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## **AC 2011-873: TEACHING ENTREPRENEURSHIP THROUGH VIRTUES**

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# Teaching Entrepreneurship through Virtues

## 1 Abstract

The literature on entrepreneurship has moved from early analysis of the characteristics of the entrepreneur to a wider understanding of the interactions of the individual with their environment. That is, success depends not only on the personality and skills of the entrepreneur themselves, but also on the social network they find themselves in (or intentionally develop). A new enterprise flourishes or fails depending on a complex milieu of factors. As educators at a faith-based school, we have found a pedagogical approach to be helpful that links individual and community characteristics in a natural way to which students can relate: through virtues. This approach can attract students to entrepreneurship who want to make a difference in the world, where they might not seek out the topic for the more typical reasons, such as the chance to create something new or the chance to get rich.

First, we begin with an overview of the relationship between the individual and the community, including a review of the literature, focusing on the transition from personal characteristics of entrepreneurs to the broader understanding of the entrepreneur *in situ*. Second, we propose a new way to think of the innovation cycle, based on the virtues of creativity, diligence, and wisdom, which are informed by other virtues, such as compassion, justice, and stewardship. Finally, we consider practical pedagogy and case studies (including experiences of our student author) to teach entrepreneurship using the virtues, which may help faculty to move beyond simple teaching of skills towards a positive influence to increase student entrepreneurial behavior.

## 2 Entrepreneurship: individual characteristics and community/social interconnection

### 2.1 How should the individual relate to community?

The literature on entrepreneurship has moved from early analysis of the characteristics of the entrepreneur to a more sophisticated understanding of the interactions of the individual with the environment. That is, success depends not only on the personality and skills of the entrepreneur themselves, but also on the social network in which they find themselves. A new enterprise flourishes or fails depending on a complex milieu of factors.

To help us think about how the entrepreneur relates to her environment, consider the question of individual versus environment in a few other domains. Perhaps the best-known incarnation of this dichotomy is the biological aspect: nature versus nurture. On the one hand, our genes rather uniquely distinguish us. Physical characteristics are the most obvious, such as eye color or height, but behavior and predispositions are also heavily influenced by our genetic makeup. On the other hand, our environment strongly influences us. Physical characteristics are perhaps less affected except in extreme environments, but certainly our behavior, knowledge, desires, and preferences are heavily influenced by the stimulus provided by our surroundings.

Gunton looks at the individuality as well as the communal relationship between humans (our social network) as a key part of our identity: “Personal beings are social beings ... it must be said that they have their being in their personal relatedness: their free relation-in-otherness....All things are what they are by being particulars constituted by many and various forms of relation.”<sup>1</sup> One of the primary thrusts of Gunton’s book is that the individual (the one) must be respected

and therefore cannot be subsumed into the community (the many); but at the same time, the community must be respected as an essential part of the individual's humanity. We need both.

Neither the individual nor the community have primacy, both are key parts of what make us human. As just one example, the individual who fears "big government" may respect a democracy for providing participation and representation in governance, but at the same time worry that such collective influence and power may lead to the majority running rough shod over the rights of the minority. Both the individual rights as well as the proper role of communal governance are needed.

According to Gladwell, the three key types of people necessary to start and sustain a social epidemic are (a) connectors, (b) mavens, and (c) salesmen.<sup>2</sup> He contends that a social idea or trend takes off when a "connector" provides the medium for the idea to spread quickly because he or she knows a large number of people, but further, the connector's network must be rather diverse, linking people from all walks of life. The social epidemic also needs the "maven" who recognizes a good idea and passes it along in a very effective way because they naturally like to help people, which makes their offer particularly attractive (and infectious). The final element, the "salesmen", helps seal the deal, persuading people to "buy" the idea. This includes verbal and non-verbal cues that make these personalities particular adept at influencing opinions. These Gladwell archetypes are helpful in examining the entrepreneur as individual vis-à-vis society. An innovation by the individual entrepreneur does not take root unless it spreads (i.e., becomes a social "epidemic") through the community.

The entrepreneur starting a company must affirm both ends of the spectrum, combining their individuality and personal drive with their network of connections and community. For example, any one individual does not typically have all the skills necessary to start and sustain a successful business, and so must be able to work with a group to provide the necessary skills. Often the entrepreneur begins the company solely by the sweat of their own brow and must learn later to delegate some tasks as the business grows and they can no longer manage every detail themselves (even with superhuman effort). Some entrepreneurs have a great idea, but have trouble getting it off the ground without help. They need to tap their social and business networks in order to raise capital, to put together the deals to go into production, to develop a marketing campaign, and so forth.

Many entrepreneurs use outsourcing and subcontracting as the contractual means of tapping their community network for skills they do not have "in house". For example, one of the authors has a business in architectural services that contracts for engineering and information technology services so that the company can focus on architecture. One of the other authors has a business in embedded computer systems engineering design services that contracts with a bookkeeper for corporate accounting services, with an attorney for legal services, with a cleaning service to take out the trash, and so forth. This allows the company to focus on its core identity and core product.

## 2.2 Literature references

Low and MacMillan discuss the tension between entrepreneurial nature and nurture in identifying these as two theoretical perspectives of entrepreneurship research design specification. A focus on nature is termed "strategic adaptation," stressing that the "key to entrepreneurial success lies in the decisions of the individual entrepreneurs who identify opportunities, develop strategies, assemble resources and take initiatives."<sup>3</sup> The other pole of

nurture is termed “population ecology,” stressing that “individual goal-driven behavior is largely irrelevant and that environmental selection procedures are the most powerful determining factors”<sup>4</sup>. In addition to a theoretical perspective to entrepreneurship research design specification, a research focus can also be placed on the nature-nurture spectrum. Here the authors divide the scale into psychological, social-cultural, and network. The first tends towards nature, the second two towards nurture. The authors then point out that the research literature started out at the nature pole and moved towards the nurture over the last couple decades: “Early entrepreneurship studies typically focused on the personality or cultural background of the individual entrepreneur as a determinant of entrepreneurial behavior. Over time, these approaches yielded to a recognition that meaningful research must adopt a more contextual and process-oriented focus.”<sup>5</sup>

Aldrich has spearheaded a view of entrepreneurship through the analogy of evolution. In a paper with Martinez, he describes the four concepts of entrepreneurship as evolutionary development: “the creation of new organizational structures (variation), the way in which entrepreneurs modify their organizations and use resources to survive in changing environments (adaptation), the circumstances under which such organizational arrangements lead to success and survival (selection), and the way in which successful arrangements tend to be imitated and perpetuated by other entrepreneurs (retention).”<sup>6</sup> Aldrich cites Low and MacMillan in moving away from individual characteristics of entrepreneurs and focusing more on the process that moves a “nascent entrepreneur” from conception of a business to successful and growing organizations.

