a result of this workshop about two-thirds of the students want to pursue entrepreneurship.

The following are some observations from this study.

• Before the workshop 95% of the students did not realize they had the potential to become entrepreneurs.

  Significant changes in attitude to entrepreneurship can be achieved through experiential workshops

• It is important that workshops work with the local industries to speed up the startup process through faster product adoption.
  
  o In the Muzaffarnager workshop the ‘Sugarcane Freshness Detector’ [Appendix E] came as a problem from the local industry and the solution was immediately absorbed for market evaluation.
  
  o In Trivandrum the Sleep Apnea Detector [Appendix E] was a relevant solution for the local community but quick industry adoption required a local business with interest in the product and Trivandrum is not the hub for such industries.
  
  o It would be interesting to study how the workshop can be adapted to allow non-local industries to contribute to this entrepreneurial process.

• Conducting workshops in a single college, with a critical mass of students is necessary for sustaining the entrepreneurial process well beyond the life of the workshop.

• The number of iterations of the entrepreneurial process increases self-efficacy. We can see that the confidence levels in the Trivandrum workshop with three repetitions of the entrepreneurial process had a much greater boost in entrepreneurial attitude over the one project Muzaffarnagar workshop.

• It is important for training programs to teach all aspects of innovation and entrepreneurship to improve self-efficacy. We see that in both workshops there was a significant increase in confidence levels of all supporting functions along with the increase in overall entrepreneurial confidence.

• Gender and Family income level did not have any impact on attitude to entrepreneurship
• None of the assumed influencers was a significant predictor of the students’ inclination to change in entrepreneurial attitude. So entrepreneurial programs need to address general populations without pre-selection.
• Creating entrepreneurship centers within colleges can sustain entrepreneurship efforts and get students started early.
• Workshops may need to be localized appropriately and this is not a significant change in the overall method.
  o The more interesting question is the adoption of the workshop for other student groups in trade, arts and social sciences and the design of the fabrication component to develop ‘maker-skills’ in those fields.
• There is scope to optimize the effectiveness of this workshop through more extensive adoption and testing.

**Future Directions**

The workshop has provided the core model for the design of a two-tier program for building an entrepreneurship ecosystem for student communities in cities, states and nations. The program aims to change the momentum of emergence of entrepreneur in entire communities.

Current entrepreneurship programs do not address the problem of picking the entrepreneurs out of the general population. To grow the number of entrepreneurs in large numbers, there is a need to provide programs that can not only identify but also enable the innovators and latent entrepreneurs as shown by this study. There is also a need to allow them to ‘practice’ the entrepreneurship process before the launch of startups to reduce the probability of failures [7], [8].

![Figure 7.1. Two-tier program for catalyzing entrepreneurs](image)

The program has three phases (the workshops of this study included phases 1 and 2)

• Enabling a friendly entrepreneurial environment in communities; Communities can be colleges, states, and regions.
• Intensive innovation and entrepreneurship training without commitment for launching startups providing the opportunity for entrepreneurial trials without fear of consequences.
• The launching of startups after identifying a worthwhile business opportunity.
The suggested implementation plan involves implementing these phases as two tiers to achieve the whole plan
- Outreach Program: to promote innovators and entrepreneurs.
- Incubation Program: to train and launch entrepreneurs.

This two-tier system can identify potential innovators and entrepreneurs, ideally during their college years, and train them in the process of starting up multiple times, before they launch their startups.

**Outreach Program**

The Outreach consists of two optional programs.

**Design and Innovation workshop (DI):**
This workshop is designed to address large groups of students through short, quick entrepreneurial workshops. The aim is to teach basic problem identification and broad design practices to students and expose them to the entrepreneurial culture. These can include large groups of students anywhere between 100-400. The workshops can be hosted in locations with convenient access for the students.

The focus of the workshop will be the following:
- Conduct field study to identify problems
- Ideate solutions as a team
- Design products
- Fabricate prototypes
- Validate solutions

There will be several such one-week-long workshops conducted at different sites by a core set of instructors and student mentors hired from previous workshops.

**Innovation, Fabrication & Entrepreneurship Workshops (IFE):**
These workshops are held at a college for students from that college. These workshops last three to five weeks and will have a small fab lab for fabrication of electronic and mechanical prototypes by the students. These, like the ones in this study, are meant to be more extensive than the DIs and include all the areas of instructions of the DI and more.

This workshop will cover the following along with the DI curriculum. There will be multiple iterations of the whole entrepreneurship process for in-depth experience:
- Opportunity validation
- Fundamentals of business finance
- Develop business plans
- Pitching and presentations

The program also helps colleges set up innovation and entrepreneurship (I&E) centers on campus and adopt the standard operation processes and uses standard...
innovation tools. These I&E centers may be connected with other colleges for creating a large community of innovators and entrepreneurs

**Incubation Program**

Incubation Program is implemented through a center that brings in potential entrepreneurship candidates and trains them to launch companies. Candidates admitted to the center are paid a stipend during the program. In effect, this center “Incubates Entrepreneurs.”

Candidates are admitted as INTERNs for a three-month program. During this time the intern goes through multiple cycles of problem identification through business plan development to learn the process of startup without actually raising funds or registering companies. Interns will realize that many of these projects may not be fit to be considered for a real startup. But it is real hands-on learning.

Once the intern has identified an opportunity and has validated it as a worthwhile project that has potential for startup, he/she becomes a FELLOW for a maximum period of nine months. A Fellow pursues an active startup program and the center helps with all the entrepreneurship steps including raising funds. The center takes equity in the startup as it was incubated under the center from the beginning with center’s funding. The Fellows are encouraged to find their cofounders from the Interns or Fellows at the Center.

The center attracts funding from outside investors to fund startups. The stipend and operations are funded through government grants and private foundations.
Appendix A: RESEARCH PROPOSAL
Proposal for Field Study

Rajesh Nair
Sept 28, 2013

Research Questions:
- Is it possible to design and integrate material and process to promote innovation and entrepreneurship in a small college setting?
- To what extent does this educational intervention have an impact on the entrepreneurial attitude of the students?

Hypothesis:
Several national level engineering schools in India, such as Indian Institutes of Technology and National Institutes of Technology, have strong programs to enable innovation and entrepreneurship among the students. An average rural or small college lacks such initiatives. The difference in the placement rates of graduates for innovation profession, and the number of entrepreneurs emerging from these colleges reflect this discrepancy.

From my study so far, almost all Indian tech entrepreneurs I met are tech innovators. These are the innovators who ventured into entrepreneurship. Can other innovators be molded to pursue entrepreneurship? Can more students be trained to become productive innovators? What are the factors that will enable this transition?

From my study of entrepreneurs, academic institutions and incubators in India so far, my experience with mentoring at MIT Media Lab Innovation workshops and conducting TechTop innovation competition for nine years, I believe that the key factor that is lacking in an average engineering college is the training on innovation and entrepreneurship process.

My hypothesis is that I&E process can be condensed into the following four steps that can be implemented in a college.
- Learning basic Innovation Processes (Problem selection, Ideation for solution creation & evaluation)
- Immersing in a 'Maker/Hacker' culture (Product development, Fabrication & coding experience)
- Training to think like an entrepreneur (Market evaluation, Strategy development, Capital)
- Receiving mentorship (Advice and inspiration from entrepreneurs with experience)

Summary of the experiment:
The experiment proposed here consists of creation of a short I&E curriculum and training some 20-25 students from one small or rural engineering college in India.

A survey to profile the entrepreneurial attitude is conducted before the experiment. To understand the changes in this attitude, the same survey is conducted at the end.
of the three-month process. The survey will be conducted among three categories of students:

- **Group A**: (20-25 students) (Study Group) Those who attend the program
- **Group B**: (50-60 students) Students in the same college as Group A at close proximity to the participating students
- **Group C**: (50-60 students) Students in one or more colleges different from the test college with no direct influence from Group A.

**Identifying Engineering schools**

After discussions with multiple colleges I have chosen Mar Basilios College of Engineering and Technology (MBCET), a small engineering college in Trivandrum, Kerala. Support from administrators, ease of access and small-town nature were the primary factors in selecting this site.

