

**2006-699: TEACHING ENTREPRENEURSHIP TO ENGINEERS: A
LOGICO-DEDUCTIVE REVIEW OF LEADING CURRICULA**

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**Teaching Entrepreneurship to Engineers:
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INTRODUCTION

Can entrepreneurship be taught? Anyone who has spent even the slightest time in the classroom ostensibly to teach entrepreneurship has probably encountered this question. It stems from an abiding belief that successful entrepreneurs are, somehow, just “different”. This belief in a “difference” factor or set of factors is rarely articulated with any level of detail. Sometimes it is stated that entrepreneurs have more energy than non-entrepreneurs. Sometimes it is stated that they are greater risk takers, sales people, leaders, or money raisers. Whatever the “difference” factor(s) is or are, it is the opinion of many critics of entrepreneurship education that the topic can be taught, but you can’t make someone an entrepreneur who does not have this “different” factor as a function of god’s will or fortunate genetics. As it is sometimes pithily articulated, one is either born an entrepreneur or not.

Legions of entrepreneurship educators around the country have heard this question and have grown weary of responding. In our opinion, the question furtively is one of those trick questions that sounds profound but has no possible satisfactory answer. It’s similar to a question like “Are you still beating your spouse”? The very attempt to answer the question provides it with undeserved legitimacy. The question about teaching entrepreneurship should not be legitimized with an answer. Entrepreneurship resides in everyone; the same way the ability to play golf resides within everyone. The goal of the golf instructor is not to make you play like Tiger Woods, it is to help you become the best golfer you can be. Likewise, the goal of entrepreneurship education is not to teach “entrepreneurship”, it is to help students become the best entrepreneurs they can become.

Entrepreneurship has caught on as a program of study on university campuses across the United States and around the world. What began primarily as a business school field of study has now migrated to other professional schools, including engineering. While the spread of entrepreneurship education has become standard and even encouraged across an increasingly wide range of disciplines, the approach to teaching entrepreneurship has not been standardized. There are a number of competing perspectives regarding the most effective curriculum for teaching entrepreneurship. To make the matter even more complex, these perspectives differ from school to school (e.g., from the business school to the engineering school) and also from student level to student level (e.g., from undergraduate student to graduate student).¹

Business schools were the initial locus for entrepreneurship education, although a few engineering programs such as the one at the Massachusetts Institute of Technology can lay legitimate claim to being pioneers of the genre. Still, it is not in dispute that entrepreneurship education has become a staple of business school curricula and is a relatively recent addition to other professional programs.² It has been estimated that entrepreneurship education today is offered in more than 1,600 business schools and in as many as 500 engineering schools. Scholars of the subject have been debating the best way to teach the increasingly popular subject. While the scholarship on curricular approaches is not as robust as the scholarship on other entrepreneurial topics, it is not without its competing schools of thought. However, little scholarship has been directed to distinguishing among the approaches and determining which is superior and under what conditions.

This paper presents a logico-deductive analysis of the leading approaches to entrepreneurship education. We have identified the six leading approaches as:

- The Business Plan approach
- The Resource Based approach
- The Entrepreneurial Mindset approach
- The Case Study approach
- The Simulation Experience approach
- The Entrepreneurial Personality approach

Since entrepreneurship education has only recently become a focus of academic scholarship, little empirical data exist on which curricular approach works best to convey the fundamentals of entrepreneurship.³ Worse, there is little agreement among scholars and other interested parties about the fundamental ends of entrepreneurship education. This latter controversy often subverts efforts to identify the appropriate means.⁴

Despite this lingering and—most likely—enduring means/ends debate, there are logical arguments that may shed light on the ends of entrepreneurship education; thus, shedding light also on the most effective means of teaching the subject. This paper explores the curricular approaches listed above from a logico-deductive perspective and suggests that a new means of teaching entrepreneurship is required. It begins with an overview of the amorphous debate about entrepreneurship education means and ends, and concludes with strong recommendations for a new curriculum—called the “Business Process Perspective”. This perspective is articulated in detail, with clear recommendations for curriculum development and curriculum variation between schools and student grade level, and recommendations for future empirical work.

Although this paper, admittedly, would be stronger with precise empirical data to support its major arguments, it is important to recognize the power and value of deductive reasoning. Such reasoning is based on a set of core or shared premises that provide a starting point for evaluation. For example, it is often beneficial for companies to state their basic values clearly before they begin to generate revenues and make profits. Without that—and without at least a commitment to remain true to these core values—a company could follow any path to acquire revenues. A baseline of shared values helps the firm retain an identity over time and select from conflicting possible strategies as it explores market opportunities.

Any logical argument needs a set of parameters to provide a framework for deductive analysis, comparison, and evaluation. For our purposes, the parameters we establish below center on what we consider to be universally agreeable ends of entrepreneurship education. With such a basic framework established the various approaches to entrepreneurship education (the means) can be evaluated and assessed according to their ability to deliver on and within these parameters. To develop these parameters we decided to identify and select those that are non-controversial and commonly practiced. We propose the following parameters to be compatible with these criteria:

1. The curriculum must be holistic, providing students with a broad perspective of the various elements of the entire business operation (marketing, accounting, finance, operations);
2. The curriculum must have a theoretical underpinning, that enables students to make sense of disparate data and information;
3. The curriculum must have a logical flow so that the various lessons build upon one another over time;

4. The curriculum must help build entrepreneurial skills among students rather than just being about entrepreneurship;
5. The curriculum must be realistic, leaving students with no illusions about the difficulties associated with launching a new venture;
6. The curriculum must be consistent with research that is ongoing into the nature of entrepreneurship, how to teach it effectively, and the ingredients of entrepreneurial success.