Singh, *et al.*,<sup>7</sup> has identified a positive relationship between the ability of the entrepreneur to recognize opportunities and the size of their social network (particularly the number of “weak links”).

Perhaps the pendulum has swung too far from individual characteristics, focusing on community and context. For example, Aldrich cites the many failed entrepreneurial endeavors that go unnoticed, as if to dismiss any particular individual’s contribution, implying that the masses simply generate lots of organization variations that are offered up blindly for the fittest to survive. But these are not random variations caused by mutations in an unintelligent genetic code but rather the thoughts and ideas of sentient, human entrepreneurs. Surely there must be some recognition that these individuals intelligently adapt because of their innate knowledge and passions.

A recent study of entrepreneurial activity in the state of Kerala in India<sup>8</sup> found that certain characteristics differentiated individuals behind successful enterprises compared to the general population. Distinctive attributes included somewhat higher economic status of family (providing a financial network), older than 35 years (providing maturity of judgment), and some technical training or work experience (providing product knowledge).

While this article is primarily focused on the teaching of virtues as it relates to engineering entrepreneurship in the business sector, there are many other examples of social entrepreneurship that can also be studied for applicable principles and potentially similar motivations. For example, Muhammad Yunus started Grameen, the microfinance banking. The Peace Corps, as a government-sponsored program, provides opportunities for recent college graduates to engage in social entrepreneurship projects on the ground level in many developing countries. Similarly, non-governmental organizations (NGO's) are also developing creative and innovative solutions to economic, health, housing and food issues in the United States and in many countries –

solutions such as treadle pumps<sup>9</sup> or an Engineers Without Borders water filter project<sup>10</sup>. Green<sup>11</sup> provides a helpful overview and analysis of humanitarian student projects within engineering programs.

Engineering students should be encouraged to apply virtues and positive societal values in whichever sector they work. In the business arena there is also an emerging trend toward discovering and meeting real customer needs at the lower levels of the economic spectrum with significant opportunities intentionally geared toward the "bottom of the pyramid" as mentioned by C.K. Prahalad. These can be innovative products and services that are also highly profitable for the businesses producing them. There are also many opportunities to collaborate among businesses, governments and NGO's to meet real and meaningful needs globally. Some students may already be inclined more toward working with a not-for-profit organization because of their own interests in integrating virtues and social values with their job and life's work. For students who are not already predisposed towards such integration, teachers can encourage consideration of virtues by looking for those opportunities within their projects, teams, and businesses (even when the projects are not tuned towards social entrepreneurship).

### 3 Innovation cycle

#### 3.1 Innovation cycles in the literature

The engineering design cycle is a set of iterative steps that guides the process of technology development. A variety of authors have proposed variations on the theme of problem definition/specification, ideation of alternative solutions, evaluation of options using decision criteria, decision/selection, and implementation. Similarly, the entrepreneurial innovation cycle is a set of iterative steps that guides the process of product and services business development. For example, Davila describes a general ideation process as the following seven tasks<sup>12</sup>:

1. Develop criteria
2. Prepare for brainstorming session
3. Brainstorming session
4. Screening meeting
5. Workshop and initial ranking
6. Brief investigation
7. Final ranking

He also notes that innovation processes must be guided by good leadership: "In companies that innovation produces best in class results, key success is tied to how well the CEO and the senior management team do the following (these are known as the Seven Innovation Rules)<sup>13</sup>:

1. Exert strong leadership on the innovation strategy and portfolio decisions.
2. Integration innovation into the company's basic business mentality.
3. Align the amount and type of innovation to the company's business.
4. Manage the natural tension between creativity and value capture.
5. Neutralize organizational antibodies.

6. Recognize that the basic unit (or fundamental building block) of innovation is a network that includes people and knowledge both inside and outside the organization.
7. Create the right metrics and rewards for innovation.

Marquis provides a similar model of the process of innovation<sup>14</sup>:

1. Recognition
2. Idea formulation
3. Problem solving
4. Solution
5. Development
6. Utilization & diffusion

Maidique provides a simpler list that combines some of these steps into just four stage of innovation: "Recognition, Invention, Development, Implementation." <sup>15</sup> Holt differentiates between the creative process and innovation process. The steps in the creative process are: "Idea germination (the seeding of a new idea, recognition), Preparation (conscious search for knowledge, rationalization), Incubation (subconscious assimilation of information, fantasizing), Illumination (recognition of idea as being feasible, realization), and Verification (application or test to prove idea has value, validation)." <sup>16</sup> In contrast, the steps in the innovation process are: "Analytical planning (to identify product design, market strategy, financial need), Organizing resources (to obtain materials, technology, human resources, capital), Implementation (to accomplish organization, product design, manufacturing, services), and Commercial application (to provide value to customers, rewards for employees, revenues for investors, satisfaction for founders)." <sup>17</sup>

### 3.2 Virtues as bridge

The stereotype of the entrepreneur is an individual who is hard driving, to the point of running over anyone in their way (thus lacking in compassion) and one who sees opportunities, but may be so narrowly focused that they miss issues of justice, sustainability, or community concerns. The literature shows that successful entrepreneurs do not fit this profile. Instead, they reach beyond themselves and depend on a fertile and supportive environment in order for their business to flourish. The stereotype of the engineer is an individual who is introverted, shy, and socially isolated, yet a technical wizard. This profile also emphasizes an individualistic nature, and again it needs to be tempered with a community network aspect.