**Selection of Students:**

- Study group consisting of about 20 students from the selected college
  - The rough spread of students vs. their year of study at college:
    - 20%: 1st Year
    - 20%: 2nd Year
    - 30%: 3rd Year
    - 30%: 4th Year
  - No other significant exposure to innovation/e-ship programs necessary
  - Academically average
  - All engineering disciplines broadly covered
  - Even mix of male and female students

**Commitment from the Colleges:**

- College must help with selection of student candidates
- This 3-month I&E program will be in addition to the students' current academic workload.
- Make available a room where the students can meet through the period. This room will be dedicated for the "I&E Center".
- Provide basic facilities, such as, AV system and web access,
- Provide access to computers, CAD tools, and software development tools
- Provide the students freedom to work at the Center during off hours and weekends
- Make the college's electronics lab and mechanical workshop freely accessible to these students so they may learn to fabricate prototypes
- Identify a faculty member who can support this effort and be the liaison to the rest of the college. (Potentially this person should be able to continue the program if the college desires so.)
- Explore if this program could be counted toward academic or extra-curricular credits.

**The schedule of the field experiment consists of:**
PHASE 1: Week 1-4
I will spend 1-2 hours every day teaching the group and 2-3 hours in mentoring students. I will work with the students to cover broad aspects of both innovation and entrepreneurship. We will go over the course content twice during the first 4 weeks; each time the student works in a different team on a new project from beginning to end. By the end of the three weeks each student should have a broad understanding of innovation, entrepreneurship and leadership thinking. The topics covered are:

- Innovation process
- Problem identification
- Evaluation of the problem for market potential and social impact
- Ideation methods for solution development
- Field validation of solution idea
- Learning to design & fabricate electrical and mechanical parts
- Prototype creation
- Product design process
- Field validation of product through interviews
- Introduction to fundamental 24 steps of entrepreneurship (Bill Aulet’s)
- Basics of finance
- Fundamentals of creating a business plan
- How to pitch ideas and ventures
- Learning the basics of leadership qualities
- Self evaluation of the innovation, entrepreneurship and leadership experience

PHASE 2: Week 5-8
During this phase the students are expected to work on one project per team at greater detail. This project could be one of the three from previous weeks or a new one. It is a team project with 3-4 students in each team.

I will offer weekly mentoring. We will invite local inventors, and entrepreneurs to speak about their experience and mentor the students through the entrepreneurship journey.

The students will fabricate multiple versions of their product at lab and workshop at the college.

At the end of this session each team will have:
- Multiple versions of prototypes of their product for demonstration
- A final working prototype
- A fairly detailed business plan
- A pitch deck, and
- Opportunity to pitch to investors or executives

The final closing event will consists of display of prototypes, presentation to larger audience consisting of students, faculty, local entrepreneurs and media.

Study of Entrepreneurship Attitudes

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Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
A survey is done to study the entrepreneurship attitude among students and the influence of this program on the attitude. The survey is done on:

- Group A, the participating students,
- Group B, a sample of students from the same college who may have spillover influence from Group A, and
- Group C, students from other colleges with little influence from Group A.

The thesis report will be developed in the fourth month.

**After the Study**

I expect the college to continue this program with the students who attended the program will teach other students; thereby creating a **sustaining ecosystem that is student-run**.

This experience will help me understand tune the curriculum that may be implemented in similar colleges in anywhere in the world.

All students will be required to keep a running journal of their experience, attitudes and technical project. I will be video documenting the two months of interactions that could be made into a short documentary.

**Time Line**

**September-November 2013:**

- Get permission from MIT-Tata Center to proceed [Done]
- Select college [Done]
- Select students who will attend the workshop (Group A)
- Develop contract document
- Identify Groups B & C for survey
- Prepare curriculum
- Equipment and materials to be acquired and shipped
- Initial Survey of Groups A, B & C

**December 2013:**

- Travel to India, arrange accommodation for 3 months
- Start Workshop Phase 1 (4-week)

**January 2014:**

- End of Program Phase 1
- Survey-of Groups A & B
- Start of Program Phase 2
- Final pitch and demonstration day
- Survey Groups A & B
- Phase 2 ends
- Return to MIT

**February 2014:**
• Completion of thesis report

Rev. 4
Appendix B: COURSE CURRICULUM
MIT-Tata Center: Workshop on Innovation, Fabrication and Entrepreneurship
Conducted At
Mar Baselios College of Engineering and Technology, Trivandrum

1. SUBJECT DESCRIPTION
This course covers the basics of innovation process, fabrication methodologies and business plan generation & pitching. The student gets an opportunity to look for problems, analyze them as opportunities, ideate solutions, create products, validate in field and develop business strategy. The theme of the course will be product and business development for the Healthcare market.

We will cover the following topics:

- Innovation process
- Problem identification
- Evaluation of the problem for market potential and social impact
- Ideation methods for solution development
- Field validation of solution idea
- Learning to design & fabricate electrical and mechanical parts
- Prototype creation
- Product design process
- Field validation of product through interviews
- Introduction to fundamental 24 steps of entrepreneurship (Bill Aulet’s)
- Basics of finance
- Fundamentals of creating a business plan
- How to pitch ideas and ventures
- Learning the basics of leadership qualities
- Self evaluation of the innovation, entrepreneurship and leadership experience

2. LEARNING OBJECTIVES
The student will be exposed to the following:

- Seeking problems to address, problem analysis and opportunity evaluation
- Ideation process to develop solution concepts
- Conversion of solution idea into a product system
- System level understanding of the business and product
- Process for product design
- Mechanical design and 3D printing
- Circuit design, circuit board fabrication and assembly
- Programming microcontrollers
• App development for PC, web, and mobile devices
• Field validation of product system
• Apply innovation theories and concepts to the rigorous identification and development of new opportunities for societal and commercial impact.
• Forge technology-based ideas into workable business concepts and learn how to test them in the marketplace.
• Differentiate and distinguish the different process activities associated with new product/process/service development, inside or outside an established firm.
• Understand the concepts of customer development and business model development.
• Critically assess and evaluate the resource assembly junctures in the development of new ventures (whether they be within established corporations or start-ups).

3. LEARNING STRATEGY
This is a hands-on learning program. The students will have access to circuit and mechanical design and fabrication labs at all hours to work on their projects. They will also have access to mentors and experts for guidance.

The students will complete two problem identification/product development/business plan development cycles in the field of healthcare.

The students will visit hospitals and interview patients, staff, physicians and people from the community to identify several existing problems. They will choose one problem to work on and estimates its opportunity potential.

The students learn fundamentals of circuits and circuit board design, mechanical design, firmware/app development and system level design of the solution.

The students learn basics of fabrication technologies where they are trained to make prototypes and validate their solution.

The students develop an elementary business plan and learn pitching methods.

The projects and business plan are presented to the public at the end of the workshop.

Role Of The Instructors
The instructor primarily plays the role of a coach or a mentor. Other than teaching the basics, each team is encouraged to explore their ideas under the guidance of the instructor.

We will have guest speaker with expertise in app development, product design, medical devices and entrepreneurship.
Role Of Participants
To achieve the learning objectives of the subject, participants will thoroughly prepare and participate in all of the classes. Please note the following four points:

Attendance:
It is important to attend every class. Since the projects are done in teams, participation of each student is important in completion of projects and their individual learning.

Project work:
Project work is a critical vehicle for learning in this course. Project work will be your opportunity to fully develop your understanding of several of the concepts we will explore in the lectures. Some materials will be largely developed from the discussions arising in project report-out sessions and the assignments leading to them.

4. ASSESSMENTS AND GRADING
This course is not graded. The student must complete the course to receive a certificate of participation.

In-class exercises:
At the end of several classes, team-based exercises will be introduced to help you practice the materials covered in class.

Project work:
There will be three projects done during the workshop on the following topics.

- Basic fabrication
- Problem identification and product development
- Problem definition, product development and business plan development

Presentations:
Throughout the course we will ask you to prepare up to four brief team presentations limited in time to 3-5 minutes. In these presentations you will report on your team’s progress towards identifying, evaluating and planning for commercial exploitation of an opportunity associated with your project work and product design approaches.

Final projects:
The students will present the final projects to the rest of the college. The final report will have the following:

- Problem definition
- Product development experience
- Commercialization plan

Documentation of Experience:
The students will create their personal blog where they discuss what they learned and how it affected their thinking. Pictures, video, source code and business plans are openly...
published. All ideas, designs and plans are considered public property.