These six primary or foundational parameters of a thoroughgoing entrepreneurship curriculum must be present for a specific approach to be evaluated as complete. These six parameters were not developed on the basis of a poll or survey; rather they are the parameters the authors have found to be non-controversial and commonsensical.

Each of the approaches to teaching entrepreneurship will be briefly reviewed and analyzed using the six parameters. After that, we provide a summary that discusses the gaps that still remain in entrepreneurship education, and in particular, entrepreneurship education for engineering and technical students. Next, we propose an alternative that we call the “Business Process Approach”. This approach was developed at the University of Houston Center for Entrepreneurship & Innovation over 15 years ago, and has been used to educate thousands of students both within the business school and in the College of Engineering there. In addition, the approach is now also being used at Arizona State University’s Ira A. Fulton School of Engineering and has been codified in a new textbook, titled “Entrepreneurism: Exploring Entrepreneurship from a Business Process Perspective”.⁵ Let’s turn now to the various approaches to teaching entrepreneurship, beginning with the business plan approach.

The Business Plan Approach

The business plan approach to teaching entrepreneurship centers, obviously, on the business plan. Under this approach, the business plan is assumed to be a central factor in entrepreneurial success. Entrepreneurial instruction focuses on developing a business plan for a real or fictitious business. The assumption that underlies this approach is that the business plan is critical to the success of a new venture. In fact, a study of leading entrepreneurship educators indicated a belief that development of a business plan is the most important feature of entrepreneurship courses. In this research, it was found that 78 of the top 100 universities offered courses in business planning.⁶

Students begin by identifying a business concept that they have an interest in pursuing. This may be an actual business that they are currently working on or one that they would be interested in learning more about. The instructor’s role in the business plan approach to teaching entrepreneurship is to help each student develop a “reasonable” business plan based on the chosen concept. The primary goals of the business plan approach are:

- To teach students how to write a compelling business plan
- To teach students how to conduct market and industry research
- To teach students how to develop financial projections
- To teach students how to integrate the various perspectives on the business concept

In general, the business plan approach to entrepreneurship instruction is formulated around a standard business plan “outline”, which may look something like this:

- I. Executive Summary
- II. Product/Service Overview
- III. Market Analysis
- IV. Industry Analysis
- V. Competitive Analysis
- VI. Marketing Strategy
- VII. Operations
- VIII. Management Team
- IX. Financial Summary

This outline is somewhat standard, although the actual classroom-based version will differ from instructor to instructor and school to school. The most important elements of this exercise center on market identification, strategy formulation, and financial summarization. Students are taught some short-hand rules for developing defensible content in each of these various sections. The assumed audience for the business plan is “investors”. Thus, the content is intended to indicate the viability of the venture and the potential returns that can be gained from a financial investment.

In addition to teaching students what content should be entered into each of the various sections of the business plan, this approach also teaches students where and how to gather and analyze information. Both primary and secondary data sources are normally used in developing each section of the plan. For example, market data can be gathered from a wide range of secondary sources for most product/service categories. Students are often also taught how to gather primary market data through the use of surveys, demographic databases, industry databases, and other techniques.

The business plan approach has real-world, intuitive merit in that it is often the case that successful entrepreneurs have built their businesses on the foundations of a well-conceived business plan. While the use of business plans by successful entrepreneurs is far from universal, the assumed utility of the business plan is a mainstay of this teaching approach. Most instructors who subscribe to this view are comfortable that, if not a necessary condition for entrepreneurial success, the ability to conduct market and industry research and develop a concise plan increases the likelihood of success.

This approach does have several problems, however. For example, it suffers from serious classroom-management and pedagogical drawbacks. Anyone who has ever taught a business planning course will readily attest that a large amount of time is often spent simply teaching students how to write effectively. Many courses in business planning begin to closely resemble courses in English composition—something most entrepreneurship instructors are ill-equipped and generally unwilling to teach. When the number of business plans being developed in a course is multiplied by the number of students in the class it’s obvious that the instructor can easily be overwhelmed with bad writing. Often, the instructor has to overlook the bad writing and focus only on the analysis that lies behind the prose. This can give students the false sense that their poor writing is acceptable to the instructor or, worse, would be acceptable to potential venture investors.

One tactic instructors often use to limit the number of plans in a course is to aggregate students into teams to develop plans in a collaborative manner. Sometimes this is done ostensibly to teach “teamwork”. While this approach will reduce the number of business plans that the instructor needs to review and critique, it has the unwanted effect of distributing work among the members of the student teams. This defeats one of the overriding purposes of the business plan approach, which is to develop the ability to integrate the various perspectives on the start-up venture.

Finally, and most challenging for this approach to teaching entrepreneurship is the lack of empirical support for the utility of the business plan to the start-up enterprise. In fact, the literature has become quite convincing that too much time spent on planning and strategizing can be counterproductive. The fundamental assumption that the business plan is crucial to new venture success has only recently been a target of empirical inquiry. The effectiveness of strategic planning as a condition for improved performance has been only tenuously established at the corporate level.⁷ For the entrepreneurial venture, the role of planning is even less-well linked to improved performance.⁸

The business plan approach to teaching entrepreneurship is effective on Parameters 1, 4, and 5; and inadequate on 2, 3, and 6. Wholistic understanding of the business is a pre-requisite for writing effective business plans that tell a compelling story about the venture. Of course, this wholistic understanding is only achieved if each student composes their own business plan. This parameter is not achieved if teams of students are used to compose plans.