Rather than emphasize either the individual or the community, in this paper we seek to bridge the two – through virtues. Virtues are admirable qualities, attributes of good character. Though they are held (or pursued) by an individual, they almost always are demonstrated in the relation of that individual to others. Thus they serve as a bridge or link between the one and the many, between the individual and the community.

Although many philosophers and ethicists have proposed virtues as a way to live in a right way, the list of virtues is not identical for each author, though there is significant overlap. The most

famous list is probably the seven “heavenly” virtues that counter the so-called seven deadly sins. These virtues can thus be thought of as the pursuit of an ideal or flight from negative characteristics. The seven virtues (and vices) are: charity (greed), chastity (lust), diligence (sloth), humility (pride), kindness (envy), patience (wrath), and temperance (gluttony).

The virtues form a bridge between the individual and the community because they regulate how the individual should behave toward the others in the community. For example, charity and greed describe how one should treat resources, either sharing them with others or hoarding them from others. Chastity and lust describe intimacy between the individual and others, particularly sexual intimacy, though not limited to this aspect.

The virtues thus appear to be a valuable tool to explore the relationship of the entrepreneur as individual and the entrepreneur at the nexus of a community network. Although their primary purpose is to encourage ethical and moral behavior (and we do not discount their value in this respect), we can also leverage the virtues as an infrastructure that helps us understand and thus teach entrepreneurship.

In the next section we introduce an innovation cycle based on virtues. These virtues themselves have appeared individually in the literature of this conference. We checked for the six virtues of interest in the ASEE National Conference Proceedings from 1996 to 2010 using a full text keyword search in October, 2010. The results are graphed in Figure 1. Most of the virtues we selected appear hundreds of times, but one appears a very large number of times – not unexpectedly, the word “creativity” is used thousands of times. Teaching based on virtues has appeared a couple times in the ASEE conference: in Jordan’s paper on virtue ethics<sup>18</sup> and in Helweg’s contrast of value and virtue<sup>19</sup>. A paper on design norms by Ermer and VanderLeest touches on so-called norms that could also be understood as virtues<sup>20</sup>.

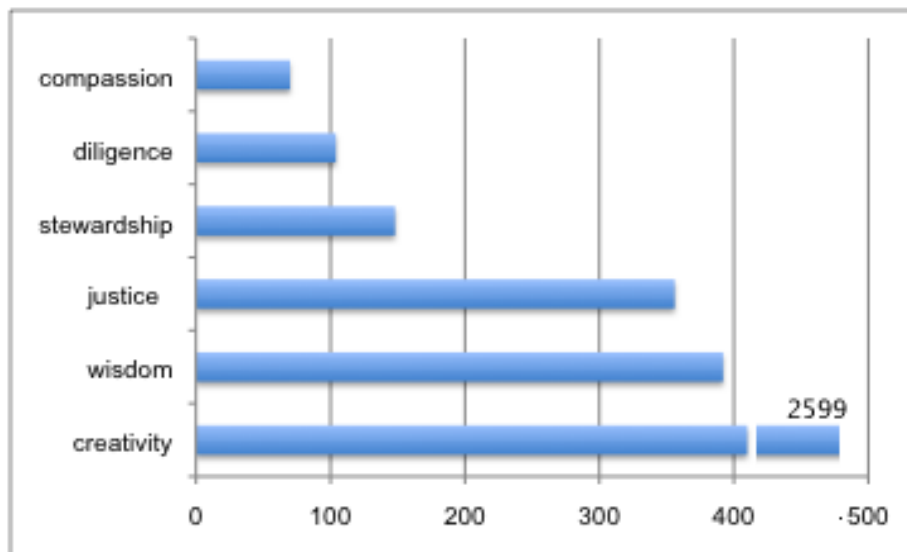


Figure 1: Frequency of Virtue Keywords in ASEE Conference Proceedings

### 3.3 The virtuous innovation cycle

The “right” set of virtues is not clear-cut. One could use classic virtues from historical Western thought (such as the "natural virtues" of prudence, temperance, fortitude, and justice) or Judeo-Christian ideals (which include faith, hope and charity/love), or perhaps the so-called seven heavenly virtues. We selected creativity, diligence and wisdom as three virtues that correlated closely to innovation, achievement, and dealing with risk – traits that are often listed as characteristics of entrepreneurial personalities in the management literature on entrepreneurship. In considering such traits and associated virtues, we started with the list of entrepreneurial character attributes listed by Glick-Smith<sup>21</sup> and then compared them to other such lists including the definitions, samples and characteristics of entrepreneurs surveyed by Gartner<sup>22</sup>. We noted the frequency and correlation of specific characteristics and compared them to the various lists of virtues. Gartner looks at entrepreneurs from a personality trait view as well as a behavioral view, and then ties these aspects to the creation of organizations. Carland, Carland and Stewart<sup>23</sup> looked at connections between basic human psychological characteristics with various levels of intuitive strengths and levels of drive, examining these connections in light of commonly cited entrepreneurial characteristics of innovation, achievement and risk. Crant<sup>24</sup> looks at the type of personality associated with entrepreneurial intentions: “Proactive personalities identify opportunities and act on them; they show initiative, take action, and persevere until they bring about meaningful change.”

We intentionally work with a rather broad definition of entrepreneurship. Our intention is to explore possible connections between certain virtues and potential applications of entrepreneurship including founding a new business, acquiring an existing business, managing a turnaround, creative activities of innovators, identification and exploitation of an opportunity, and development of a niche in the market or development of a strategy to satisfy some need.<sup>25</sup> The remainder of this section briefly defines our proposed virtues for innovation and provides a few quick examples.

#### 3.3.1 Defining creativity

Creativity is "the ability to make or bring into existence something new through imaginative skill" (Merriam Webster) and is synonymous with ingenuity and inventiveness. Creativity is a core skill in engineering for brainstorming alternative solutions to a specified problem. It is an important ingredient in anticipating consequences that might otherwise go unforeseen. Even seemingly straightforward tasks such as problem specification are often complex challenges that require creativity to tease out the whole story. Creativity in entrepreneurship can be found in innovations in organizations, products and services, processes, and in marketing, operations and finance as well as in leadership and management.

