Building Innovation Capacity Through Entrepreneurship Educational Programs

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New university graduates are often described as having an underdeveloped skill set to effectively engage in innovation related activities. Frequently, senior management in firms that hire engineering students express concerns that the new graduates show an inability to function effectively in their first jobs after graduation[1]. Competence in technical subject matter is acknowledged, but the interpersonal skills in an organizational context, and knowledge specific to the process of innovation are described as lacking[2].

With some exceptions, undergraduate degree programs are typically missing the focus and curriculum that provide a platform for the development of skills related to innovation. Exposure to the relevant learning is often relegated to in-course project work and capstone projects, which are often more focused on the development of technical skills related to the program of study.

Conventional research-focused engineering graduate programs also typically overlook the essential skills related to driving innovation in an organization. Graduate students generally become skilled in the pursuit of technical knowledge. The research conducted will typically have a focus related to the application of technology, or to satisfy curiosity. The process of stakeholder engagement in the definition of the problem being researched is usually confined to the student's supervisor and, in the best case scenario, a handful of others with whom the graduate supervisor collaborates. Often, the topic of research is broadly predefined by the student's supervisor who has successfully negotiated the funding to support the research to be conducted, and who needs to generate publications as an outcome of the funding.

In response to the needs of industry, many institutions of higher learning have been developing minors or entire programs, at both the undergraduate and graduate level, to provide education that develops innovation skills[2]. It seems that almost every campus now has some sort of formal or informal entrepreneurship course or program. Typically, these programs focus only on the mechanics of innovation in the context of creating a start up or a new design. Although the act of participating in such programs will develop other transferable 'soft skills', this development is not an intentional focus of these programs. In this chapter, we share the elements of a program that includes transferable 'soft skill' development in a deliberate way. The focus here is on skills directly relevant to the innovation process.

The skills needed to drive innovation in an organization can be broadly categorized into three types, which we adopt here as our framework for the innovation teaching and learning process:

i) **Process Knowledge**: the application of knowledge relevant to the process of innovation. This knowledge includes an understanding of the innovation process, the art of framing a problem to be solved, the identification of added value, the detail and mechanics of building a business case, and an understanding of the ambiguity and conceptual dynamics of evolving a business concept.

ii) **Thinking and Doing Skills for Innovation**: the personal skills needed to effectively function in an innovation context. The skills include the ability to work with incomplete information and ambiguity, the creativity skills to engage effectively in value creation, and team skills for effective collaboration.

iii) **Leadership and Personal Character Development**: the personal and interpersonal skills needed to effectively negotiate the cultural and social interactions that facilitate an effective innovation process with relevant stakeholders within, and external to, the organization.

In each of these categories, it is possible to communicate relevant knowledge in a codified form, such as a written document, a presentation, or a video. This communication will familiarize the student with the relevant subject matter but will not develop a level of functional expertise. Functional expertise is developed when the codified subject matter is experienced through practice. For example, the student might conceptually understand the process of collecting stakeholder input that is typical of a design thinking process, but might be unable to recognize the salient observations needed for problem definition without the experience that practice brings.