An effective business plan provides students with skills in financial and market analysis (Parameter 4). Often, the business plan exercise is the first time students actually “get it” when they consider how to bring a product to market and whether or not people will decide to buy their offerings. This exposure to market and financial considerations also promotes a measure of realism (Parameter 5). Courses in marketing and finance often focus on concept mastery in the absence of real-world application. The business plan creates a context where students, often for the very first time, really encounter how their thinking tools can be used for practical ends.

Generally, there are no canonical concepts that underlie the business plan approach. Instead, students are normally taught how to use currently fashionable jargon such as “first mover advantage” and “core competence” to add spice to their plans. These fashionable terms are not taught, learned, or used in a manner that enables generalization from one context to another. Thus, Parameter 2 is not achieved in the business plan approach.

There is a logical flow to business plan instruction (Parameter 3), usually following a variation on the business plan outline listed above. This is not a building of understanding in the way one course builds upon the knowledge gained in the previous course. Rather, it is the logical process of composing an intelligible document that provides little basis for a next phase of instruction. For example, it is extremely rare to find a course on “how to use the business plan to finance your business” or “how to use the business plan to operate your business”. Once the business plan is written, that is usually the end of it.

The Resource Based Approach

The resource based approach to teaching entrepreneurship centers on the theoretical perspective of the same name. The resource based perspective on entrepreneurship attempts to explain entrepreneurial activity and success as a function of the utilization of resources. This perspective was originally articulated by Marc Dollinger and is explored in detail in his book “Entrepreneurship: Strategies and Resources”.⁹ Specifically, this perspective holds that successful entrepreneurs are those who are able to gather and exploit resources that have four essential characteristics:

1. They are rare
2. They are valuable
3. They are hard to copy
4. They are difficult to substitute

The goals of teaching entrepreneurship using the resource-based approach is to help students understand that entrepreneurship is fundamentally a gathering and application of existing resources in new ways. Organizing resources in a manner that is valuable to a market provides opportunities for the generation of profits. For engineering students, there are a number of unique elements included within an entrepreneurship education that utilizes this approach:

- Highlighting rarity as one source of value creation
- The definition of “value” as a function of a market
- The importance of protecting value via legal means

The scarcity or rarity of a resource makes it more valuable. Under this approach, entrepreneurs are taught to seek market opportunities where the provision of a product or service is comparatively rare. This could be the case in markets with limited number of incumbent competitors, or in markets that are created around novel or unique product/service offerings that can be protected. Students are taught to analyze markets for unique opportunities and to focus on establishing means for protecting market position. This approach to teaching entrepreneurship is a better fit for technology entrepreneurs than service entrepreneurs. The concept of “scarcity” and “intellectual property protection” is better understood by engineers and technologists who have created novel products or technologies in the laboratory and desire to commercialize their innovations, as opposed to, say, business students who are eager to establish a restaurant or nightclub. The latter is not likely to be centered on “resources” as much as “opportunity” or “speed to market”. It would be a stretch to conceive of these latter sources of competitive advantage as “resources”.

A resource becomes valuable as a result of its attraction to a particular market. While this may seem like a highly intuitive and even obvious statement, to many technology or engineering oriented entrepreneurs it can be a revelation. They simply have not been trained to view the concept of “valuable” as being a market-derived variable. Instead, they are taught to view value as an abstract concept that is determined within the context of scientific theory or engineering metrics such as “tolerances” or “specifications”. In that regard, the teaching of “value” as a measure of market interest is enlightening for technology and scientifically inclined entrepreneurs. For example, the theory of disruptive innovation suggests that entrepreneurs can sometimes enter markets by offering worse versions of what is currently available to

customers.¹⁰ Serving “overshot customers” with such innovation means using less than optimum materials, design, feature sets, and engineering processes. This approach to engineering and design may be counter-intuitive to the well-trained engineer who has not previously considered the power of markets in establishing the prevailing definition of “value”.

The notions of “difficult to copy” and “difficult to substitute” are also market or, at least, industry specific terms, but they are not difficult for engineers or scientists to appreciate. Their standard training involves the competitive quest to be original and to strive for recognition based on this originality. This training focuses on career development through originality, not business development. Still, the concepts transfer well. Scientists and engineers are taught to regard originality as a goal for individual career development. This is not dissimilar to the concept of originality for business development. The concept of originality also contains the corollaries of intellectual property protection and sustaining the protection over a period of time—both of which are equally important in the scientific career as in business development.

While this approach to teaching entrepreneurship to engineers has many merits it also has several problems. The most significant problem is the focus on important concepts—such as “value—as discrete or “factual” elements. This can be beguilingly appealing to engineers and scientists who are familiar with and even thrive on this type of learning. While conceptual understanding is important, it is more important for engineers and other technically inclined entrepreneurs to understand the process that creates and exploits the concepts. For example, while it is very important to understand that value is a market-based measure, it is more important to understand how to create value within a market and exploit value creation for profit. Similarly, while it’s important to understand that intellectual property value must be created and protected by legal means, it’s more important to understand how to exploit that value protection for profit within an appreciative market.

From the comparative perspective of the fundamental Parameters we’ve established, this approach is capable of achieving Parameters 2,3, and 6; but it does not adequately cover Parameters 1,4, and 5. There is a strong theoretical underpinning to this approach. This strength, unfortunately, may also be the source of its greatest weakness. The approach is based on theoretical assumptions that are, essentially, axiomatic. From the four axioms of resource value are derived the lessons for success in entrepreneurship. Students are not exposed to common business terminology equivalents, but rather shown how the axioms in the parlance of the theory actually apply to real-world examples. This fails Parameters 4 and 5.