Some companies specifically encourage individual creativity. For example, Google allocates one day each week for employees to pursue their own ideas and pet projects. IDEO takes problems from almost any domain (including products or services) and uses multi-disciplinary team to tackle them, creating space for creativity by using very fluid, diverse teams. Many institutes of higher learning provide a sabbatical leave (traditionally every seven years) for faculty to recharge and pursue a research project.



### 3.3.2 Defining diligence

Diligence is "perseverance with a steady, earnest and energetic effort" and is synonymous with industriousness. The diligent entrepreneur has determination, thoroughness, and perseverance to endure to the completion of a project. Thomas Edison remarked on the necessity of diligence in the process of invention: "Genius is one percent inspiration, ninety-nine percent perspiration."<sup>26</sup> The founders of Amway Corporation first dabbled in several other businesses, including a flying school, a drive-in restaurant, and a vitamin business until they finally hit on a successful formula for a biodegradable cleaner that they first sold out of their basements.<sup>27</sup> A significant part of the testing and refinement process of an innovative idea is thoroughness in exploring all appropriate alternatives – turning over each “stone” to make sure the testing covers all angles and does not miss any critical steps or issues.

### 3.3.3 Defining wisdom

Wisdom is the ability to discern inner qualities and insights. It is good judgment and intelligence. A wise person is "marked by deep understanding, keen discernment and a capacity for sound judgment." Furthermore, wisdom is more than simple knowledge or memory for information, or command of countless facts. Elliott captures this idea of deep intelligence in his poetry.

*The endless cycle of idea and action,  
Endless invention, endless experiment,  
Brings knowledge of motion, but not of stillness,  
Knowledge of speech, but not of silence;  
Knowledge of words, and ignorance of the Word.  
All our knowledge brings us nearer to our ignorance,  
All our ignorance brings us nearer to death,  
But nearness to death no nearer to God.  
Where is the Life we have lost in living?  
Where is the wisdom we have lost in knowledge?  
Where is the knowledge we have lost in information?  
The cycles of Heaven in twenty centuries  
Bring us farther from God and nearer to the Dust.*

Choruses from "The Rock" by T. S. Elliot

Wisdom is key for the entrepreneur in identifying the opportunity where others have not, discerning whether this is the right prospect to pursue at the given moment. Entrepreneurs are often non-linear thinkers, estimating the probability of success in the face of ambiguous and incomplete information. Wisdom often includes a person's beliefs and attitudes that lead to decisions toward a selected course of action, leveraging understanding, discernment, and judgment. (a) Understanding is more than simply learning facts or theories; it is a deeper level of intelligence that requires connecting various aspects of knowledge within a specific context of relationships in time. (b) Discernment requires narrowing the field of options and alternatives, converging on the best and most feasible solutions. This involves not only critical analysis, but also developing objective data on which to base decisions and an intuitive sense of what alternatives have the greatest likelihood of successful implementation –sensing customer and market demand in the face of broader economic situations, including potential and existing competition. (c) Judgment is required to make good decisions regarding pursuit of potential

directions, ideas, or products. We base our selection of the right opportunities or making the right decisions on some personal belief or value system that defines “right” or on a corporate belief or value system, mission or vision – which is indirectly based on the defining group’s beliefs and value systems. Thus, judgment is part and parcel of our worldview.

### 3.4 Informed by other virtues

Although many businesses and some individuals make maximization of profit their only goal, many entrepreneurs find success (including financial) when their focus is not solely profit. They make meaning<sup>28</sup> and make a difference through their business. Thus while long-term profitability (and short-term positive cash flow) is certainly necessary for a business to remain viable, the meaningful goods and services the business supplies to meet the needs of the community around it often serves as the main purpose and driver of a business.

Innovators are often most productive, encouraged, and least constrained when they are motivated by intrinsic factors in addition to extrinsic factors related to profit motive. This led us to identify three additional virtues that inform and support the virtuous innovation cycle of creativity - diligence - wisdom. We chose to explore here the additional virtues of compassion, justice and stewardship. We selected three to encourage and inspire entrepreneurial students and engineers to consider more widely the context of their relationships, community and global society as a whole. Benevolence, social attitudes, market morality, comprehensive awareness, and value systems are also often mentioned as characteristics of many entrepreneurs although not as frequently as creativity/innovation, diligence/perseverance, and wisdom/good decision-making or reasonable risk-taking. Concern for others beyond ourselves and for doing the “right thing”, as well as taking a concern for the environment in a sustainable way are all growing considerations among the current generation of students and should be further encouraged for even wider inclusion and implementation into entrepreneurial education.

The virtue of compassion calls for love and caring of others. Compassion encourages the development of innovative goods and services that make the lives of others better.

Compassionate entrepreneurs are concerned for how they treat and relate to all stakeholders of a product (including employees, customers, suppliers, consultants, producers, government officials). Compassion strategically directs creativity away from simply improving one’s own lot to the broader concern to help others. Compassion can help fire diligence but it also tempers diligence so that a balance is achieved with time with one’s own family and concern for the whole lives of co-workers and employees. Entrepreneurs must use wisdom to make the best decisions possible, but their decisions should be based on the most compassionate products and outcomes for the greatest number of people and not solely on profit.

The virtue of justice calls for a sense of fairness and equity. This is justice in a broader sense than simple retributive justice that metes out punishment for wrongdoing. It is justice that establishes fair treatment and equity. In making decisions about which innovations to pursue, entrepreneurs must also consider what is just. Their processes and working relationships should be fair with a concern for the interests of all stakeholders and not only their own interests, not only the interests of the paying customer. The code of ethics for many of the engineering societies has the idea of justice behind many of its guidelines. Furthermore, many entrepreneurs and indeed many of our engineering students come from a religious faith background that emphasizes the principle of justice. Justice requires honesty in all dealings, operations, and finances. Honesty in the marketing of innovative products or services does not exaggerate or

promise what the product cannot realistically provide or deliver, as a matter of fairness. Testing and verification of products should be both accurate and transparent. Justice also means that employees and suppliers ought to be paid their full due in a timely manner, as a matter of fairness.