LAB FACILITIES
The students will learn and have access to the following development resources:

- Electronic schematic & circuit board design CAD (Eagle CAD)
- Mechanical design CAD (SketchUp)
- Circuit board fabrication (board milling machines, soldering stations)
- Mechanical fabrication (3D printers, mechanical lab)
- Electronics test station (Power supply, oscilloscope, multi-meters)
- Machine shop (Basic machines and assembly stations)

CLASS SCHEDULE OVERVIEW

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Class Schedule</th>
<th>Subject</th>
<th>Learning Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-Dec</td>
<td>Sat</td>
<td>10am-4pm</td>
<td>-Introduction to workshop</td>
<td>-Develop a simple product design</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-System design of solution</td>
<td>-3D print parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Mechanical CAD (SketchUp)</td>
<td>-Assemble and test</td>
</tr>
<tr>
<td>8-Dec</td>
<td>Sun</td>
<td>10am-4pm</td>
<td>PCB Fabrication &amp; Assembly</td>
<td>-Assemble Arduino board</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-Student time to finish project</td>
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<td>9-Dec</td>
<td>Mon</td>
<td>4:30-6:00pm</td>
<td>Electronics basics</td>
<td>-Circuit basics</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<td>-Eagle CAD Introduction</td>
</tr>
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<td>Tue</td>
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<td>Microcontrollers</td>
<td>-Arduino Programming</td>
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<td>11-Dec</td>
<td>Wed</td>
<td>4:30-6:00pm</td>
<td>Ideation Exercise 1</td>
<td>-Problem selection</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-Solution ideation</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Opportunity estimation</td>
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<td>Thu</td>
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<td>Field visit</td>
<td>-Trip to medical college hospital</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Interviewing patients, staff, doctors</td>
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<td>Problem definition for Project 1</td>
<td>-Discussion of problems found and selection of final</td>
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<td>Sat</td>
<td>10am-4pm</td>
<td>-Android/ Web programming</td>
<td>-App dev on Android</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>-Project 1 Solution architecting</td>
<td>-Interfacing Arduino to Android</td>
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<tr>
<td>15-Dec</td>
<td>Sun</td>
<td>10am-4pm</td>
<td>Project1 design/ fab with guidance</td>
<td>-Student time to design/ fab product revision 1.0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Customer on solution idea</td>
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<td>16-Dec</td>
<td>Mon</td>
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<td>-Intro steps to Entrepreneurship</td>
<td>-Beachhead market</td>
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<td>-Elevator pitch</td>
<td>-Market opportunity evaluation</td>
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<tr>
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<td>-Customer profile</td>
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<td>-Presentation Basics</td>
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<td>17-Dec</td>
<td>Tue</td>
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<td>-Customer feedback on product</td>
<td>-Students start design &amp; fabrication of product rev 2.0</td>
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<td>-Final presentation deck</td>
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<td>DEMO DAY (Project 1)</td>
<td>App teams demonstrate and pitch their product and business idea</td>
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<td>Thu</td>
<td>4:30-6:00pm</td>
<td>-Reflections and documentation</td>
<td>-Lessons learned</td>
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<tr>
<td></td>
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<td>-Plan for Project 2</td>
<td>-Tech and experience documentation</td>
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Catalyzing Entrepreneurship from the Ground Up:
An Experiment in Small-Town India
<table>
<thead>
<tr>
<th>Date</th>
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<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
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<td>20-Dec</td>
<td>Fri</td>
<td>4:30-6:00pm</td>
<td>Field visit for Project 2</td>
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<tr>
<td>21-Dec</td>
<td>Sat</td>
<td>10am-4pm</td>
<td>Problem evaluation/ selection</td>
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<tr>
<td>22-Dec</td>
<td>Sun</td>
<td>10am-4pm</td>
<td>Solution Ideation</td>
</tr>
<tr>
<td>23-Dec</td>
<td>Mon</td>
<td>4:30-6:00pm</td>
<td>Solution Review by medical device experts</td>
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<td>24-Dec</td>
<td>Tue</td>
<td>4:30-6:00pm</td>
<td>Teams work independently through process</td>
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<td>25-Dec</td>
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<td>28-Dec</td>
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<td>10am-4pm</td>
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<td>Fri</td>
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<td>4-Jan</td>
<td>Sat</td>
<td>10am-4pm</td>
<td>Teams work independently through process</td>
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<tr>
<td>5-Jan</td>
<td>Sun</td>
<td>No class</td>
<td>Teams work independently through process</td>
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<td>Mon</td>
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<td>Project 2 status update</td>
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<td>Guest lecture on Medical product development</td>
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<td>Wed</td>
<td>4:30-6:00pm</td>
<td>Internal demonstration of project and feedback</td>
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<td>Thu</td>
<td>4:30-6:00pm</td>
<td>DEMO DAY (Project 2)</td>
</tr>
<tr>
<td>10-Jan</td>
<td>Fri</td>
<td>4:30-6:00pm</td>
<td>Reflections and documentation</td>
</tr>
<tr>
<td>11-Jan</td>
<td>Sat</td>
<td>10am-4pm</td>
<td>Project 3 Kick off</td>
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<tr>
<td>12-Jan</td>
<td>Sun</td>
<td>No class</td>
<td>Travel to off site location for field research</td>
</tr>
</tbody>
</table>

- Develop three potential solutions for review by external experts
- Poster/ PPT slide for each idea
- Redesign of solution from feedback
- Teams pitch problem/ solution idea
- Demo prototypes
- Business opportunity/ plan
- Identify potential problem areas
- Current trends
- -Preparation for Demo Day 2
- Presentation to College and public
- -Lessons learned
- -Technical and experience documentation
- -Potential problems to tackle from experts
- -Team project with support from mentors

Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Time</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-Jan</td>
<td>Mon</td>
<td>4:30-6:00pm</td>
<td>Project fabrication</td>
<td>Team project with support from mentors</td>
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<td>Tue</td>
<td>4:30-6:00pm</td>
<td>Business Plan review</td>
<td>Team project with support from mentors</td>
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<td>Wed</td>
<td>4:30-6:00pm</td>
<td>Field feedback</td>
<td>Team project with support from mentors</td>
</tr>
<tr>
<td>16-Jan</td>
<td>Thu</td>
<td>4:30-6:00pm</td>
<td>Design review</td>
<td>Team project with support from mentors</td>
</tr>
<tr>
<td>17-Jan</td>
<td>Fri</td>
<td>4:30-6:00pm</td>
<td>Design iteration</td>
<td>Team project with support from mentors</td>
</tr>
<tr>
<td>18-Jan</td>
<td>Sat</td>
<td>10am-4pm</td>
<td>Business plan/ pitch</td>
<td>Team project with support from mentors</td>
</tr>
<tr>
<td>19-Jan</td>
<td>Sun</td>
<td>No class</td>
<td>Product prototype integration</td>
<td>Team project with support from mentors</td>
</tr>
<tr>
<td>20-Jan</td>
<td>Mon</td>
<td>4:30-6:00pm</td>
<td>Final Preparations</td>
<td>Team project with support from mentors</td>
</tr>
<tr>
<td>21-Jan</td>
<td>Tue</td>
<td>4:30-6:00pm</td>
<td>Final Preparations</td>
<td>Team project with support from mentors</td>
</tr>
<tr>
<td>22-Jan</td>
<td>Wed</td>
<td>4:30-6:00pm</td>
<td>DEMO DAY (Project 3)</td>
<td>Open to College, Public and Media</td>
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<td>23-Jan</td>
<td>Thu</td>
<td>4:30-6:00pm</td>
<td>Reflections and documentation</td>
<td>Lessons learned, Technical and experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>documentation</td>
</tr>
</tbody>
</table>
Appendix B: INVENTORY LIST FOR FAB LAB
The components used for building prototypes at the workshop were sourced and carried from US. This list is a subset of the list of components suggested by Fablab at Center for Bits and Atoms, MIT. An online inventory list and requesting system was implemented on GoogleDoc to track usage.