The Revenue Based Approach also fails Parameter 1 in that it does not convey a wholistic view of the new venture. Its focus on resource acquisition, development, and protection is primarily about marketing and strategy. Students will not develop understanding of accounting, finance, and operations under this approach.

The Entrepreneurial Mindset Approach

The entrepreneurial mindset approach to teaching entrepreneurship originally was based on the work of Rita Gunther McGrath and Ian MacMillan and embodied in their book titled “The Entrepreneurial Mindset”.¹¹ The book was not written as a textbook, but rather as a trade publication intended for a general business audience. Nonetheless, the principles in the book—including the consumption chain, the attribute map, and the real options approach to market

entry—have been applied to classroom instruction. One of the authors of this paper (Duening) has made extensive use of this approach, especially in Executive MBA classrooms where the focus is more on “intrapreneurship” than on entrepreneurship.

The entrepreneurial mindset approach is perhaps more descriptively defined as a “market based approach”. McGrath and MacMillan focus much of their attention in their book on analyzing, dissecting, and understanding markets. Their model takes into account the various activities that firms—primarily, in this case, corporations—must undertake to optimize the likelihood of generating profits from innovation. They develop a host of tools that are very useful for the understanding of markets, the positioning of current competitors within a market, and the niche opportunities that may exist and that represent a new opportunity.

The entrepreneurial mindset approach is designed to develop a way of seeing opportunity that is resident within a market. It is assumed that a grasp of the various tools developed in the book will provide would-be entrepreneurs with a fresh set of insights into how markets behave. The text itself is rich with examples of how the tools would apply to market or strategy innovations from leading companies. Using these in the classroom works best when students are required to apply each tool to real-life situations they have encountered or are currently encountering.

The entrepreneurial mindset approach is similar to the case study approach detailed immediately below. The entrepreneurial mindset is actually the adoption of a set of analytic devices and tools that purportedly enable students to develop insights into profit-making opportunities. In fact, there is a growing body of literature that examines the cognitive functions of entrepreneurs. This literature base has found a number of specific thought processes that are unique to entrepreneurs. None of these thought processes are centered in the analytic tools that comprise the entrepreneurial mindset approach. Rather, the cognitive processes that researchers have associated with entrepreneurs and which sets them apart from non-entrepreneurs include both learnable and more or less innate patterns. Innate patterns include such things as a bias toward action, tolerance of ambiguity, and a tendency toward overconfidence or optimistic thinking.¹² Learnable patterns include such things as directed searching for countervailing data to avoid decision making based on limited information (the Law of Small Numbers); learning to use a devil’s advocate to avoid the common “overconfidence bias” that entrepreneurs tend to have.¹³

These emerging elements of the research based “entrepreneurial mindset” are quite different from the tools and techniques of the teaching approach by that name. That is not to deny the utility of the tools that the entrepreneurial mindset approach convey to students; but it is to call into question the foundations of the pedagogy. No research supports the notion that the tools outlined by McGrath and MacMillan are endemic to entrepreneurs. In fact, no two entrepreneur instructors would likely choose the same set of tools and techniques to teach students in entrepreneurship courses. The result of teaching the particular tools of the entrepreneurial mindset will not necessarily create more entrepreneurs. Rather, this approach results in a market-oriented mindset that helps structure thoughts about how markets function, how they can be entered, and how they can be defended. In that sense, the entrepreneurial mindset approach is similar to new product development or enterprise innovation courses. As the authors of this paper have determined, this approach is effective for upper-level or executive MBA. It is not particularly suited for engineering entrepreneurship education.

The entrepreneurial mindset approach is strong on Parameters 2,3,5, and 6; but fails on Parameters 1 and 4. It has a solid theoretical underpinning, including a wide range of new

conceptual approaches developed by the authors themselves. The curriculum flows logically from market analysis through intellectual property protection and market entry.

The entrepreneurial skills developed by students as a result of exposure to this curriculum (Parameter 4) are centered on analysis rather than real world skills. While the tools that comprise this curriculum certainly apply in the real world, it is difficult to apply many of them in an entrepreneurial setting. They are far better suited for the more leisurely planning and cycle times common to large organizations than they are to the chaos of the entrepreneurial venture.

The approach is realistic (Parameter 5), extolling the virtues of market contact every step of the way. Market contact ensures the application of theory is evaluated within the context of a market and its behavior. For the entrepreneur, there is nothing more important than market contact, feedback, and market-driven adaptation.

The main criticism of this approach is its focus on market-analytic tools to the exclusion of many other components of entrepreneurship. It simply lacks instruction in the key entrepreneurial activities of resource acquisition, legal structuring, cost analysis and control, and operations. The latter is particularly lacking. For example, absent entirely from the entrepreneurial mindset approach is the entrepreneur's desire to create an organizational engine that runs, generating revenue and throwing off profit, without need for the entrepreneur's constant attention.¹⁴

The Case Study Approach

The case study approach to teaching entrepreneurship is perhaps the least common type. It is an extension of the Harvard Business School case study method. Most entrepreneurship faculty are unfamiliar with this approach. Those who do adopt it will not find the rich set of case materials that are available in other disciplines. Case studies in management, organizational behavior, corporate finance, business ethics, and a wide range of other disciplines have been developed over decades. In many of these fields, practicing faculty are aware of "classics" and there is a rich body of secondary literature on how to use the cases in the classroom.