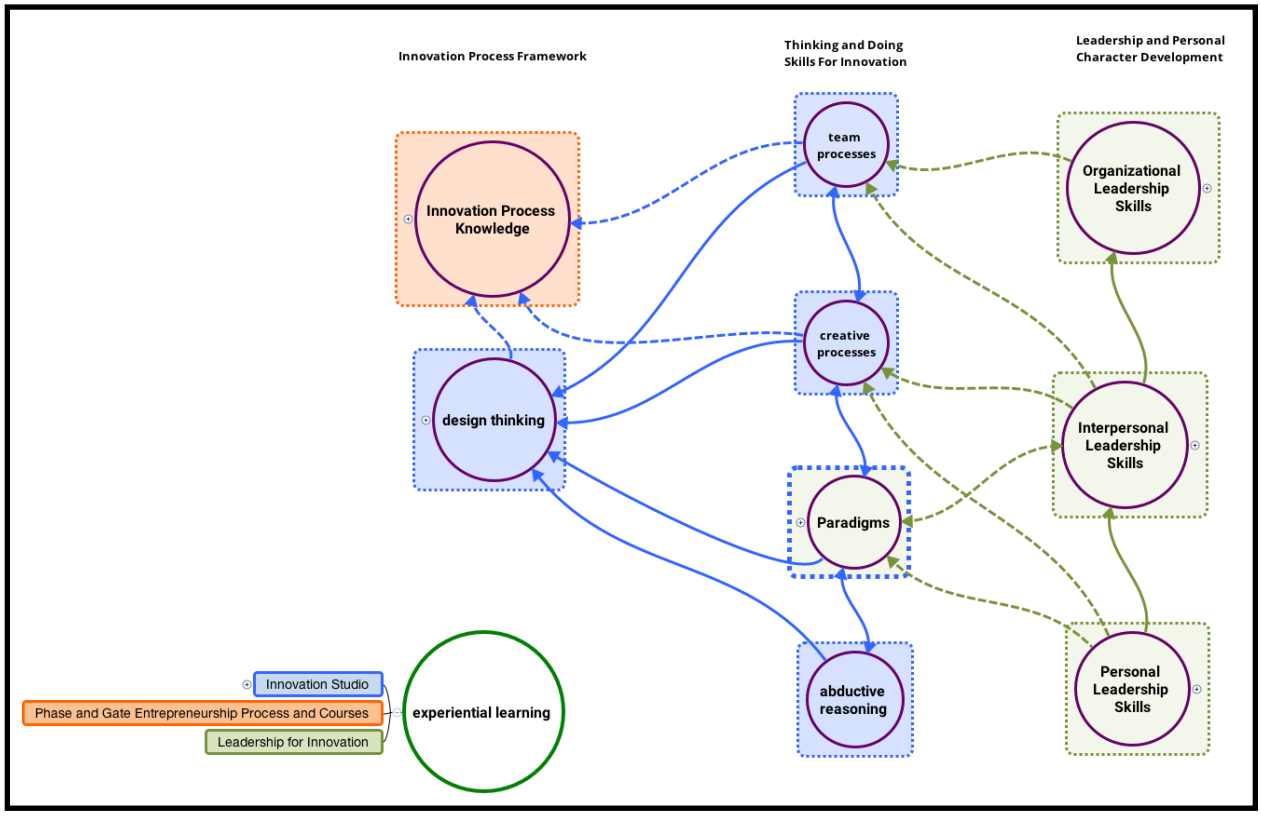

Figure 1: An experiential teaching and learning framework to build innovation capacity.

The recognition that functional expertise in innovation is developed through experience has implications for educational programs that purport to deliver such expertise. It is clear that the simple communication of codified information is not sufficient[2].

Here we concern ourselves with the design of educational programs in which students develop innovation related skills by first hand experience. Key skills needed to support the innovation

process are identified and discussed in the context of the learning process and outcomes. The author provides a description of how known practices have been incorporated into the teaching and learning paradigm at McMaster's W Booth School of Engineering Practice and Technology.

Of particular interest in this description of teaching and learning to build Innovation Capacity is the relationship to the student's development of leadership skills and character. This element is often overlooked or taken for granted in most entrepreneurship educational programs, which tend to focus on the process elements.

The framework for the layout of the discussion in this chapter is depicted in Figure 1. The figure attempts to express the development and learning relationships between the different elements of an experiential learning framework in practice in the W Booth School at McMaster University.

The figure is constructed to portray three key elements of experiential learning at the W Booth School and the relationship between these elements. Experiential learning in the Entrepreneurship Master's programs in the W Booth School encompasses the entire Masters' degree work of the student and is delivered through three main curricular elements: The Innovation Studio, the Leadership for Innovation course, and the bulk of the Entrepreneurship program which consists of the Enterprise Project Process and associated courses. The Master's level programs in the W Booth School are designed to create 'real' businesses as part of the students Masters' degrees.

As can be seen in Figure 1, the Enterprise Project and associated courses provide Innovation Process Knowledge. This element makes up the bulk of the curricular programming. The Innovation Studio provides the bulk of the Thinking and Doing Skills for Innovation, delivered in a design thinking context. The Leadership for Innovation Course provides students with awareness and experiential opportunities to build leadership skills and character. The relationship between these elements is meant to represent a cascade of learning and development opportunities to build and reinforce student learning and development. To be clear, although there is opportunity to practice skills in the Leadership for Innovation course, the bulk of practice will occur in the Innovation Studio and in the Innovation Process Knowledge curricula. The Leadership course and the Innovation Studio are delivered, primarily in the first months of the programming, whereas the Innovation Process Knowledge element runs the length of the students program in the School.

Innovation Process Framework

Here we briefly review the Innovation Process Framework in use at McMaster's W Booth School, so that the reader may appreciate the context in which Innovation Thinking and Doing Skills development, and Leadership and Personal Character Skills development, are happening.

An education in new business creation necessarily involves learning about all of the elements that make up the characteristics of an emerging business. The high level list of these elements in Table 1 will be recognizable to anyone well versed in the art of new business creation. It is the mental checklist of items that need to be addressed in order to define a proposed business. Part of the work of creating a business involves the work of gathering and synthesizing the information that underlies these descriptors of the emerging business.