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<th>PART NO</th>
<th>MANUFACTURER’S NUMBER</th>
<th>DESCRIPTION</th>
<th>VENDOR</th>
<th>List Unit Price (US$)</th>
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Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
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Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
### Catalyzing Entrepreneurship from the Ground Up:
#### An Experiment in Small-Town India

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<tr>
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<td>Red ABS 3D Printer Filament</td>
<td>Type: Filament, Diameter: 1.75 mm, Material: ABS, Color: Red, Shade: Red</td>
<td>Inventables</td>
<td>39</td>
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<td>Inventables</td>
<td>39</td>
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<tr>
<td>250 TNF01</td>
<td>NDS355ANCT-ND</td>
<td>MOSFET N-CH 30V 1.7A 3-SSOT-</td>
<td>Digi-Key</td>
<td>0.26336</td>
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<td>200 XT08M</td>
<td>535-10004-1-ND</td>
<td>CER RESONATOR 8.00 MHZ W/CAP SMD</td>
<td>Digi-Key</td>
<td>0.2475</td>
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<tr>
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<td>XC1109CT-ND</td>
<td>CER RESONATOR 20.00MHZ SMD</td>
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<td>5 MO008</td>
<td>RN-UFL-SMA6</td>
<td>6&quot; Coax Cable w/U. FL Roveing Networks RF Cable Assemblies</td>
<td>Mouser</td>
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<td>5 MO009</td>
<td>XB2B-WFUT-001</td>
<td>Xbee Wi-Fi (S6B) Digi Intl WiFi/802.11 Module</td>
<td>Mouser</td>
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<td>5 MO010</td>
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<td>Class 2 Single Mode Laird Tech Bluetooth module</td>
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<td>50 IC013</td>
<td>AD8615UJZ-REEL7CT-ND</td>
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<td>Digi-Key</td>
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Appendix C: SURVEY 1
Survey on Innovation and Entrepreneurship Attitude
This survey is done as a part of my research at Massachusetts Institute of Technology to understand change in entrepreneurial attitude among engineering students after exposure to innovation, fabrication and entrepreneurship practices.

Participation in this survey is voluntary. You may decline to answer any or all questions. You may decline further participation, at any time, without adverse consequences. Your confidentiality and/or anonymity are assured.

Please read the instructions for each questions carefully, marking your responses and reviewing your answers for correctness. Within this survey there are no right or wrong answers and it would be appreciated if you answered all questions honestly and accurately as possible.

The survey will take about 15 minutes to complete.

The information you provide will be treated in complete confidence and your identity will not be revealed. The only reason we ask for your name is to link the different surveys together.

If you have any questions, please contact me at rainair@mit.edu.

Please proceed if you are willing to participate in this research.

Thank you,
Rajesh Nair
MS Candidate in System Design and Management Program
Massachusetts Institute of Technology

(Special thanks to Dr. William Lucas from MIT for his advice and Dr. Shima Barakat and Dr. Monique Boddington of University of Cambridge. This survey was inspired by their work in this field.)

INTRODUCTION

1. Name:
   Please enter First and Last names

2. Gender
   Mark only one oval.
   ○ Male
   ○ Female

3. Age (in Years)

4. Contact E-mail:
5. Your Home Town:
Example, Kochi, Kerala, India OR Dallas, Texas, USA

6. Your home town is a:
Mark only one oval.

- Village
- Town
- City

7. What is your native language?
Mark only one oval.

- Malayalam
- English
- Other:

8. What was your language of instruction at middle school (before high school)?
Mark only one oval.

- Malayalam
- English
- Other:

9. What was your language of instruction at high school (before college)?
Mark only one oval.

- Malayalam
- English
- Other:

10. What is the highest level of education of either of your parents?
Mark only one oval.

- High school
- Bachelor degree
- Masters degree
- PhD
- Professional (Engg, Medicine, Law ...)
- Other:
11. **What discipline are you pursuing for your degree?**
   
   *Mark only one oval.*
   
   - Mechanical
   - Electrical & Electronics
   - Electronics & Communications
   - Computer Science
   - Civil Engineering
   - Information Technology
   - Chemical Engineering
   - Bio-technology
   - Other: ________________________________

12. **Your year of study at college?**
   
   *Mark only one oval.*
   
   - First Year (Freshman)
   - Second Year (Sophomore)
   - Third Year (Junior)
   - Fourth Year (Senior)
   - Post Graduate (Masters/ PhD)
   - Other: ________________________________

13. **How many members make up your permanent household, including you?**
   
   How many surviving members in your family including you, your siblings and parents.
   
   *Mark only one oval.*

   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] 7
   - [ ] 8
   - [ ] 9
   - [ ] 10

14. **How many siblings (brothers & sisters) do you have? (Excluding you)**
   
   *Mark only one oval.*

   - [ ] 0
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] 7
   - [ ] 8
   - [ ] 9
   - [ ] 10

15. **Compared to other students in your college, where do you feel your family’s annual income stands?**
   
   This is only an estimate.
   
   *Mark only one oval.*

   - [ ] Bottom 25% group
   - [ ] 25-50% group
   - [ ] 50-75% group
   - [ ] Top 25% group
16. Have you taken any course on design, innovation or fabrication development before?  
   *This could be a workshop on engineering design, model making or fabrication.*  
   Mark only one oval.  
   - [ ] Yes, Once  
   - [ ] Yes, More than once  
   - [ ] Never  

17. Have you taken any course on Entrepreneurship development before?  
   Mark only one oval.  
   - [ ] Yes, Once  
   - [ ] Yes, More than once  
   - [ ] Never  

18. How often have you thought about starting a company in the past three years?  
   Mark only one oval.  
   - [ ] Never  
   - [ ] Very, often  

19. Do you know personally anyone who has started businesses in the past 2 years?  
   Mark only one oval.  
   - [ ] I don't know anyone  
   - [ ] I know 10 or more people close to me  

20. Has anyone in your household ever started a business?  
   Mark only one oval.  
   - [ ] Yes  
   - [ ] No  

21. How often do you discuss business related topics in the family?  
   Mark only one oval.  
   - [ ] Never  
   - [ ] Every day
22. How big do you feel are the opportunities for starting a business in the area where you live?
Mark only one oval.

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<tr>
<td>No opportunities at all</td>
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<tr>
<td>Extremely good opportunities</td>
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23. When do you think you want to start your company?
How many years from now?
Mark only one oval.

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<td>Never</td>
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<td>10 years or later</td>
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24. Do you think all the hardship, uncertainty and chances of failure in starting a company are worth the gain?
Mark only one oval.

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<td>Not worth the trouble</td>
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<tr>
<td>Absolutely worth the struggle</td>
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25. How qualified do you feel you are to start a new business?
Rate your level of comfort with your knowledge, skill and experience required for starting up.
Mark only one oval.

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<td>Not qualified</td>
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<tr>
<td>Very qualified</td>
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26. Do you know what additional skills you need to become an entrepreneur
Mark only one oval.

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<tr>
<td>I don't know what I am missing</td>
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<td>I know exactly what I need to learn</td>
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27. How does fear of potential failure prevent you from starting a business? 
Mark only one oval.

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<td>Stops me</td>
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<td>Not at all</td>
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28. In India, most people would prefer that everyone had a similar standard of living. 
Do you agree with this statement? 
Mark only one oval.

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<td>Very True</td>
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29. In India, most people consider starting a new business a desirable career choice. 
Do you agree? 
Mark only one oval.

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<td>Absolutely True</td>
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30. In India, those successful at starting a new business have a high level of status and respect. 
Do you agree? 
Mark only one oval.

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<td>Very True</td>
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31. In India, you will often see stories in the public media about successful new businesses. 
Mark only one oval.

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<td>Not at all</td>
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<td></td>
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<td>Everyday in TV, newspaper...</td>
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32. In India, entrepreneurship is not very risky and is a sure way to attain wealth. 
Mark only one oval.

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<td>Totally Agree.</td>
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AUTHENTIC PERFORMANCE

33. Are you being challenged by your current academic workload?
Mark only one oval.

0 1 2 3 4 5 6 7 8 9 10

Current course workload is overwhelming

34. How often do you think of ideas for new ways of doing ordinary things?
Mark only one oval.

0 1 2 3 4 5 6 7 8 9 10

Never

Several times everyday

35. How often do you dream of creating software/products solutions?
Mark only one oval.

0 1 2 3 4 5 6 7 8 9 10

Never

Always

36. How good are you with making things with locally available materials?
Mark only one oval.

0 1 2 3 4 5 6 7 8 9 10

Not Good at making anything

I put together a hacked solution with what is around

37. Have you created toys and other products as a child?
Mark only one oval.

0 1 2 3 4 5 6 7 8 9 10

Never

I always made my own toys
38. How is your capability to invent and design new products?
Mark only one oval.