The virtue of stewardship calls for the frugal and efficient use of all of the resources we have at our disposal (as individuals, as a company, as a nation, and even as a planet). Much of the work towards sustainability aligns with this virtue. Teaching at a faith-based school, this virtue plays out of a worldview that entrepreneurs and engineers have a responsibility to care for our natural resources because they are from the Creator's hand. This means developing products or processes that make use of natural resources without unduly damaging them or harming the natural environment.

#### 4 Teaching virtuous entrepreneurial behavior

Skills and knowledge in technical engineering domains and in business domains provide our students with tools for decision-making (including entrepreneurial engineering decisions). However, these often do not go far enough, because they only answer “what” and “how” while virtues (and their implied values) inform the questions of “why” and “for what purpose?” Students with ambitions to make a difference in the world need to answer all these questions.

The main focus of this paper is not so much the teaching of virtues but rather the use of virtues as a way to teach entrepreneurship. While some have promoted virtues as the new driver of business (c.f. Vogel<sup>29</sup>), it is important to recognize the challenge of teaching virtues themselves – certainly a problem that has been with us throughout human history. Virtues (which imply not just knowledge but behavior and attitude) are not so much taught as caught by mentoring and modeling. Thus teaching them moves beyond simple knowledge transfer to more active encouragement, fostering, and enablement. We begin this section with some general comments about teaching virtues, and then look at some specific suggestions for each of the three innovation virtues.

Teachers can make use of more open-ended class discussions, where students find a challenging but safe place to explore the infusion of virtues in their innovation and decision-making processes and projects. Teachers can also foster multi-disciplinary environments, helping students form more varied teams including those that combine engineers with students and practitioners in business, economics, sociology, psychology, politics, education, art, and history. The Innovation Encounter competition (discussed later in this paper as a case study) is an example of this mixed-team approach.

Questions about virtues can be asked right from the beginning of each project, during the project, and as part of the post-evaluation. Teachers can also share from their own work and personal experiences, demonstrating the impact of the consideration of virtues on their own work, teaching, and lives – recounting how virtues have been helpful or even necessary to bring an innovation to a marketable reality. We have the opportunity to push students beyond the typical questions, to set higher standards and goals for them, to encourage them to make a positive difference in society and the global community of which they are all a part.

Project reports can require students to also do reflection in writing. Learning is enhanced by using a variety of learning and teaching styles and methods, to both reach all students who have varied learning styles and to stretch students beyond their main or preferred learning style.

In the remainder of this section we suggest a few pedagogical techniques that may be helpful for teaching each of the three innovation virtues (creativity, diligence, wisdom). Then in section 4.4 we examine some options for curricular design related to these virtues. We close this section by providing some case studies from the student's point of view in section 4.5.

#### 4.1 Creativity pedagogy

Like most of the virtues, creativity can be difficult to teach because it is not simply a set of facts to be memorized but is a complex set of mental tasks, a behavior, an attitude, a characteristic. It is caught from a mentor as much as it is learned from a teacher. We recognize the output of creative thinking, but can often have difficulty describing the process we went through while creating (and thus have difficulty teaching it). Nevertheless, significant strides have been made in teaching creativity in engineering and business in the last decades (e.g., see case studies at the end of this paper or see Pappas<sup>30</sup> for a survey paper on teaching creativity).

Creativity can be fostered by providing real life problems and opportunities for meeting global and personal needs, by teaching a process of investigation and problem-solving individually and in teams across disciplines, and by encouraging novel solutions and new perspectives without discounting new ideas too quickly. The teacher can encourage creativity by providing the appropriate resources along with an environment conducive to developing new ideas and concepts, while at the same time asking appropriately hard questions. Creativity can be promoted in teaching as well as in management by encouraging students to ask broader questions, to avoid elimination of potential options too soon, to think of the wider context, and to make connections between theoretical ideas and concepts with practical and useful applications that are needed by society. Creativity via networking can be seeded by connecting students with other professors and professionals who provide additional perspectives and resources.

Innovation and project courses often provide the intellectual space for creativity. However, many traditional engineering lecture courses can stifle creativity by using "canned" problems with single solutions. Furthermore, the packaging of labs and lectures into small slices can make it difficult to allow for the time necessary to explore and innovate (which can be detrimental to both creativity and diligence, the next virtue considered).

#### 4.2 Diligence pedagogy

Diligence can be taught through case studies of specific entrepreneurial engineers and companies who have been consistently persistent. Examples of diligence can range from historical figures such as Thomas Edison to contemporary entrepreneurs such as Sergei Brin of Google. Students should also explore the tension between wide-open creativity and the diligence required to be systematic, to follow through, and to persevere.

Teachers can encourage students to set big and lofty stretch goals as well as specific, measureable, and achievable goals. Students can be encouraged to develop their personal commitment to the project and their team, and to develop realistic but challenging schedules and time frames with specific dates. Thoroughness can be fostered by continually asking questions of students to make sure they have considered all of the relevant questions, that they can provide a good justification for their choices, that they have estimated the risk, have done a cost/benefit analysis, and so forth. Encouraging students to persist, to see problems and obstacles as opportunities that can lead to additional new ideas and a competitive advantage, can foster perseverance. Teachers can share their own experiences with persevering as well as stories and

examples from other innovators and innovative organizations that led to breakthroughs after significant hard work and patience. Personal encouragement from teachers to students can support and energize students and student teams to persist. One of the beauties of such encouragement is that it costs only a small amount of time and can make a significant difference in the eventual successful implementation of an innovation.

### 4.3 Wisdom pedagogy

Wisdom is necessary to make balanced and informed decisions about which process to use, what options to consider, how to narrow possibilities to those with the most potential for application and profitability, and which solutions may have the potential for the greatest good while minimizing the potential negative impacts on society. Wisdom starts with information and knowledge (from books, faculty teaching, and more), but often only becomes real insight from watching and interacting with someone with more work and life experience, so that the student can learn from and build upon the teacher's hard-gained know-how. Interaction between student and teacher provide a dialogue, a two-way discussion and sharing of insights and values. Teachers can encourage understanding by helping students see the connections and potential relationships between concepts.