De-risking the new business creation process involves the working of these elements in a systematic way to ensure that each of the elements has been satisfactorily addressed and that

each of the elements contribute to the description of the emerging business in a self-consistent and cogent manner.

The complete definition of a new business does not typically emerge all at once, as a result of some culmination of the many different knowledge gathering activities that are carried out by the new business creation team. The definition of the emerging business is a fluid process in which many assumptions are put forth, tested, and adjusted so as to develop a coherent description of the emerging entity. As the team works the project, knowledge and information changes, and synthesis of new knowledge and information takes place to strive for the self-consistent description that is needed for validation and risk reduction. This work is carried out until the information represented by the deliverables in Table 1 'crystallizes' into a cogent, self-consistent description of the emerging business.

Opportunity Identification

The Business Opportunity
- Problem
- Solution
- Unique Selling Point
- Value Proposition
- Business Model

The Customer
- Customer Definition
- Voice of the Customer

The Technology
- Description and Use Analysis
- Architectural Diagram
- Status

Market
- Description
- Segmentation and Adjacencies
- Sizing

Competition
- Identification
- Technologies
- Sources of Competitive Advantage

Intellectual Property
- Identification of IP issues and impact
- IP protection plan

Opportunity Development

Development Plan
- Project Plan forward
- Key Risks and Hurdles

Proof of Concept
- Description of the Prototype
- Customer Validation
- Technology Validation

Financial Plan
- Preliminary Financial Model
- Pro-forma Income Statement
- Pro-forma Cash Flow
- Pro-forma Balance Sheet

Business Development & Launch

Business Strategy
- SWOT Analysis
- Strategic Choice of Path to Market
- Maximization of sustainable competitive advantage

Go-To-Market Plan
- Lead Customers
- Supply chain
- Marketing Plan
- Sales Plan
- Partners and Suppliers

Table 1: A high-level summary of business elements that describe an emerging business. These elements represent deliverables in a new business creation process.

A convenient way to manage the work of the team and the resulting information flow is to set interim milestones, or targets, with respect to the state of the description of the emerging business. Practitioners in large corporations practice innovation management processes to accomplish this[3,4,5] work. The familiar 'phase and gate' processes for new product development are examples of this approach[6]. The 'items' needed to fully describe a new product are organized into deliverables that are worked by the project team in a phase of activity in order to generate a self-consistent picture of the new product which is reviewed at specific project milestones or 'gates'. If the deliverable information is self-consistent and describe an opportunity that supports continued investment, the project team moves to the next phase of activity in which the deliverables are designed to further refine the description and knowledge around the new product and overall opportunity. Such process are designed to lower new product or business development risk while increasing new product investment as the team progresses through the process. Inconsistent or non-validating information at one of

the gates results in a reconsideration of the overall project and in either some further re-definition before further investment, or an outright abandonment of the project.

The discipline offered by the phase and gate new product development process drives the desire to approach new business creation with the same approach. Hence, innovation management processes for new business creation used in large corporations historically took on the phase and gate approach in which specific deliverables related to the description of the emerging business were reviewed at specific milestones. In these gate reviews, the deliverables are examined for validation of the new opportunity, and the work that must be done to refine such validation, as well as the self consistency of the emerging business story