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| Poor | | | | | | | | | | Excellent

39. How confident do you feel about your capability to identify new market opportunities?
Mark only one oval.

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| Poor | | | | | | | | | | Excellent

40. How confident do you feel about your capability to start a new company?
Mark only one oval.

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| Poor | | | | | | | | | | Excellent

41. How confident do you feel about your capability to work with a team?
Mark only one oval.

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| Poor | | | | | | | | | | Excellent

42. How confident do you feel about your capability to inspire and lead a team?
Mark only one oval.

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| Poor | | | | | | | | | | Excellent

43. How confident do you feel about your capability to operate an organization and manage people?
Mark only one oval.

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44. How confident do you feel about your capability to explain and convince someone of your idea?
Mark only one oval.

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| Poor | | | | | | | | | | Excellent
45. How confident do you feel about your capability to estimate cost of starting a venture?  
Mark only one oval.

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<tr>
<td>Poor</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Excellent</td>
</tr>
</tbody>
</table>

46. How confident do you feel about your capability to know if an opportunity is worth investing money in?  
Mark only one oval.

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</thead>
<tbody>
<tr>
<td>Poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Excellent</td>
</tr>
</tbody>
</table>

47. How confident do you feel about your capability to develop a business plan?  
Mark only one oval.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Excellent</td>
</tr>
</tbody>
</table>

48. How confident do you feel about your capability to estimate the market potential for a product or service?  
Mark only one oval.

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</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Excellent</td>
</tr>
</tbody>
</table>

SOCIAL INFLUENCE

49. How often have your ideas, designs and creations been complimented by your friends, family and associates?  
Mark only one oval.

<table>
<thead>
<tr>
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<th>0</th>
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<tbody>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very often</td>
</tr>
</tbody>
</table>

50. How often have your good ideas, designs and creations been used by others? (These need not be technical ideas)  
Mark only one oval.

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Never</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>Always</td>
</tr>
</tbody>
</table>

Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
51. How often have you seen your ideas in use or later developed by others?
Mark only one oval.

<p>| | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Very Often</td>
</tr>
</tbody>
</table>

52. How well do you work with a team when there is disagreement?
Mark only one oval.

<p>| | | | | | | | | | | |</p>
<table>
<thead>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>I work well under disagreements</td>
<td>I can't work under team tension</td>
<td></td>
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</table>

53. How does starting a company (even if it fails) affect your future?
Mark only one oval.

<p>| | | | | | | | | | | |</p>
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<tr>
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<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>It helps me for my next adventure</td>
<td>It would ruin my career.</td>
<td></td>
<td></td>
<td></td>
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</table>

54. Is it worth betting everything on a startup if you saw an opportunity that you believe in?
Mark only one oval.

<p>| | | | | | | | | | | |</p>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Absolutely worth it</td>
<td>It is very risky to start. It is only for those with lots of experience</td>
<td></td>
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</tbody>
</table>
55. Do you think it is important to have academic degrees before starting companies?
Mark only one oval.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
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<th>6</th>
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<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all.</td>
<td>Degrees are a waste of time for a startup.</td>
<td>Degrees are needed for learning process of startup and as a safety measure if it fails.</td>
<td></td>
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</tbody>
</table>

56. How many of your friends have the skills to develop software apps or products?
Mark only one oval.

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<thead>
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<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>About half of my friends</td>
<td></td>
<td></td>
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</tbody>
</table>

57. How many friends do you have who have skills and experience to startup a company?
Mark only one oval.

<table>
<thead>
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<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>About half of my friends</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

58. Do you gain confidence to do things from what your friends do?
Mark only one oval.

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<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Definitely YES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

59. How often do you and classmates get to "make" or develop products in your college?
Mark only one oval.

<table>
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<tr>
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<th>10</th>
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</thead>
<tbody>
<tr>
<td>Never</td>
<td>Quite often</td>
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</tbody>
</table>
EMOTIONAL STATES

60. How often have people directly or indirectly encouraged you to create products?
Mark only one oval.

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</tr>
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<tbody>
<tr>
<td>Never</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very Often</td>
</tr>
</tbody>
</table>

61. How often have people directly or indirectly encouraged you to start up a company?
Mark only one oval.

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<thead>
<tr>
<th></th>
<th>0</th>
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<th>10</th>
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</thead>
<tbody>
<tr>
<td>Never</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very Often</td>
</tr>
</tbody>
</table>

62. How is your capacity to work at vigor and dynamism even under stressful periods?
Mark only one oval.

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<thead>
<tr>
<th></th>
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<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Excellent</td>
</tr>
</tbody>
</table>

ABOUT THE SURVEY

63. How well did the survey cover Innovation, Fabrication & Entrepreneurship?
Mark only one oval.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Not Well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very Well</td>
</tr>
</tbody>
</table>

64. Was the survey easy to understand?
Mark only one oval.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
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<tbody>
<tr>
<td>Very Difficult</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very easy to follow</td>
</tr>
</tbody>
</table>

Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
65. Do you have anything to add to this survey?
Please give your thoughts on how this survey may be improved.

THANK YOU

Thank you for completing the survey.

Best regards,

Rajesh Nair
MS Candidate (System Design and Management)
Fellow, Tata Center for Technology and Design
Email: r.nair@mit.edu
Phone: +1 603-566-9638

Rajesh Nair
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Fellow, Tata Center for Technology and Design
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Phone: +1 603-566-9638
Appendix D: SURVEY 2
Entrepreneurial Attitude Survey
Pre-Program

This survey is done as a part of my research at Massachusetts Institute of Technology to understand change in entrepreneurial attitude among engineering students after exposure to innovation, fabrication and entrepreneurship practices.

Participation in this survey is voluntary. You may decline to answer any or all questions. You may decline further participation, at any time, without adverse consequences. Your confidentiality and/or anonymity are assured.

Please read the instructions for each question carefully, marking your responses and reviewing your answers for correctness. Within this survey there are no right or wrong answers and it would be appreciated if you answered all questions honestly and accurately as possible.

The survey will take about 15 minutes to complete. The information you provide will be treated in complete confidence and your identity will not be revealed. The only reason we ask for your name is to link the different surveys together.

If you have any questions, please contact me at rajnair@mit.edu.

Please proceed if you are willing to participate in this research.

Thank you,
Rajesh Nair
MS Candidate in System Design and Management Program
Massachusetts Institute of Technology

(This survey was developed with a lot of help from Dr. Shima Barakat of University of Cambridge. It was adapted from the Callino Participant Survey from Centre for Entrepreneurial Learning, Judge Business School at University of Cambridge. This survey has material that is the copyright of the EHGI group and the Cambridge-MIT Institute.)

<table>
<thead>
<tr>
<th>Q1</th>
<th>1. Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q2</th>
<th>2. Gender?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>Female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q3</th>
<th>3. Age.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10. What is the highest level of education of either of your parents?
- High School
- Bachelor degree
- Masters degree
- PhD

11. What discipline are you pursuing for your degree?
- Mechanical
- Electrical & Electronics
- Electronics & Communication
- Computer Science
- Civil Engineering
- Information Technology
- Other (Please Specify)

12. Your year of study at college?
- Freshman (First year)
- Sophomore (Second year)
- Junior (Third Year)
- Senior (Fourth year)

13. How many members make up your permanent household, including you?

14. How many siblings (brothers & sisters) do you have? (number excluding you)

15. Which, if any, of the following people have ever run their own business? (Select yes or no. If Yes how often did you talk to them about their business).

<table>
<thead>
<tr>
<th>Run their own Business</th>
<th>Spoke to them about their business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Never</td>
<td>Almost never</td>
</tr>
<tr>
<td>a. Father</td>
<td>Yes</td>
</tr>
<tr>
<td>b. Mother</td>
<td>Yes</td>
</tr>
<tr>
<td>c. Mentors</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Q16
16. Compared to other students in your college, where do you feel your family's annual income stands?
- Bottom 25% group
- 25-50% group
- Average
- 50-75% group
- Top 25% group

Q17
17. Have you ever taken a module/course in Enterprise/Entrepreneurship/Business development before?
- No
- Yes, one course
- Yes, More than one course

Q18
18. Do you have an idea for a Project/Business?
- No (Please skip to next section)
- Only a vague idea
- Yes, but the details are not clearly identified
- Yes, and many of the details have been thought about and investigated
- Yes and already running Project/Business

Q19
Cultural Influence
Please answer these questions and check your answer in one of the cells.

| a. How often have you thought about starting a company in the past three years. |
|-------------------|---|---|---|---|---|---|---|---|---|---|
| Never 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |
|   |   |   |   |   |   |   |   |   |   |

| b. Do you know personally anyone who has started businesses in the past 2 years? |
|-------------------|---|---|---|---|---|---|---|---|---|---|
| Never 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |
|   |   |   |   |   |   |   |   |   |   |
Self-Rating Skills and Abilities

Q19 Where on the scale would you rank your current skills and abilities? Please estimate where you believe you rank compared to your peers.