Judgment often comes with greater professional and life experiences which the teacher and senior staff can share with students and junior staff. Sharing of mistakes made and lessons learned can be particularly helpful, along with how to avoid most mistakes or missing opportunities with a rationale for making better decisions in the future. Students must come to own this experience, and thus must be allowed to try out their growing discernment with guidance, but not stifled or narrowly directed by their teachers, i.e., they must learn to learn, capitalizing on their successes and also benefiting from their mistakes. This need to own the experience is typical of all the virtues: one must practice them – actually incorporate and use them in real life problem solving. If they are only studied and are not used in practice by a student, then the “head” knowledge is not integrated with the rest of the worldview and is not easily or readily applied.

Wisdom can be taught in tandem with diligence – pushing and stretching students to evaluate risks and opportunities, to ask the right questions, and to be self-motivated in an iterative process of constant refinement – all of these activities to promote diligence can then lead students to consider and wrestle with broader contextual questions beyond just solving a specific problem but generalizing and seeing the larger pattern.

### 4.4 Curriculum

#### 4.4.1 Incremental and repeated

Multiple classes, projects, and problems allow students to grow and learn at a reasonable pace and to build on what they have learned previously in incremental steps. The innovation process in entrepreneurial engineering must be iterative and thus the infusion of virtues in the design and implementation of ideas will likely require an iterative approach as well. An incremental approach could, for example, ask students to learn virtues in greater number and in greater depth while they proceed through the curriculum, so that they internalize them and become self-motivated when they enter the work place.

#### 4.4.2 Experiential learning

Internships can serve as an introduction to entrepreneurship if the company is a start-up. It is more difficult to find an entrepreneurial experience within an established company, but it is not impossible – for example, “intrapreneurial” teams within some companies carry a product all the way through its development, marketing, and production cycle; another possibility is a company that provides innovation services, such as Sundbergferar.

Within the engineering department at Calvin, students take an Engineering Internship Workshop during their sophomore year. Our internship coordinator (a faculty member within the department) shares experiences with how employers hire, what characteristics they seek, how to answer tough interview questions, and professionalism on the job. The internship coordinator helps students to send out resumes and make networking connections. Students are required to follow-up with leads. The engineering internship course (which can be completed more than once, for each internship experience) requires students to write an essay and make a public presentation on their experience.

Within the business department at Calvin, the internship program follows the general outline of Kolb’s Experiential Learning Techniques<sup>31, 32</sup> of Action/Active Experimentation, Cognition/Abstract Conceptualization, Reflection/Reflective Observation and Experience/Concrete Experience. This methodology provides a strong learning experience for the students participating in the program while incorporating teaching the virtues. The students typically start with a cognitive session with abstract conceptualizations, teaching the virtues in a lecture setting (a pedagogical technique that is well suited for those who prefer abstract conceptualization). These lectures provide the backbone from which the student can learn about the necessary virtues to engage the world as an entrepreneur. This is mostly an informative section that helps the students to learn the attributes of these virtues. Students are then moved to an observational phase where they can watch a mentor practicing the virtues in a real world setting. This learning touches on Kolb’s concrete experience technique, allowing the student to take what they learned scholastically and see it take shape in real-world situations. This phase can demonstrate the complexities with which the virtues come together and show that they don’t always do so in an ideal fashion. The next component of the program is experiential with concrete problems and situations. Students in this phase work on an innovation project of their own choosing while applying the virtues they have learned and seen in practice. This implements the active experimentation learning technique and gets the student “off the bench”. In this learning, the students are no longer observing another person or sitting in class, but actually applying the things they have learned in those situations to real-world problems that they must solve. There is a huge difference between being a passive observer and being the one making the decisions about a project in which one is heavily invested. This teaches the tension between the virtues and how complex it can become to follow those virtues. Finally, the students must discuss and write about their experience in a reflective phase similar to Kolb’s reflective observation technique. In all of the confusion and even chaos that comes with tackling innovative problems, there is a good chance that the virtues were overlooked in some instances. One does not naturally look through the list of virtues and make a decision on that basis, yet that is not to say the virtues did not influence these decisions. Providing time to look back and recognize those situations in which the virtues were utilized helps to tie all the learning techniques together, and open the student's eye to the many and complex uses of virtues in the world.

## 4.5 Case studies from a student perspective

Earlier in the paper we noted the value of multidisciplinary teams because of the insight and value of diverse viewpoints. We practiced this even in the writing of our paper. Our three authors include one member of the business faculty, one member of the engineering faculty, and an engineering student. Much of the paper up to this point has been our combined thinking about innovation virtues, primarily from the teacher's viewpoint. This section on case studies is based on our student author's experiences, reflecting back on them from the perspective of our proposed innovation virtues.

Competitions are an excellent way to foster the growth of innovation virtues. Competition can teach the entrepreneurial skills in a setting conducive to learning virtues as well. Likewise, students may understand virtues more easily in this "safe" environment before they are tested in the complex setting of the business world. Competitions provide an excellent medium for applying classroom knowledge to situations that necessitate application. Classroom learning comes alive when student competitors must persevere through real problem descriptions and ethical dilemmas. In this section, we examine examples of the Science Olympiad Robot Ramble, ASEE Novel Endoscope, and Innovation Encounter competitions to find their contributions to teaching innovation virtues.

### 4.5.1 Creativity

Creativity is probably the most sought attribute for engineering competitions such as Science Olympiad or the ASEE Novel Endoscope competition. Both provide environments for students to encounter problems that must be solved in an innovative manner. Many of the best engineering competitions do not simply encourage, but demand creativity of successful competitors.

