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Effective Communication:
The What, Why, and How of Entrepreneurship

Entrepreneurship is increasing in importance and presents a good career opportunity for engineering students. Engineering schools should imbue an understanding of entrepreneurship, knowledge of why it is important, and a sense of how students might go about pursuing it. This article discusses some aspects of this challenge for engineers and, particularly, for engineering educators.

WHAT IS ENTREPRENEURSHIP?

The *Merriam-Webster Dictionary* definition of entrepreneur is "one who organizes, manages, and assumes the risks of a business or enterprise." Each of these words is important. Entrepreneurship occurs in a business context, meaning the objective is to sell a product or service and make a profit. In business, risk is associated with uncertainty, which most commonly arises from investing in a product or service without assurance of sales and profits, usually implying that the product or service is new and innovative so that there is limited experience to draw upon. Assumption of risk is particularly significant because it means that the entrepreneur himself/herself stands to lose something, whether it is money or reputation (fortunately, financial risk is often assumed by the organization). Including the words *organization* and *management* imply that the entrepreneur is the leader, the one who sets the agenda.

Entrepreneurship can happen in any business context, all the way from large corporations to start-up companies. Large companies can afford to take on large opportunities, in terms of scope or needed resources, whereas start-up companies are the best way to pursue point solutions that extend an existing context or pursue ideas that are more radical and yet require fewer resources. Large companies often encounter difficulties executing new ideas because it is difficult to change the direction of an existing organization. For basic questions that help judge the level of entrepreneurship in a large company, see the "How to Judge Entrepreneurship in a Large Company" sidebar. The most effective way to pursue a new idea is by starting with the germ of the idea and then attracting people who are excited and committed to making it happen. That can happen in large companies, but the path is smoothest in a start-up. Although a start-up doesn't necessarily have more talented people, it typically has more focus on customer needs in order to ramp up sales quickly. Many students start their professional careers with large corporations, and some leave to become entrepreneurs, starting up new businesses lacking the resources of a large company.

Entrepreneurship is hard and perceived risks are high [1]. Entrepreneurs usually need the motivation that comes from pursuing one's own great ideas rather than somebody else's. One reason entrepreneurship is hard is that the idea is only a seed, a starting point, and technology is an enabler but only part of the challenge. Subsequent to the idea, a lot of innovation is needed, and making the idea work in the real world is challenging. There is a wealth of issues that have to be dealt with, including financing the venture. Many of these are listed later.

"DSP Education" continues the cycle on "Effective Communication," which includes articles on technical presentations, technical writing, preparation for entrepreneurship, and technical management. We invite you to send suggestions for new topics and/or authors, and general feedback by e-mailing SPM_columns_forums@yahoo.com.

HOW TO JUDGE ENTREPRENEURSHIP IN A LARGE COMPANY

■ What fraction of sales come from products that appeared in the past two years?
■ How many customers have you personally interacted with in the past year?
■ What new partnerships have been created in the past two years?

WHY ENTREPRENEURSHIP IS IMPORTANT

Entrepreneurship is increasingly important, in developed countries as well as in developing countries. Government statistics suggest that 10% of all jobs in the U.S. economy are with companies that have been in business five years or less, and this percentage is growing. The opposite, low-risk execution on well-specified tasks is something that lower-wage countries can execute effectively, especially in light of advances in transportation and communications that have effectively shrunk the world. Commoditization of older technologies focuses competitive juices on cost reduction. If students in developed and developing nations want to assure

themselves of satisfying and well-paying careers for the long term, they need to be the ones who come up with new ideas and refine them in close contact with the users and the market, who organize and manage the realization of those ideas, who assume risk while seeking return, and who decide what to outsource. In other words, they need to be entrepreneurs of some form. They will also find satisfaction in helping their own nation maintain its economic standing in the world.

A more immediate reason why entrepreneurship is important is the maturation of a variety of segments of our information and communication technologies. We now have a rich and comprehensive set of technologies to work with, and they are cost effective and have sufficient performance for most purposes. In the application domain, most of the "low hanging fruit" of automation or digitization of existing functions has been "picked, sold, and eaten." Continued technological advance is essential, of course, but in the future the most important and challenging task facing information technologists is identifying new applications; that is, doing old things in new ways, or new things. Note the word "new" here, since in a business context this implies entrepreneurship.

MOTIVATIONS FOR ENTREPRENEURSHIP

Graduating engineering students need to decide whether they want to enter a job that executes well-specified designs, to become entrepreneurs, or to do something in between. Often they will take conventional jobs in large businesses or laboratories to gain experience and

maturity and later migrate to entrepreneurship in smaller companies with far less resources. There are also intermediate possibilities, like working for an entrepreneur rather than necessarily being one, or working in a large business that has a start-up culture.