- Start a successful business if you want to.
- Do able to persuade colleagues or managers they should take a new idea seriously.
- Analyze an abstract concept or idea in a real problem or situation.
- Start a successful social enterprise if you want to.
- Work on collaborative projects as a member of a team.
- Recognize a good opportunity if you see it.
- Motivate others to work together.
- Lead a group with members who strongly disagree with one another.
- Understand what it takes to start your own business.
- Create novel solutions to problems.
- Understand the languages of new ventures creation.
- Understand what it takes to start your own social enterprise.

Self-Assessment of more Specific Skills and Abilities

Q20 These questions ask you about your confidence in how you perform specific tasks. For each statement below select a number from 0% to 100% to indicate how confident you are that you could perform that skill or ability now. (Choose one response for each statement.)
<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Recognize when an idea is good enough to support a new project or venture.</td>
</tr>
<tr>
<td>b.</td>
<td>Write a clear and complete business plan.</td>
</tr>
<tr>
<td>c.</td>
<td>Estimate the number of people who are likely to buy a new product or service.</td>
</tr>
<tr>
<td>d.</td>
<td>Know how much to place the proper financial value on a startup company.</td>
</tr>
<tr>
<td>e.</td>
<td>Get suppliers to support venture with favorable prices and contract terms.</td>
</tr>
<tr>
<td>f.</td>
<td>Persuade someone to put a sum into a new company.</td>
</tr>
<tr>
<td>g.</td>
<td>Meet with users and then write a set of clear requirements for a product to meet their needs.</td>
</tr>
<tr>
<td>h.</td>
<td>Have a new product concept based on a technology and have a rough idea if it's practicable.</td>
</tr>
<tr>
<td>i.</td>
<td>Translate functional requirements for a product into a design of a prototype.</td>
</tr>
<tr>
<td>j.</td>
<td>Lead a technical team developing a new product to a successful result.</td>
</tr>
<tr>
<td>k.</td>
<td>While reviewing a familiar article, recognize an implication not mentioned in the readings.</td>
</tr>
<tr>
<td>l.</td>
<td>Be aware of feelings of all the members of a group working on a shared task.</td>
</tr>
<tr>
<td>m.</td>
<td>Find an approach.</td>
</tr>
</tbody>
</table>
### Attitudes Towards Future Work Environments

Q21 Please indicate to what degree you disagree or agree with each of the following.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The idea of high-risk, high-pay entrepreneurs appeals to me.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>b. The idea of starting a company does not appeal to me.</td>
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<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>c. The experience of starting a company is valuable even if you fail.</td>
<td>()</td>
<td>()</td>
<td>()</td>
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<tr>
<td>d. I often think about ideas and ways to start a business.</td>
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<tr>
<td>e. It would kill my current job.</td>
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<td>f. I would kill my current job to start a new business that bored.</td>
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<td>g. At least once I will have to take a chance and start my own company.</td>
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<td>h. I am willing to pay a high premium price for a chance to get wealthy.</td>
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<tr>
<td>i. The idea of investing in a big company into new markets excites me.</td>
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<td>j. Starting a company is too much like betting against the odds.</td>
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<td>k. If I have an opportunity to start a company, I'll take it.</td>
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<td>l. I would be reluctant to start a company even if I had a really good opportunity.</td>
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</table>
### Q22

**Q22 How likely are you to do the following in the future? Choose one response for each statement.**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all likely</th>
<th>Not very likely</th>
<th>Somewhat likely</th>
<th>Quite likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Continue studying or study for a higher/advanced degree.</td>
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<tr>
<td>b. Pursue/already pursue a teaching career.</td>
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<tr>
<td>c. Pursue/already pursue a career in academic research.</td>
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<tr>
<td>d. Pursue/already pursue a career in industrial research.</td>
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<tr>
<td>e. Pursue/already pursue a career in business.</td>
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<tr>
<td>f. Set up/already set up your own company.</td>
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<tr>
<td>g. Join/already in a company as an employee.</td>
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</tbody>
</table>

### Creative Skills

**Q23 How do you rate your ability to.....**

<table>
<thead>
<tr>
<th>Task</th>
<th>Poor</th>
<th>Not very good</th>
<th>Adequate</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Demonstrate originality in your work.</td>
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<tr>
<td>b. Take risks in terms of producing new ideas in doing a job.</td>
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<tr>
<td>c. Find new uses for existing methods or equipment.</td>
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<tr>
<td>d. Solve problems that have caused others difficulty.</td>
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<tr>
<td>e. Try out new ideas and approaches to problems.</td>
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<tr>
<td>f. Identify opportunities for new products/processes.</td>
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<tr>
<td>g. Generate novel but operable business-related ideas.</td>
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<tr>
<td>h. Serve as a good role model for creativity.</td>
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<tr>
<td>i. Generate ideas revolutionary to the field you are in.</td>
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</table>
Q23 How important do you feel are the following traits? Drag and drop in order of priority from highest to lowest

1. Finding solutions to complex problems.
2. Coming up with new ideas for products.
3. Engaging in analytical thinking.
4. Creating new procedures for work tasks.
5. Improving existing processes or products.

Q24 When working in a team how do you rate your ability to...

- Poor
- Not very good
- Adequate
- Good
- Very Good
- Excellent

a. Demonstrate originality.
b. Take risks in terms of producing new ideas.
c. Find new uses for existing methods or equipment.
d. Solve problems that have caused others difficulty.
e. Try out new ideas and approaches to problems.
f. Identify opportunities for new products/processes.
g. Generate novel but operable work-related ideas.
h. Serve as a good role model for creativity.
i. Generate ideas revolutionary to our field.

Q25 To what degree do you agree or disagree with the following statements.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree

a. I enjoy working within a team.
b. I am a good team worker.
c. I find it easy to solve problems within a team.
d. Within a team I take a leading role.
e. I find it easy to balance different ideas within a team.
f. I find it difficult to deal with disagreements within a team.

Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
Innovation

Q26 How do you rate your ability to...

<table>
<thead>
<tr>
<th></th>
<th>Poor</th>
<th>Nor very good</th>
<th>Adequate</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Apply new ways to achieve goals or objectives.</td>
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<td>b. Apply new and practical ideas.</td>
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<td>c. Apply new technologies, processes, techniques, and/or product ideas.</td>
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<td>d. Apply new ways to increase quality.</td>
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<tr>
<td>e. Apply creative solutions to problems.</td>
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<td>f. Apply a fresh approach to problems.</td>
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<tr>
<td>g. Apply and champion ideas to others.</td>
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</table>

Q27 Quality of this survey

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<thead>
<tr>
<th></th>
<th>Difficult 0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>Easy 100%</th>
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<tbody>
<tr>
<td>How well do you rate your understanding of the language of this survey?</td>
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<td>Difficulty in completing this survey?</td>
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<tr>
<td>Ease to understand the questions?</td>
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Appendix D: CALL FOR APPLICATIONS

The notice posted to invite students of Mar Baselios College to apply for the workshop.

DO YOU WANT TO LEARN TO DESIGN & FABRICATE COOL PRODUCTS, AND START YOUR FIRST STARTUP COMPANY?

THE WORKSHOP

This is a two-month long workshop where you will learn to:

- Look for problems and evaluate them for financial opportunity and social impact
- Ideate and architect multiple solutions
- Develop physical products with mechanical, electronics and software
- Learn to prototype circuit boards and 3D print parts
- Validate your solution in the field
- Evaluate business opportunity and create business plan
- Pitch your ideas and launch your company

We are looking for 20 students from MBCET in first to final year of study and all disciplines of engineering. No previous exposure to innovation or entrepreneurship programs necessary.

There will be no charge for those selected to attend this workshop.

COMMITMENT FROM THE STUDENT

- This workshop workload is in addition to your regular class work
- The program will require 6-10 hours of work each week including instruction time and lab hours.
- Must maintain satisfactory performance in your regular courses to continue on the program and must show good conduct.
- You must stay and complete the workshop.

HOW TO APPLY

Create a 1-minute video about "Why you want to attend this Innovation and Entrepreneurship workshop".
Post it on YouTube.

Fill in application form at: http://tinyurl.com/MBCETWorkshop
And place link to your YouTube video in the space provided.