Entrepreneurship cases are less well developed than the canon of cases in other disciplines. In many case-oriented entrepreneurship classrooms, in fact, the cases are derived not from academic databases, but rather from the pages of popular magazines. Instructors who utilize *Entrepreneur* or *Inc.* magazines in their classrooms must augment the "cases" (they are really "stories") with discussion questions and take-away lessons. In other words, the instructor must work harder to use the case method in entrepreneurship classrooms than is the case for instructors using the case method in other business discipline classrooms.

The case approach was designed and is used in several leading business schools explicitly to develop student analytic skills. To achieve that end, cases must have rich detail about the business situation, providing ample opportunity for nuanced analysis. Students often work on cases in teams, with the express intent of teaching teamwork, allowing each to focus on the element of the case that draws upon their unique expertise. Often, the teams compete with one another for the most fluent or effective resolution of the situation under study in the case. The emotion that drives the case analysis is interpersonal competition (ego), not the entrepreneurial profit motive (survival). Students in case-study based programs compete to be the smartest. They are not focused on being better risk takers, decision makers, or fund raisers.

With the intent of the “classical” case-study approach to develop analytic skills, it is questionable whether the instructional techniques honed over the years in the leading business schools transfer to the entrepreneurship classroom. While the research into entrepreneurial traits has not been able to identify any bona-fide “must have” personality characteristics, it is not usually thought that strong “analytic” skills are a pre-requisite for success in new ventures. Rather, the entrepreneur is expected to be able to make decisions about market opportunities rapidly, and in the absence of definitive information. Additionally, entrepreneurs are less well served if they are competing on classroom “intelligence”. As most entrepreneurs will attest, there is a vast difference between market savvy and classroom “smarts”.

The case study approach is effective in achieving Parameters 1 and 5; but fails to achieve Parameters 2,3,4, and 6. Many cases tend to be wholistic, requiring students to analyze the venture detailed in the case from a variety of perspectives. This approach also helps create a sense of realism as students analyze the situations and critique each others’ analyses and conclusions. This debate is similar to the types of ambiguities and controversies that attend real venture development activities.

Courses that employ the case study method may have theoretical underpinnings (Parameter 2). To the extent that they do, however, they may subvert Parameter 1. That is, the case study approach is sometimes used within the context of a single course within a particular discipline (say, marketing). As such, a distinct theoretical perspective is often conveyed in the course. This perspective is then applied to the case studies assigned by the instructor. When cases are used to apply only a single theoretical perspective, Parameter 1 suffers.

The case study approach is not concerned with Parameter 3. In fact, it is often the classroom debate that governs the flow of the course rather than a logical set of lessons. Parameters 5 and 6 are not relevant to this approach except as stated above when a particular theoretical perspective is used within a single course and analyzed through the case method.

The Simulation Experience Approach

The simulation approach to teaching entrepreneurship centers on creating a scenario that resembles a real-world entrepreneurial experience. Many instructors have adopted simulation as an add-on to the case study method. Students engage in case studies to begin to develop a feel for entrepreneurial situations and decision making. After a sufficient number of cases have been studied and discussed, the instructor migrates to a simulation, where individual students or student teams engage in decisions that have simulated consequences and results. Some instructors elect to run the simulation as a competition, with cash or other non-monetary prizes at stake.

There are a variety of entrepreneurship simulations on the market that are available for use in the engineering classroom. As one might expect, these simulations vary in quality and depth. Still, most have the same objectives:

- To provide a decision making context with consequences
- To provide a context for business research and analysis

- To provide a context for applying business concepts
- To provide a sample of the uncertainty of entrepreneurship
- To provide a context to experience entrepreneurial emotions

From the above, it's clear that simulations are designed to address some of the process-oriented skills that are required for success as an entrepreneur. The process orientation of simulations addresses both cognitive and emotional applications. Students need broad contextual understanding to make effective decisions within the simulation environment. This requires data gathering, analysis, and timely decision making. As decisions generate consequences students will also feel appropriate emotions—anxiety, optimism, joy, disappointment—in line with the feedback they receive on the consequences of their decisions and actions. This effect can be heightened by the instructor if friendly competition is added to the simulation with significant rewards for the top competitors.

Pre-packaged simulation curricula for use in the technology entrepreneurship classroom come in a wide range of options. In some ways, they reflect the variety of approaches to teaching entrepreneurship discussed in this paper. That is, some simulations use the business plan as the centerpiece, requiring students use live data to gather, collate, and present information about markets, industries, and customers within the context of a business plan. Other simulations focus on small business settings, where students are required actually to make decisions about merchandise mix, pricing, cost allocation, and other core business decisions.

Some of the leading technology entrepreneurship simulations are:

- **New Business Mentor:** This business-plan advisor is based on the Kauffman Foundation's Fast Trac program
- **FastTrac Tech:** This program created by the Kauffman Foundation is a two-phase multi-session simulation created by technology entrepreneurs. The course is divided into two parts: Feasibility Testing and Business Planning. All FastTrac training requires certification from Kauffman.
- **Go Venture (www.goventure.net):** This program is available to instructors from K-12 through graduate education. The flexible software underlying this simulation can be used in technology entrepreneurship classrooms as well.
- **BizTech 2.0 (www.nfte.com/biztech/):** This program was originally designed for high school students, but is now billed as a resource for students 13 and older and is available in an online format. Students require at least 25 hours of time to use the system, which also allows for student-student and student-teacher interactions.