Why would a student want to become an entrepreneur? The most successful entrepreneurs are the ones

> **ENTREPRENEURSHIP CAN HAPPEN IN ANY BUSINESS CONTEXT, ALL THE WAY FROM LARGE CORPORATIONS TO START-UP COMPANIES.**

who set out to "change the world for the better" and yet are realistic and pragmatic. That is why so many entrepreneurs move from one opportunity to another, and ultimately retire to spend most of their time helping younger entrepreneurs with money or shared experience. Some entrepreneurs are exercising a social conscience and just want to make a difference, while others crave doing something new and untried. Sometimes the motivation is the independence of not having a boss (although in reality everyone has a boss, even if it is a board of directors). Entrepreneurship can be financially rewarding, but students should be aware that the path to success is iffy; this is where risk sneaks in. Anecdotal statistics for successful early-stage venture capital funds suggest that approximately one-third of the investments are written off as complete losses, one-

third return some modest amount, and one-third pay for all the rest many times over. Thus, the odds are against an entrepreneur helping create a successful business or even being backed by a successful fund. This applies to each venture, so entrepreneurs who fail or have modest success often learn from experience and try again. Cultures and countries that are most successful at stimulating entrepreneurship are those that don't punish failure, viewing it realistically as an inevitable consequence of risk and as a valuable learning experience that is likely to enhance future success.

An engineering education can encourage entrepreneurship by instilling a social conscience in students, a sense that the ultimate goal and reward of engineering is applying scientific principles to the betterment of society, but also awareness that misguided efforts can do harm. There are many compelling examples of both betterment and harm to draw upon in the curriculum.

WHAT INVESTORS LOOK FOR

With rare exception, anybody who wants to start their own company to pursue a new idea will need investors who supply the capital necessary to undertake significant efforts, taking part ownership in return for assuming financial risk. One exception consists of companies requiring modest funds (typically from the founders, their friends, and families) who attract early customers and become self-funding. Another exception consists of companies that receive government funding; for example, the U.S. military has provided early-stage funding for many businesses to pursue new technologies, like the Bose Corporation that started with military contracts and subsequently moved into commercial markets.

Generally investors look for three things. First is the quality of the people. Are they smart and committed and are they realistic about the full spectrum of issues they must deal with? Do they recognize their own strengths and weaknesses, and will they function as a

> **WHAT A VENTURE CAPITALIST MIGHT ASK YOU BEFORE MAKING AN INVESTMENT**
> - Who will pay for your idea, why, and how much?
> - Who are the competitors (established companies and start-ups)?
> - Who is in your team and what skills have they demonstrated?
> - How and why will your team beat the competition?
> - How will you deal with challenges that arise?
> - Have you ever failed in business? What did you learn from this?
> - How much investment is required to reach positive cash flow?

team to fill any gaps? Second is a promising idea for a product or service, one that is new and different, not subject to competition from established players, and hopefully includes intellectual property protection that will undermine new forms of competition. Third is a market for the product or service. There should be qualified customers who want the product or service and are willing to pay enough to ultimately yield a profit. For typical questions an entrepreneur should be prepared to answer, see the "What a Venture Capitalist Might Ask You Before Making an Investment" sidebar.

Engineering education can help by teaching that it is not just about design, but also about the design of something that customers actually want. The ultimate test is receiving multiple orders from or purchases by customers. If the customer is another engineer, this is relatively easy. But when the targeted user or customer falls in an entirely different group, the challenging task of establishing "need" and "want" is not addressed sufficiently in engineering curricula. Educators can help by providing project experiences where students practice serving a need for others, such as students from other disciplines, university staff, or citizens in the surrounding community.

COMING UP WITH THAT IDEA

Innovation can be taught. Of course, some people are intrinsically more creative that others, but anybody can enhance their creativity [4]. Some ideas just come out of the blue, but there are also simple and systematic paths to innovation. First, students should be strongly encouraged to pursue diverse interests. Without exception, an outside interest, whether it be sports or music or public policy or just hanging out with friends, can be turned into an opportunity to apply information technology in new ways. Social networking sites like MySpace arose because students pondered better ways to support and extend their social group. Students interested in popular media (music, video, and movies) may identify new opportunities for signal processing innovations. All

they have to do is be observant and critical. They should ask what is going on, and how can it be done better or differently by leveraging an understanding of technology? Project experiences can also mix students who care deeply about some application domain with students who know a lot about technology and allow them to practice merging their perspectives to invent and develop new ideas. Before considering joining an entrepreneur's team after graduation or beyond, see the "What to Ask an Entrepreneur Before Joining His or Her Team" sidebar for some questions to ask.