One important aspect of creativity highlighted by competitions is the ability to take a step back and look at things from a different angle. This may actually involve looking at a material from a different physical and figurative angle. For example, in a mechanical engineering course an issue with testing a theory arose where the only solution identified so far was to completely manufacture a new part – a costly and time-consuming yet unproven answer. The problem was presented to a student, who looked at the current tooling and was able to design a workable setup to test the idea. The student came across this solution by looking at the tooling, considering previous solutions, and then going in a new direction – turning the tooling upside down and using some masking tape as a quick, temporary fastener. This student learned to think outside of the box through participation in competitions. Competitions intentionally limit resources available to the contestants, forcing them to be creative. In the Robot Ramble Science Olympiad competition, it was not always the best-funded robots that achieved success. Limited funds forced one team to strive for a better idea rather than purchasing better materials or borrowing ideas from others. By attacking the problem from a novel angle, they were able to beat teams with thicker wallets. Creativity can be inspired in other ways through competition as well. Sometimes it can be as easy as making it a design parameter. In the novel endoscope design competition at the 2010 ASEE conference novelty was a necessary condition, forcing teams into the right mindset of constantly asking themselves what "novel" implied for this competition. Competitions that force teams to leverage unique advantages and uncover new opportunities can significantly enhance entrepreneurial education that focuses on virtues such as creativity.

#### 4.5.2 Diligence

Competitions can be key to training students in diligence. Diligence supports every step of the entrepreneurial cycle. It pushes the entrepreneur to look for a better solution. And when that solution is found, it helps to bring that solution to fruition despite countless obstacles that line the path to completion.

Competitions are fertile entrepreneurial environments. They mimic real life where an initial answer produces many more follow-on problems. A good example of diligence in a competition comes from a Science Olympiad practice in which a team thought their robot had been completed. They took it to the testing surface only to watch their design go up in smoke (literally)! There was no clever solution to this problem; it was solely an issue of whether the students had the will to start all over on something they had worked on for so long. They persevered and went far in the competition because they were determined to fix their previous mistakes and make their next generation robot even better.

Equally important, competitions teach one that diligence pays off in the end. The team that participated in the ASEE competition had a deadline of mid-June and with end-of-semester exams and class work, not much physical progress had been made on their design. This meant a lot of time in late May and early June spent in a garage: gluing, testing, building, designing, etc. All of this was occurring while their phones kept buzzing with friends inviting them to the beach or a pool party! Their diligence eventually paid off – entrepreneurs go the extra mile even when it is hard to do. Competitions can help to teach this attribute.

#### 4.5.3 Wisdom

An engineer I was shadowing once told me to learn from the mechanics in the shop (regardless of whether they went to college or had a high degree). He was right in a profound way and this piece of wisdom has two important lessons. First lesson: there is no substitute for experience. Knowledge can be taught and is useful but wisdom is where knowledge interacts with experience to produce insight far more valuable than raw facts. Consider the robotics competition. The team did not come up with the previously mentioned out-of-the-box idea right off the bat; the first year they attempted the challenge they failed miserably, never achieving a competition-ready robot. They started their design process in a basement, just thinking about it. They thought and thought and finally came up with a “brilliant” solution. It had a very unique process cycle with many intriguing complexities that all fit together beautifully and worked perfectly – in their heads at least. When everything came together in reality and it was time for integration testing, the motors were not strong enough, the process didn’t flow, and, more than anything, it was far too complex. What they lacked in success they made up for in experience – the next year they knew how to size the motor to deliver 5 ft-lbs. of torque and how to avoid major issues that inevitably pop up. They learned to anticipate Murphy’s Law. Second lesson: people from different backgrounds and settings are important. A smart group member will never dismiss anyone or any idea too quickly. A webinar hosted by Applied Innovation Alliance<sup>33</sup> put it this way – no idea is worthless; everything you see and hear has potential to make your project better. A seemingly terrible idea was mentioned for some real reason and respecting the person who said it enough to find that reason can lead to a solution that may otherwise have been missed. Competitions such as Innovation Encounter help to foster wisdom in this regard. It is a team-based design competition that presents the students with a problem and 5 hours later asks for a solution. This forces the students to interact and rely on one another like they never would have to in other



competitions. The team from Calvin College was a diverse group of Engineering, Computer Science, Marketing, and Accounting majors. While some originally thought the majority of the core work would be done by the engineers alone, the actual result was far more symmetrical. Engineers and computer scientists worked on development of the product while still consulting with and helping the business and marketing teammates who were busy researching in their areas of expertise. Engineers could bounce ideas off people who thought about things in a non-technical way. These differing perspectives influencing the decision-making brought strength to the team that few other teams had (which were mostly comprised of engineers.) This team was a well-oiled machine running on organization and collaboration and the end product was something far greater than any one collegiate concentration could have achieved alone.

Another example is the cardboard canoe race, a Calvin College tradition that challenges students to make a canoe out of cardboard, plastic bags, and duct tape. The students all come together the day of the race, put their canoes in the murky water of a large campus pond and paddle with cardboard oars like their lives depend on it while friends cheer from the banks. The merit for this competition does not lie in the problem statement however; its usefulness resides in its accessibility. Entrepreneurship and the ideas and projects that result are quite demanding. Such situations can shake the determination and nerves of even the most seasoned entrepreneur and thus the stereotypical goals of money and fame don't always motivate. Entrepreneurs need to “catch the bug”. They need to learn to love the project and pursue accomplishing something substantial. This competition provides a medium for going beyond the typical student routine and creating something worthy of pride while still having a lot of fun. The key is to create an event that is enjoyable enough to draw people in but also facilitates these entrepreneurial passions.

#### 4.5.4 Supporting virtues

The supporting virtues of justice, compassion, and stewardship naturally occur in the competition setting as well. Competitions illuminate the need for justice. The strict rules of these competitions teach innovation in a setting where unfair advantage and dishonesty are harshly punished. Additionally, in competitions where funding is needed, the team may have to write a petition for funds. These are very educational and demand an honest review of the anticipated cost and the expected rewards. A good example of compassion in competitions is in the ASEE design competition when an endoscope innovation was required. Ideas of patient comfort and recovery came into play in the development of this design. Many ideas were discarded because the team was almost certain it would violate the Hippocratic “do no harm” oath. It taught the students to put themselves in the shoes of the future user and what using the product would entail. Would the design lessen the current discomfort of this procedure or compound it? Competitions also encourage stewardship in potential entrepreneurs. Competitors have to be good stewards of the limited funds and resources available to them, researching before purchasing, using creativity to make a good idea work without the ideal materials, and generally conserving what they are given so an end product can be reached.