DEADLINE FOR APPLICATION: October 11 2013

Workshop on Innovation and Entrepreneurship

This workshop is conducted as part of a research program at Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

December 2013- January 2014
A1 Mar Baselios College of Engineering and Technology, Trivandrum, Kerala.
Appendix E: LIST OF PROJECTS FROM THE WORKSHOPS

Projects from Mar Baselios College Trivandrum:

1. **Digital Stethoscope**: Can a remotely located healthcare provider hear heartbeat over the web? This instrument was designed as the first of a list of devices for telemedicine.

2. **Detection of Apnea in Neonatal babies**: About 3 million premature babies are born in India every year. About 2.5 million suffer from Apnea that can cause death. This boot worn by the baby monitors blood oxygen content and wakes the baby in the middle of an apnea attack to protect the child.

3. **Low-cost Digital Medical Records**: How can stacks of medical documents of patients be scanned and sorted to make medical visits more productive. This team created a cellphone based scanning system that stores document images in a database on the cloud. The Aadhar number is used as the unique ID.

4. **Vein Finder**: To find the veins of a person during IV cannula using infrared imaging.

5. **Multi-Patient Care Cart**: How can a nurse service multiple patients in one trip? This cart helps keep track of medicines and care devices for each patient in separate drawers that open only with unique patient ID.

6. **Monitoring cotton swabs**: Misplaced tools or cotton swabs create problem for surgeon and patients. This device locates RF enabled scabs.

7. **Inflatable braces for use at accident site**: Low cost, light and inflatable braces for limbs, body, head and neck, that offers right solutions at accident sites.

8. **Feeding apparatus**: A programmable device that can deliver liquid food at the right rate to the patient.
9. **Automated pill dispenser**: Equipment that can keep track of medication schedule and provide the right medicine at the right time and record events.

10. **Drip-rate meter for Intravenous fluid infusion**: A device that displays drip rate on standard IV systems and control to preset levels.
Projects from Shri Ram Group of Colleges, Muzaffarnagar:

1. **Freshness detection of cut sugarcane**: Sugar mills cannot identify fresh cut cane from stale. But the production quality is affected by old cane. This device detects stale canes in seconds.

2. **Dust monitor in factories**: Alarming the factory workers about the dust level helps them remember to wear the mask. This device shows dust level as visual alarm.

3. **Sugar crystal analyzer**: Sugar crystallization process is done to achieve crystals at certain required sizes but currently it is visually estimated. This device measures sugar crystal sizes using computer imaging.

4. **Cooling Helmet**: Factory workers do not wear safety helmets, protection glass or dust mask because it is hot in the factory floor and is very uncomfortable to wear them. This helmet blows filtered air so the head is kept cool and eyes are protected with an attached visor and dust is kept out.
5. **Moisture meter for bagasse**: A handheld device that can measure moisture of bagasse used as fuel for power cogeneration plant or as raw material for paper plant.

6. **Remote controller for tube-well pumps**: The farmer walks to the farm to power on or power off tube-wells. It gets more difficult due to constant power interruption. This device enables the farmer to control the tubewell over mobile phone.
7. **Low cost water filter**: Porous clay pot made with husk and clay acts as water filter. In addition a solar powered UV LED kills microbes making it usable in villages where clean water is not available.

8. **Dung cake maker**: Villagers make dung cakes for use as fuel. This device helps increase the productivity and is less stressful on the women that make them.
9. **Manual sugarcane cutter**: This device is a foot-operated cutter that reduces the physical strain on the farmer.

10. **Power source for rural application**: A simple dynamo based device that can be attached to any rotating machines, such as sewing machine, can be used to charge cell phones or LED lamps.
Appendix F: ANALYSIS OF SURVEY RESPONSE BY GENDER

The following are the eight questions selected for this study to evaluate change in confidence in critical factors that influence entrepreneurship attitude.

1. How qualified do you feel you are to start a new business?
2. How is your capability to invent and design new products?
3. How confident do you feel about your capability to identify new market opportunities?
4. How confident do you feel about your capability to explain and convince someone of your idea?
5. How confident do you feel about your capability to estimate cost of starting a venture?
6. How confident do you feel about your capability to know if an opportunity is worth investing money in?
7. How confident do you feel about your capability to develop a business plan?
8. How confident do you feel about your capability to estimate the market potential for a product or service?

The answers to each of the eight questions listed from Trivandrum and Muzaffarnagar workshop surveys are shown in the following pages. The order of the graphs in each case is:

1. Graph 1 shows the average of the confidence shown by men, women and all
2. Graph 2 shows the distribution of confidence levels for all students before and after the workshops.
3. Graph 3 shows the distribution of confidence levels for male students
4. Graph 4 shows the distribution of confidence levels for female students
1. How qualified do you feel you are to start a new business?
   - This question probes the awareness of the steps or process of startup and the confidence that the student feels about starting up.
   - Average shift in confidence for the whole group is 3.14 in a 10-point scale.
   - Female students started at a lower point compared to male students.
   - Both male and female students showed a positive change of about 3.1.
   - The distribution curves show this shift clearly.

**Ability to Startup (Trivandrum)**

- **Score Distribution Plots**
  - Male: Pre: 6.26, Post: 4.07
  - Female: Pre: 3.14, Post: 4.77
  - All: Pre: 6.81, Post: 4.77

- **Count Plots**
  - Male: Pre: 4, Post: 6
  - Female: Pre: 3, Post: 6
  - All: Pre: 3, Post: 6

**Ability to Startup (Muzaffarnagar)**

- **Score Distribution Plots**
  - Male: Pre: 4.77, Post: 6.52
  - Female: Pre: 5.81, Post: 6.52
  - All: Pre: 5.81, Post: 6.52

- **Count Plots**
  - Male: Pre: 2, Post: 6
  - Female: Pre: 1, Post: 6
  - All: Pre: 2, Post: 6
2. How is your capability to invent and design new products?
   - This question covers both perceived skill levels and individual confidence of
     the student to design and develop products
   - Both male and female students showed an improvement in their confidence in
     developing new products by about 1.7.
   - Female students showed a change of 2.2 as compared to male students (1.3)

Capability to Invent and Design Products (Trivandrum)

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<tr>
<th>Score</th>
<th>Pre - All</th>
<th>Post - All</th>
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<tbody>
<tr>
<td>10</td>
<td>5.43</td>
<td>6.37</td>
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<tr>
<td>8</td>
<td>3.22</td>
<td>4.71</td>
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<tr>
<td>6</td>
<td>5.80</td>
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<tr>
<th>Score</th>
<th>Pre - Male</th>
<th>Post - Male</th>
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<tbody>
<tr>
<td>10</td>
<td>5.32</td>
<td>6.67</td>
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<tr>
<td>8</td>
<td>4.59</td>
<td>5.52</td>
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<td>6</td>
<td>5.14</td>
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<th>Post - Female</th>
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<td>7.58</td>
<td>8.21</td>
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<tr>
<td>8</td>
<td>7.11</td>
<td>7.67</td>
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<td>6</td>
<td>7.14</td>
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Capability to Invent and Design Products (Muzaffarnagar)

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<th>Pre - All</th>
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<td>6.35</td>
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<tr>
<td>8</td>
<td>4.88</td>
<td>5.14</td>
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<tr>
<th>Score</th>
<th>Pre - Male</th>
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<tbody>
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<td>10</td>
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<th>Score</th>
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<th>Post - Female</th>
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<td>6</td>
<td>7.14</td>
<td>7.58</td>
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</table>
3. How confident do you feel about your capability to identify new market opportunities?

- The workshop covered identification of problems and evaluating these as opportunities with financial promise or/and social impact
- Financial opportunity, TAM, SAM, SOM
- Value proposition, price threshold, value to customer

**Identification of New Market Opportunities (Trivandrum)**

![Graphs showing scores and counts for female, male, and all participants pre and post](image)

**Identification of New Market Opportunities (Muzaffarnagar)**

![Graphs showing scores and counts for female, male, and all participants pre and post](image)
4. How confident do you feel about your capability to explain and convince someone of your idea?