Taking something that exists and extending it is a great source of ideas, one that is especially valued by investors because the idea in a sense comes prequalified. This can take the direction of doing something better for existing users (like the iPhone) or identifying new uses or users for something that already exists. There are great examples of ideas that didn't require technological advance, but just made an existing concept more attractive to new people. The Nintendo Wii, for example, specifically targeted groups previously clueless about gaming and succeeded in drawing many in by simplifying and extending the human interface and providing entirely new genres of games.

Another path to innovation is thinking about how we arrived where we are, and asking what alternative paths could have been pursued and whether they might be better. In some cases, the path was rather arbitrary, and in other cases our predecessors were enlightened and constrained. For example, we don't use electronic components much anymore. Is that because they no longer make sense, or because we failed to update the concept with advances in semiconductor and software technology?

There are other means to innovation that don't require much thinking at all. The research community (academic, governmental, and industrial) comes up with ideas all the time, and most of them are never exploited. All we have to do is stay plugged in. Through undergraduate research experiences that allow students to rub noses with researchers and attending research seminars, students can become practiced at learning and evaluating other people's ideas. In the application domain, end-users are great sources of innovative ideas [5]. They appreciate and understand the application context and can often conceptualize what needs to be done, but may not have the technological savvy to carry it out and may be delighted when somebody grabs their idea and pursues it. The moral is to stay active and involved, be curious and open minded, and do not reject ideas as out of hand. If you do have an idea, stress test it by talking to some potential customers or venture capitalists.

Perhaps the most important path to innovation is diversity, including diversity of discipline, diversity of experience, and diversity of interest. If engineering students only hang out with fellow engineering students, technology ideas flow freely but application ideas not so much. Any activities that get students forming friendships with a diverse group of people will set the stage for an entrepreneurial future.

RISK AND REWARD

Entrepreneurship entails risk in the hope of reward. This means that the greatest enemy of entrepreneurship is comfort, complacency, and self-satisfaction. Students need to be imbued with a sense of urgency and activism. To

encourage this state of mind, any form of commitment or activism, like politics or social awareness, is useful. For example, a student who is deeply concerned about global climate change or alleviating poverty and becomes an activist is developing a sense of positive action and impact that is a natural precursor to entrepreneurship. He/she will also learn that complete (or even limited) success is never assured.

WORKING WITH DIFFERENT PROFESSIONS

The germ of an idea is only the starting point. To reach the finish line, many classic business issues must be addressed. Success will necessitate working with different professions, including investing, finance and accounting, marketing and sales, engineering and development, manufacturing, and legal. Especially important are product marketing, which defines and refines the wants and needs of customers, and business development, which involves listening to what customers want (in contrast to what you have to sell) and then somehow bridging the gap. Willingness to pay (and at what price) is critical because it determines

whether the idea is economically viable, and needs to be tested with customers. Whether the entrepreneurs do these functions themselves or hire specialists, working closely with potential customers is critical. See the "Words of Wisdom

> **AN ENTREPRENEUR STARTING A NEW BUSINESS FACES DAUNTING CHALLENGES, INCLUDING BUILDING A PRODUCT OR SERVICE THAT WORKS, SELLING IT TO CUSTOMERS, FINANCING OPERATIONS, COACHING NEWLY HIRED PEOPLE TO WORK AS A TEAM, AND ON AND ON.**

from Peter Drucker" sidebar for a clear statement of the customers' importance.

Students can set the stage for effective communication and collaboration with the professions by taking an introductory course in any of these areas, gaining an appreciation of what value they add and exposure to sometimes-

obscure lingo. Sometimes the engineering curriculum leaves the impression, intentionally or inadvertently, that technology is an end in itself. Design it right and it will be successful.

Experience teaches that the market doesn't always choose the best technology, but sometimes just an acceptable technology. Many other factors play into success or failure. For example, although many technologists prefer Unix, in the market battle of Unix versus Windows, Unix was hurt by its fragmentation and usability and other nontechnological factors. The more educators can imbue the notion that many dimensions of expertise have something essential to add, the more their students will be successful at entrepreneurship. Here, again, any opportunity to interact with a diverse group of people is valuable.

CHARACTERISTICS OF SUCCESSFUL ENTREPRENEURS

There are some personal qualities associated with successful entrepreneurs. Many of these are largely innate, implying that engineering schools have an opportunity to tailor their admissions process to students with an entrepreneurial bent. But the curriculum and education can also be influential.

Almost by definition, entrepreneurs like to follow a different path, so anything that discourages a culture of conformity and encourages exploration and debate is helpful. Assertive and go-getter traits are helpful, so rewarding classroom participation and giving some freedom for independent exploration is worthwhile. Liberal arts colleges often have debate clubs, so why not engineering schools?