#### 4.6 Assessment

Assessment of virtues is notoriously difficult because it involves not only knowledge and comprehension but also internalized behavior change, which may not become evident in the short term. As a pilot approach to assessment, one of the authors taught a brief lecture-style class on the definition and application of the innovation virtues in a course on iPhone application development. The lecture included student engagement in defining virtues and imagining their

use in product development in general and for iPhone apps specifically. The following class day, the students completed a quiz and also a survey of two questions related to the virtues the previous day. A five level Likert scale was used for responses, coding them as follows:

-2 = Strongly disagree
-1 = Disagree
0 = Neutral
1 = Agree
2 = Strongly agree

Table 1 shows the results of the survey (with an admittedly small sample of only 20 students), with graphical representation in Figure 2

Table 1: Virtue Survey Results

	Average
1. The brief study of virtues related to innovation positively impacted my perception of entrepreneurs.	0.89
2. The brief study of virtues related to innovation positively impacted my own desire to pursue entrepreneurial activity.	0.32

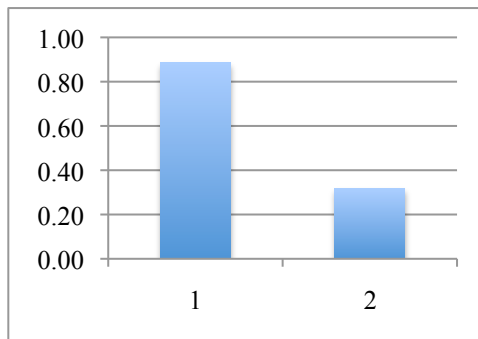


Figure 2: Virtue Survey Results

This assessment had a small sample size and has at least some bias because these particular students were somewhat self-selected for entrepreneurship. However, as a pilot instrument, it at least demonstrates one way that the difficult problem of measuring virtue education could be measured – by focusing on observable outcomes that we hypothesize are positively influenced by virtues.

## 5 Conclusion

In this paper we argued that both individual characteristics of the entrepreneur as well as the environment around the entrepreneur contribute to success in bringing innovations to market. We then proposed a set of innovation virtues that form a bridge between the attributes of the individual and the community around them. The virtues of creativity, diligence, and wisdom can

provide a mental model and framework around which students can form their thinking about innovation. We then provided some initial ideas for teaching virtues as part of an entrepreneurship curriculum. We conclude now with an acknowledgement that application of virtues is not as simple as we may have portrayed and a summary of possible next steps.

### 5.1 Tension between virtues

Often the virtues work in concert: wisdom and diligence can lead to better ideas and thus creativity; compassion and stewardship can lead to a green initiative that saves money for the company and protects the environment simultaneously. However, the virtues do not always complement each other. In the case study on the endoscope design competition, the specifications stated that a realistic novel endoscope should be made – but the competition was judged by the total time for the endoscope to perform its function. Here the virtues of compassion and creativity collided. In this instance the team wanted to design a device that was not excruciatingly painful for a real human subject; yet speed was the determining factor for the competition.

One mechanism to explicitly consider and balance tensions between design criteria is the use of a decision matrix. Each potential solution alternative is listed as a row in the matrix and each decision criteria is listed as a column. Weight and strength are classic examples of design criteria that may be in tension. Ideally one wants to maximize strength and minimize weight, yet higher strength necessitates higher weight. So the matrix allows the designer to clarify that trade-off. We can add virtues as additional decision criteria as an organization method to clarify the tensions with other design criteria (including other virtues). While this method draws attention to the complexity of the interaction between virtues, it does not solve that tension and thus students should have the opportunity to explore these tensions and see the consequences of their chosen trade-offs in real projects.

### 5.2 Further work

More work should be done to correlate specific examples of teaching methodologies with each virtue. For instance, the cardboard canoe competition could more explicitly connect creativity in the formation of the actual teams to greater innovation of the design and construction of the canoe. It could also promote stewardship of the environment with spare and effective use of materials in the construction of the canoes as well as the recycling of the materials used. Diligence could be stressed in terms of developing a reasonable schedule that allows for consideration of more options and the wisdom of using trial runs.

Additional examination of the tension between virtues would be helpful. Entrepreneurs often must make decisions that naturally create conflict between virtues. Educators should help students develop their own decision-making process based on their own value system as an aid to making balanced decisions, so that the student comes to expect (and not fear) these situations fraught with ambiguity and tradeoffs.

We did a pilot assessment for this paper. A realistic assessment would require a longitudinal study to provide justification for the value of our proposed approach of innovation virtues and to provide evidence for the effectiveness of specific teaching methods related to these virtues. We hope to explore teaching virtues in senior project classes (both engineering and business) to determine the impact on student decision-making and the correlation with subsequent

predilection for volunteering and participation in other entrepreneurial-related activities such as competitions or clubs.

One final area for further study would pursue the question of how best to encourage students to take the initiative in pursuing entrepreneurial related opportunities, to volunteer their own time and energies toward them rather than simply complying because it is a course requirement. Our student author certainly did take the initiative to engage in entrepreneurial projects and participate in entrepreneurial competitions, but how might teachers identify and encourage a larger number of students to do likewise? Our student author had a natural inclination and interest in creative engineering design, which he pursued on his own well before college, then later gravitated toward those kinds of opportunities within coursework and also in voluntary competitions such as the cardboard canoe and concept designs. We are thus interested in the characteristics of students who decide to voluntarily participate in such activities to look for correlation with various curricular features related to entrepreneurship. Our goal would be not only to teach intellectual knowledge of methods, process and virtues but also to create an environment that nurtures a noticeable behavior change – where students begin to incorporate virtues or the consideration of virtues in their creative and entrepreneurial projects and endeavors.

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