The simulation experience approach effectively addresses Parameters 1,3,4, and 5; but it fails on Parameters 2 and 6. This approach is exceedingly adept at presenting the venture development process from a wholistic perspective. Students are required to make decisions and live with the consequences of business systems. The “ripple effects” and “externalities” that are a natural part of venture operations are often only revealed through simulation. For example, the famous “Beer Game” invented to demonstrate the system-wide effects of decisions taken at various stages of a supply chain never ceases to amaze trainers and instructors who employ it. The

enlightenment displayed even by seasoned supply chain and purchasing managers as the logical decisions they make lead to bottle necks and inventory buildups are astounding. Only a simulation, where the entire supply chain cause and effect links can be viewed holistically, is able to reveal the consequences—sometimes, unintended—of decisions taken for valid reasons.

The simulation approach does not adequately arm students with theory-based concepts that can be generalized from one situation to another. It also does not rely on academic research. Most simulations simply require decisions to be made and then, according to the rules and algorithms of the game, consequences are ineluctably derived.

The Entrepreneurial Personality Approach

Another approach to teaching entrepreneurship centers on what is referred to as the “entrepreneurial personality”. This approach has as its foundation the common belief that entrepreneurs have distinctive personality traits that others can learn and internalize to a greater or lesser degree. These personality traits are often thought to include some of the following:

- High energy
- Risk taking propensity
- Tolerance of ambiguity
- Decision making ability
- Salesmanship skills
- Negotiation skills
- High need for achievement

While this is not an exhaustive list, it is reasonable to assume that an entrepreneurship course using the entrepreneurial personality approach would touch on some or all of these “traits”. The goals of the course using this approach will include:

- Familiarize students with basic entrepreneurial traits
- Distinguish these traits from those of other career tracks
- Attempt to build competencies in the entrepreneurial personality traits
- Establish practical steps to improve traits over time

This approach has seen fewer practitioners over the years as the scholarship directed at identifying a distinctive entrepreneurial personality has not borne fruit. In fact, as a line of research this particular area has mostly dried up.¹⁵ As a result of the lack of results from scholarship in this area, most entrepreneurship educators who are on an academic track do not use the entrepreneurial personality approach. However, this approach is common among entrepreneurs who teach basic courses in entrepreneurship. Since they have not been exposed to the disappointing scholarship in this area they are not pre-disposed to reject the premise that entrepreneurs are such by virtue of something unique about their personality. In addition, their experience is rich with entrepreneurial personalities who tend to display some or all of the characteristics listed above.

The major problem with the entrepreneurial personality approach, of course, lies with the dearth of conclusive scholarship on the subject. What scholars have concluded is that entrepreneurs

have myriad personality traits, and none are either necessary or sufficient conditions for success. Thus, not only have scholars abandoned this approach because research provides no guidance on exactly which traits to teach, but also because teaching entrepreneurship under this approach can possibly do more harm than good. For example, if a student does not possess a trait that has been deemed to be critical by a particular instructor for entrepreneurial success, might they not conclude—perhaps, falsely—that they cannot become a successful entrepreneur? This possibility makes further use of the entrepreneurial personality approach a moral issue in addition to one of simple pedagogical efficacy.

The entrepreneurial personality approach fails to deliver on Parameters 1,4,5, and 6. It does not provide a wholistic perspective on entrepreneurship, focusing only on the personality characteristics required to be a successful entrepreneur and how to develop those characteristics. Normally, the exercises and activities undertaken as part of this curriculum are focused on developing required personality traits, not on the skills required to be effective entrepreneurs. For example, students may be placed in teams in the attempt to develop communication and teamwork skills. That may be useful, but it does not teach when and how to use such skills in the entrepreneurial setting.

As the academic research into the entrepreneurial personality has mostly been abandoned for lack of consistent findings, this approach has little basis in reality. Declaring this or that trait to be a necessary condition for entrepreneurship simply doesn't have empirical support. While the approach may have a theoretical underpinning and a logical flow, this provides inadequate support for recommending this approach to entrepreneurship.

Reflections on the Various Curricula

The approaches to teaching entrepreneurship discussed above each have unique strengths and weaknesses. The ongoing debate about which to use in the classroom might be expected within any discipline as competing approaches to instruction are introduced and vie for supremacy over time. The teaching of entrepreneurship is complicated by the fact that it often involves a multi-disciplinary student cohort. With this complication, it is difficult to make generic assumptions about common prior knowledge. For example, teaching entrepreneurship to upper-division business school undergraduates allows the instructor to make assumptions about prior exposure to introductory accounting, finance, management, and marketing. No such assumptions can be made about engineering or science undergraduates. Their prior curriculum may have included a business course or two, but almost certainly lacks the comprehensive survey of introductory courses common to the business undergraduate.

It may be that curricular innovation simply has to follow multiple paths for entrepreneurship education. It may be that the approach to teaching it in the business school is simply qualitatively distinct from the way it is taught to science and technology students. This would not be unusual. Business schools have made a small fortune in their non-degree, for-profit programs offering courses with titles like “Finance for Non-Financial Managers”. This curriculum evolved outside of the normal business school offering and does not influence formal curriculum development in finance. It is influenced by market forces and curriculum is adjusted to meet the needs of a niche group of managers who need basic financial knowledge to advance their careers.

It is our belief, however, that the instance of the business school continuing education course in finance has almost no overlap with the instance of entrepreneurship education and its migration to engineering schools. Perhaps more closely aligned with the challenges facing engineering entrepreneurship education is the practice of teaching management and finance courses to professional school students within non-business professional schools. For example, hospitality programs and schools offer courses in management and basic finance. These are taught by their own faculty and usually do not include business school faculty members. Nonetheless, these programs generally do not develop distinct textbooks or curriculum. Such courses utilize texts and curricula designed for business school students. The cases and examples utilized by the instructor in the non-business programs are appropriately modified, but the underlying texts and curricula are not.