An important skill for success, not only in entrepreneurship but in most career contexts, is selling, interpreted broadly. Coming up with good ideas is one thing, but convincing others is both essential and often much harder. It is also important to accept that qualifying ideas with others is essential, because sometimes they are not meritorious or have a fatal flaw. Assertiveness should go only so far, and a willingness to modify and improve ideas, seek advice from many quarters, or aban-

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WORDS OF WISDOM FROM PETER DRUCKER

This management guru memorably asked the three questions that every company seeking to establish a brand must ask itself:

> "What is our business?"
> "Who is our customer?"
> "What does our customer consider valuable?"

To wit :

> If we want to know what a business is, we have to start with its purpose. And the purpose must lie outside the business itself. In fact, it must lie in society, since a business enterprise is an organ of society. There is only one valid definition of business purpose: to create a customer. The customer is a foundation of a business and keeps it in existence. The customer alone gives employment. And it is to supply the customer that society entrusts wealth-producing resources to the business enterprise.

> Because it is the purpose to create a customer, any business enterprise has two—and only two—basic functions: marketing and innovation. These are the entrepreneurial functions. Marketing is the distinguishing, the unique function of the business. [2]

He also wrote :

> Innovation is the specific instrument of entrepreneurship, which is the act that endows resources with a new capacity to create wealth. [3]

don marginal ideas entirely is essential. Entrepreneurs have to sell not only to customers, but also investors, and those groups often have very different perspectives to overcome. Lest they become discouraged, entrepreneurs have to face and accept rejection, because many (and probably most) potential investors and customers will walk away no matter how great the idea. Project experiences where students have to accomplish things in a team are essential, including experiences that are not well-defined and are structured so that different paths must be explored and temporary failure and recovery is expected. Rapid and frequent communication is essential to quickly learn what sells and what does not.

Since so many ducks must be aligned, entrepreneurs need to have a broad perspective and be open thinkers. This is arguably a weakness of existing engineering education that can be addressed through curriculum and through a tailoring of the classroom and project experience. For the same reason, entrepreneurship is hard work and requires long hours. Engineering students are unusually good at this, but often their activity is so structured and focused that it shuts off outside interests and experiences that would be useful and broadening. Summer or part-time jobs with small companies also help to fill this gap.

LEARNING ENTREPRENEURIAL SKILLS

Many of the skills for successful entrepreneurship can be explicitly identified and included in an engineering education [6]–[8], and there are available whole courses of study in entrepreneurship [9]. In many ways, coming up with the first idea is similar to academic research. Often the problem is not well-defined, and developing a useful and tractable question is half the battle. Research experiences that take the student outside the comfortable and structured existence of courses can be valuable. Working with, influencing, and motivating a team is something that can be practiced in project experiences, professional society initiatives, or team sports. Project management has well-

recognized best practices that can be explicitly taught and practiced. Various business issues have associated courses offered by business schools. There are also some career strategies listed in the "Dos and Don'ts Before Becoming an Entrepreneur" sidebar that will help.

CONCLUSIONS

An entrepreneur starting a new business faces daunting challenges, including building a product or service that works, selling it to customers, financing operations, coaching newly hired people to work as a team, and on and on. In spite of formidable competition, and a fair prospect of failure, a number of entrepreneurs do press on against the odds, and there are many successes, some spectacular ones. The entrepreneurial personality considers all this not only challenging, but fun and exciting. Among the recent spectacular successes who benefited from an engineering education are (in signal processing) Irwin Jacobs and Andrew Viterbi (QualComm), Ray Stata (Analog Devices), and Henry Nicolas and Henry Samueli (Broadcom).

For business opportunities that require a significant technology component, and where technology has to be molded to new uses, today's engineering education is certainly very relevant. But regarding other aspects of entrepreneurship, it is not nearly so clear. Are entrepreneurs' chances of success enhanced by their engineering education, or is their education in some ways an impediment? These issues can and should be

discussed, but there is always an opportunity to do better. The future of our technologies depends on it.

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> **DOS AND DON'TS BEFORE BECOMING AN ENTREPRENEUR**
>
> **DO…**
> - Hold different jobs (engineering, sales, operations) to broaden your experience
> - Start at the bottom but also manage teams of people
> - Seek jobs that encourage you to pursue your own ideas and refine those ideas with the help of customers
> - Develop an understanding of finance and accounting
> - Practice executing a strategy that you helped develop
>
> **DON'T…**
> - Hold the same job to the point that you are no longer learning
> - Do only what you are told without expressing your point of view
> - Rigidly execute a strategy even though it is clear it will not lead to success