- Basics of pitching (Hook, Constraint, Solution, Impact)
- Team and individual pitching of ideas
- Short elevator pitch and longer business pitch
- Daily presentation practices

Communication Skills (Trivandrum)

![Graphs showing communication skills scores for Trivandrum](image)

Communication Skills (Muzaffarnagar)

![Graphs showing communication skills scores for Muzaffarnagar](image)
5. How confident do you feel about your capability to estimate cost of starting a venture?
- Cash flow, operational costing, financial planning,
- Corporate structures, shareholder, BoD, management
- P&L, Balance sheet

**Venture Planning (Trivandrum)**

[Graphs showing score distribution for Venture Planning (Trivandrum) comparing Pre and Post assessment for different categories (Female, Male, All).]

**Venture Planning (Muzaffarnagar)**

[Graphs showing score distribution for Venture Planning (Muzaffarnagar) comparing Pre and Post assessment for different categories (Female, Male, All).]
6. How confident do you feel about your capability to know if an opportunity is worth investing money in?
- Market analysis: Competition, alternate methods, barriers to entry
- SWOT analysis
- Investment, Growth, Exit strategy

Investment Opportunity Evaluation (Trivandrum)

Investment Opportunity Evaluation (Muzaffarnagar)
7. How confident do you feel about your capability to develop a business plan?
   - Understanding one’s business: customer, channel, offering, pricing, investment
   - Presenting to promoters and investors
   - Financial planning, business strategy

**Capability to Develop Business Plan (Trivandrum)**

**Capability to Develop Business Plan (Muzaffarnagar)**
8. How confident do you feel about your capability to estimate the market potential for a product or service?
- Current market, future markets, pivoting
- Core competency, new applications, ways to reach market
- Understanding stakeholders
- Value proposition

Market Potential Evaluation (Trivandrum)

Market Potential Evaluation (Muzaffarnagar)

Catalyzing Entrepreneurship from the Ground Up: An Experiment in Small-Town India
Appendix G: LETTER FROM PRINCIPAL OF MBCET COLLEGE

03 March 2014

MIT-Tata Center Workshop on Innovation, Fabrication and Entrepreneurship

Background

MBCET is an Engineering College located in the city of Trivandrum, in the southern tip of Indian continent, which was established in 2002. We offer Bachelor’s degree programs in Engineering disciplines such as Civil, Mechanical, Electrical, Electronics & Communication, Computer Science and Information Technology. We also offer Master’s degrees in Power Control and Drives, Control Systems, Computer Science and Engineering, Telecommunication, Signal Processing, Structural Engineering and Machine Design.

Kerala is a state with 100% literacy but low entrepreneurship. Students from Universities in Kerala primarily look for job after their graduation. MBCET has had only very few students that created their startups while studying in College since the college started. When Mr. Rajesh Nair, who is doing this as part of his MS thesis, proposed the idea of holding this workshop for coaching students on the process of innovation, fabrication & entrepreneurship, so they can startup while during their time in college, I found it quite attractive and agreed to host the workshop.

The Workshop

50 students from all engineering disciplines and academic years were selected through an application process that tested primarily for their personal drive and not for academic performance.

Mr. Nair brought equipment such as 3D printer, CNC milling machine, vinyl cutter and an extensive inventory of electronic and mechanical components.

The college prepared a 1600 square-foot room specifically for this workshop. It housed the daily classes, group meetings, and the fabrication lab. Having dedicated space helped the students use it as their own workspace during the workshop.

The workshop was held between 7 Dec 2013 and 25 Jan 2014.

Mr. Nair worked closely with me during this period such that the College could extend the maximum help for the workshop.
The ten teams of five each were taken through three cycles of problem identification, solution creation, product fabrication, and business pitch. The thirty projects went from simple mind exercise & technology learning, to intense product design and market analysis. The final projects were demonstrated to the faculty, rest of the student body and the public in the closing day. The students pitched their products and business venture to local government agencies, entrepreneurs and investors.

**After the Workshop**

The impact this workshop had on the students is spectacular. The energy for pursuing entrepreneurship has significantly increased among students.

- The college is planning to convert the workshop facility into the Innovation and Entrepreneurship Centre for the college.
- The initial fifty students will form the entrepreneurship club that will report to me. They will expand the clubs to train more students from the College.
- We will acquire fabrication equipment similar to what Mr. Nair brought and set up a Fabrication Lab at the centre.
- As of now, six teams have launched their startup venture and a few more are in the planning stages.
- Any student member of these startups will receive 20% attendance and 4% marks as bonus, as specified by the University of Kerala guidelines.
- These students are planning to avail incubation facilities offered by the Government of Kerala to build their companies faster while they are completing their degree.

The College and I personally would like to thank Massachusetts Institute of Technology- Tata Center for conducting such a workshop at MBCET. This was an eye opener and an extraordinary experience for the students. The initiative that was started by this program has made a significant change in the attitude of not only the participants but the student community as a whole. More students are coming forward with their ideas to start companies as never before. I would like to see this as a change in the college where an average student has transformed from a potential job seeker to a job maker.

With best regards

Dr T M George
Principal
Mar Baselios College of Engineering and Technology
Appendix H: ANALYSIS OF PREDICCTOR FACTORS OF CHANGE

Two MIT graduate students Andrew Radin and Ellen Chen took up the analysis of the data from the two workshops to identify any predictor to the final change experienced. This was done as their final project for the course *The Analytics Edge* (15.071).

We attempted to use data from the initial survey to try and predict improved confidence, we chose to use the change in “How confident do you feel about your capability to start a new company?” as our dependent variable.

Instead of trying to predict the exact absolute change, we decided to try to predict whether or not the change would be above a certain level. In this case we chose >2 as that level because we believed this would signify a significant increase in confidence. We still predicted the absolute level and then assigned a 1 if it was >2 (a success) or a 0 if it was <=2.

**Baseline Model**

As a simple baseline model we predicted that all students would have a < 3 change (or a 0) in confidence, which breaks down to the following confusion matrix with an accuracy of 0.65.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>34</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>0</td>
</tr>
</tbody>
</table>

This provides a good baseline model to benchmark against, but would not be helpful in the real world as we cannot assume that all students will not have a meaningful change in confidence from this workshop when 35% of students actually did.

**Determining Useful Independent Variables – Visualization & Linear Regression**

We approached determining our useful independent variables through visualization and linear regression\(^1\). We started with mapping all potentially useful independent variables against the change in confidence followed by a linear regression as displayed in the following chart. In the chart we have three examples comprising:

- **a not useful variable** (knowCo0: the data is relatively stochastic, the t-statistic is much greater than 0.05, and the adjusted R-squared, or its predictive power on its own, is just 1%)
- **a useful variable** (fearPrevent0: there is a linear relationship, the t-statistic is less than 0.05, and the adjusted R-squared is 7.8%)
- **a potentially useful variable that we believe is endogenous** (confBPlan0: strong linear relationship, very low t-stat, adjusted r-squared of 35%, however we believe confidence to develop a business plan is autocorrelated to confidence to start a business and thus not useful)

\(^1\) Note that we initially considered using logistic regression as well, but after plotting the variables there did not appear to be any exponential relationships.
Most of the variables appeared fairly stochastic (or random), but there were a few variables that appeared to be linearly correlated per the following table:

| Variable Name                | Pr(>|t|) | Adjusted R-squared |
|-----------------------------|---------|--------------------|
| knowCo0                     | 0.213   |                    |
| fearPrevent0                | 0.0265  |                    |
| confBPlan0                  | 0.000003|                    |
| relativeIncome              | 0.1489  | 0.0712             |
| bizDiscuss0                 | 0.0219  | 0.8608             |
| fearPrevent0                | 0.0265  | 0.0781             |
| relativeIncome              | 0.0090  |                    |
| relativeIncome              | 0.0380  |                    |
| relativeIncome              | 0.1286  |                    |

However, when we ran a linear regression on the aforementioned variable, our R-squared was quite low (0.2926), thus not particularly predictive of the exact absolute change. But as mentioned, we wanted to predict success (or a >2 change). When we compared these numbers, our accuracy was relatively high (76%), however when tested this model against our test dataset, the accuracy was much lower (57%). Comparing this to the baseline model (which has a 65% accuracy) we would be more accurate by assuming all students would not have a significant change.

We used other modeling techniques as well including CART, random forest, and clustering. Each of these models suggested alternative predictive variables than the linear regression model did which indicated to us that there are not clear predictive variables. In addition, the accuracy of these models was relatively low compared to the baseline.

Given that there were not clear predictive variables across the modeling techniques and the accuracy of prediction was relatively low, we determined that there are not clear patterns in the
data across both sets. In other words despite the demographic and pre-workshop information we have about the students, we cannot predict success (a change in confidence >2) with any assuredness.
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