We suggest that, in the interest of curricular advance and the development of entrepreneurial skill sets that can be empirically validated a common approach across various schools is required. That is, it is simply not in the interest of entrepreneurship instructors or students to believe that separate educational curricula are required in the business school and in other professional schools to teach entrepreneurship. A unifying approach is required that brings together the basic elements of each of those examined so far, and which meets all six parameters of effective entrepreneurship education that we've identified. This approach should also be capable of making fundamental assumptions about prior knowledge without leaving some students behind. Finally, this approach should enable instructors to introduce practicing entrepreneurs into the classroom without losing their credibility. That is, there needs to be a robust theoretical underpinning to the curriculum that makes sense of the "war stories" and anecdotes that practicing entrepreneurs bring into the classroom, often to great effect.

Analyzing the various curricular approaches within the context of our logical parameters at least provides a place to begin the debate on which approach works the best. This analysis is summarized in Table 1:

Table 1 Here

The approach to teaching entrepreneurship that seems capable of achieving each of the parameters is the so-called "Business Process Approach". This approach has been under development for more than a decade in business schools and professional schools across America. Its strengths lie in its ability to provide a theoretical framework for teaching entrepreneurship that doesn't discriminate from one type of student to another. Its greatest weakness lies in its origination by non-mainstream academics and scholars who are not part of the established academic entrepreneurship in-groups. Magnifying this "outsider" status is the lack of sustained data collection and analysis that would add credibility to the logical arguments of this paper. Clearly a major critique of the arguments presented here will be that there are scant data to validate them. The only reply to that is, "guilty as charged". Still, it is our opinion that our inabilities as scholars and academics should not stand in the way of our enthusiasm for the approach to teaching entrepreneurship that we had a hand in creating and have been using over thousands of students. Let's now turn to a brief overview of the Business Process Approach.

An Alternative: The Business Process Approach

The University of Houston's Center for Entrepreneurship & Innovation (CEI) was founded in 1992 by a combined team of committed entrepreneurs and academics. None of the founders had previously taught entrepreneurship. Thus, they came to the assignment with open minds and common goals. The goals were to develop a curriculum that would utilize existing faculty expertise (the CEI was housed in the business school) combined with the practical experiences of practicing entrepreneurs. The founders wanted to develop a curriculum that would provide students (in this case, primarily undergraduate business students) with a chief executive officer's perspective on a business. The thinking was that an entrepreneur simply is the CEO of the business—no matter how big or small.

To develop a CEO's perspective the team that was debating the curriculum reviewed each of the alternatives noted in the preceding section of this paper. It was clear from reviewing the various perspectives that there were strengths and weaknesses associated with each one. Some of the perspectives, such as the real options approach or the resource based approach were focused on only a small sub-set of concerns the CEO must have to manage effectively. The real options approach, for example, is focused on market entry and market development strategies. The resource based approach is focused on establishing and maintaining competitive advantage.

Other approaches, such as the entrepreneurial personality approach, arguably teach from the perspective of the CEO, but they lack scholarly support. The simulation approach places the student into the role of the CEO. This approach has merit, but if offered in the absence of reflection and learning can be counterproductive to the teaching/learning process. There are also few options available to instructors to offer high quality simulation experiences to students.

With the lack of an off-the-shelf alternative that was suitable to their desire to teach entrepreneurship from the perspective of the CEO, the team elected to create a brand new curriculum that would address their concerns and achieve their objectives. When they examined what it meant to view a venture from the CEO's perspective, it was clear that business processes were the main items of concern. In other words, the CEO of the entrepreneurial venture must be concerned with overseeing and ensuring that various business processes are performing effectively. This is vastly different from being taught to perform a process or business function at the level of a practitioner. For example, the CEO must be concerned with and understand the accounting process, but he/she doesn't need to be a skilled accountant. This oversight/performance distinction applies across each of the various business disciplines: management, finance, information systems, operations, marketing, and accounting. The entrepreneur/CEO needs to understand the underlying and interconnected logic of each of these processes without necessarily being or becoming an expert in any of them.

As the focus of the curriculum crystallized in the minds of the founding team of scholars and entrepreneurs, it became clear that what they needed to do was design a new approach to teaching entrepreneurship. The approach had to center on the oversight/performance distinction, providing entrepreneurship students with a comprehensive perspective that would enable in-depth understanding of the processes within a venture. As the team understood them, the primary processes within a venture are those that:

- Generating revenue

- Controlling costs
- Acquiring capital
- Business planning
- Managing operations

To capture each of these various business processes within the context of an entrepreneurship education the curriculum development team elected to develop a course around each process. Thus, the core program consists of four courses, focusing in turn on revenue, cost, capital, and the business plan. Then it was decided that a fifth course would also be useful—one that integrated the learning from the first four. The fifth course, for lack of a better name, was called the “implementation” course. It was built around business plans that the students had by then constructed through the other four courses. In later years, the implementation course was also augmented by a one-week student competition called “Burger Fest”. Students in the CEI entrepreneurship program create real small businesses selling hamburgers and other fare on campus and compete to determine who can generate the most revenues and, separately, the most profits.

Note that one of the primary goals in the business process approach is to teach entrepreneurship from the “CEO perspective”. That means there will be less depth in each of the courses than might be found in a “normal” business school course of the same title. Since the program was designed to utilize “regular” faculty into each course the problem became how to persuade them to teach their subject matter at a depth suitable to “the CEO perspective”. The solution the curriculum team devised was to combine regular business school faculty with a practicing entrepreneur in each classroom. Further, this collaboration was intentionally established to emphasize that both the faculty member and the entrepreneur were to be in the classroom at the same time. Rather than simply alternate classroom appearances the faculty member and entrepreneur work together to deliver the course content to students. This creates a dynamic where the faculty member is responsible to ensure that all theoretical concepts and constructs have a tether to the real world of entrepreneurship, while the entrepreneur is responsible to ensure that all his or her “war stories” result in a lesson or moral that has general application.

Note also that the business process approach to teaching entrepreneurship integrates many of the primary elements of the other curricular approaches that we’ve examined. The business plan is created as a part of the program, and is also taught as a separate and distinct course. The business plan is developed over a period of several semesters, building in the lessons of the revenue, cost, capital, and operations lessons. As such, the instructors teaching business planning are not overwhelmed with the need to provide feedback on multiple, new business plans. Rather, the course focuses on integrating the output of the other courses in the context of an investment-grade business plan.

The essential lessons of the “simulation based approach” are conveyed during the “Burger Fest” event held during the final semester in the program. This lesson requires students to adhere to generally acceptable business practices, and to explore techniques for making revenue and profits under conditions of a level playing field. Each student team has the same basic “storefront”, equipment, and initial conditions. Establishing a competitive advantage leading to increased revenues and profitability is a test of acquired business acumen, skills, and creativity.

The business process approach to entrepreneurship education has now been applied to thousands of students over a period of 14 years at the University of Houston, Arizona State University, and other campuses around the country. This approach was first used in the CEI program at the University of Houston, primarily in the business school. Around 1997, the engineering dean at UH requested that a course in entrepreneurship be taught to engineering students. The business process approach was modified and condensed to be delivered in two semesters. Of course, some of the elements of the full program had to be eliminated to accommodate the two-semester framework. For instance, the engineering students are not required to develop individual business plans. Instead, they form teams of five students to create a company and prepare its business plan. Each team elects corporate officers and submits an Annual Report to the instructors. Engineering students also do not have a “Burger Fest” equivalent opportunity. As of this writing, the program in engineering is entering its eighth year and continues to be a popular program among the students.

This experience with the engineering students at UH was the catalyst to attempt to understand the business process approach as a general entrepreneurship curriculum. It was not until 2003 that one of originators of the curriculum and a co-author of this paper (Sherrill), determined that the approach could be captured within the context of a single textbook. Working with the other co-author of this paper (Duening) the two produced a manuscript that ranged over the revenue, cost, capital, the business plan, and implementation processes that comprise the business process approach.

Significantly, the business process approach achieves each of the parameters deemed essential to effective entrepreneurship curricula. This analysis supports the business process approach as a basis for teaching entrepreneurship across colleges and across student levels. The CEO perspective on the start-up enterprise can be taught and it can to a greater or lesser degree—depending on student motivation and aptitude—be mastered. Slight modifications in the nature of the delivery methods may be required for different student cohorts or colleges. Engineering schools, for example, may better deliver the business process approach in a one semester format due to the normally full curriculum most engineering schools already require of undergraduate students. Engineers may also spend greater time focused on IP documentation and protection processes, as this is often the core element of technology-based ventures.

Conclusions

While not an empirical study, this discussion of the various curricular approaches to entrepreneurship is instructive to those who wish to teach it to engineering and technical students. It is the opinion of the authors of this paper that entrepreneurship curriculum should be continuous across the various disciplines. Thus, although entrepreneurship education is relatively new in the engineering and science disciplines of most campuses, it is not the case that the curriculum must be created out of whole cloth. Rather, instructors of entrepreneurship within the engineering and technical sciences can begin their exploration of entrepreneurship curricula in the business schools, where the practice had originally begun.

Other than the Business Process Approach, none of the leading curricula that we examined were able to meet the six basic components of a thoroughgoing entrepreneurship curriculum. Yet, the business process approach is the least well known as it was developed at a small southern school by a team of people outside of the mainstream in academic entrepreneurship. It is instructive

that, among the founding curriculum design team were some of the leading entrepreneurs in Houston. Many of these founders remain tied to the program. Some still teach regularly in the classes that now include graduate and engineering spinouts.

An engineer without some training in Entrepreneurism is in much the same position as an inventor. The product of the inventor's mind is valuable, but he reaps a small portion of the material gain his invention garners. With an understanding of the business process and the role played by its various elements, the engineer might find that he could participate in some phases of the commercialization of his idea. At the very least, he will be able to value his idea more accurately and not waste his time on ideas that are not commercially feasible.

While this paper has not delved into the empirical results of the Business Process Approach, it would not be difficult to do so. Over the past decade and more the program has graduate hundreds of students, and thousands more have been exposed to the curriculum in microcosm via the introductory course. The latter now regularly enrolls more than 500 students per semester in several large sections. The alumni of the program are exceedingly loyal, choosing regularly to attend dinners and other gatherings and to meet and greet incoming students.

Research should be conducted on the outcomes achieved by Business Process Approach and compare and contrast these data with those from other curricular approaches. At minimum, this research would have to investigate each approach on the six non-controversial components of a complete entrepreneurship curriculum. As we have already concluded, all but the Business Process Approach will be lacking in at least one of the components.

Table 1

Curricula	Parameters					
	1	2	3	4	5	6
Business Plan Approach	X			X	X	
Resource Based Approach		X	X			X
Entrepreneurial Mindset Approach		X	X		X	X
Case Study Method	X				X	
Simulation Experience Approach	X		X	X	X	
Entrepreneurial Personality Approach		X	X			
Business Process Approach	X	X	X	X	X	X

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