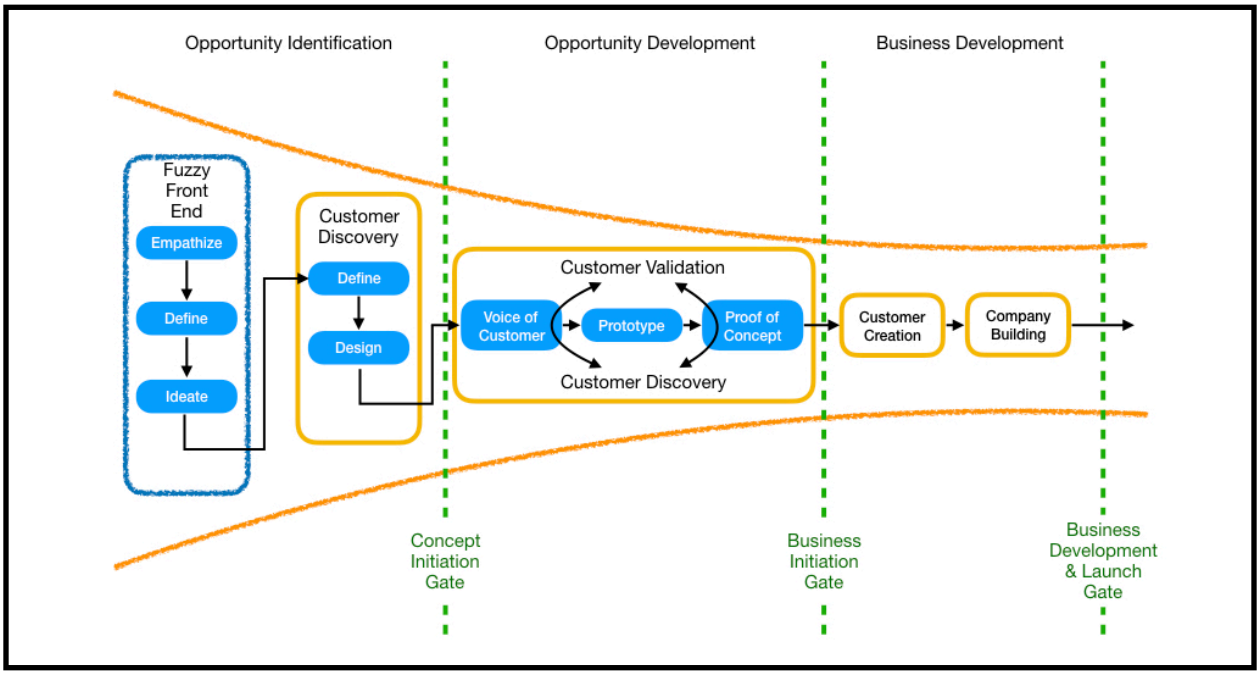

Figure 2: The Enterprise Project Process

across all of the deliverables.

Although these innovation management processes offered a disciplined approach to new product or new business creation, the practice within a large corporation has typically slanted toward that large corporation environment. This diminishes the value of the as-practiced processes for the entrepreneurial start-up, or even for the creation of businesses in markets that were new to the large corporation. Specifically, the focus on serving existing customers by practitioners in large corporations, diminished the emphasis on customer understanding, which was taken for granted (resulting in an elevated level of new product or new business failures). The correction of this issue is the thrust of the approach proposed by Steven Blank in his book "The Four Steps to the Epiphany"[7], in which the innovation process is reframed to be customer-centric.

The customer centric approach represents the 'state of the art' in innovation management and should be the basis of any education in new business creation. The approach outlined by Blank's Customer Development model lends itself very well to the discipline of a 'phase and gate' approach to innovation management. Blank acknowledges the difference between a management process and the actual process of innovation. Phase and gate processes give the impression of a steady progression from one set of deliverables to the next. Anyone that

has worked at creating a new product or a new business knows that the reality is quite different. The process of innovation is messy and does not typically proceed in a linear way. Refinement of understanding of customer and stakeholder perspectives often generate iterations of concepts that challenge the cogency of other elements that describe the emerging product or business. Synthesis is constantly taking place to attempt to restore self-consistency among the defining elements and these 'pivots' are a key part of the process of innovation.

An intellectual understanding of a phase and gate innovation management process is insufficient to develop the student's capacity to innovate and add value in 'real world' circumstances[2,8]. The capacity to innovate must include an understanding of the messiness of the innovation process and this can only be gained through experience of the process. Guiding the student through the experience of trying to create a business, and finding the best way to do this, provides an experiential learning approach. This thought was the premise behind the Master's level Entrepreneurship programs at McMaster University (Figure 2) and elsewhere[9].

This 'learn by doing' approach requires the student to find a business idea, form a team, and engage customers and other stakeholders in the process of new business creation. This process starts with the attempt to define a new business concept, which will ultimately end up being the initial product or service that is offered to the first customers of the new business. Ultimately a group of students (or students partnered with others outside of the program) must coalesce into the project team that will work the initial concept (develop the deliverables in Table 1), using the new business creation process and tools, into an investible business.

The issue of where a preliminary business idea comes from is glossed over in much of the innovation management literature that is focused on the process perspective, and the source of an initial concept is taken for granted. In corporations new ideas will come from employee interactions with customers, suppliers, regulators, and even other coworkers, although even in corporations, the process of developing these initial concepts is often ill-defined. This front-end activity is sometimes referred to as the 'fuzzy front end'[10] of innovation because of the lack of definition or description of what is to be done. In the corporation, these interactions have the consequence of exposing the nascent innovator to problems to be solved that can add value for potential customers. A Masters level entrepreneurship student typically has limited exposure to such interactions and the ability to generate meaningful value adding concepts is limited in the absence of such interactions.

The cultivation of these interactions is therefore an essential component of the starting point for any experiential educational program. The concept of innovation as a social activity is particularly relevant here, particularly among STEM educated students who will have the tendency to pursue the development of a socially uninformed technological 'eureka' (due to popular innovation folklore) in the quest for new business concepts. What is needed is an approach that relies on the development of an understanding of the problem-solution dynamic informed by the point of view of stakeholders. Many larger corporations have also been grappling with this same issue (as a consequence of innovation activities being driven by the R&D or product engineering department) and have resorted to the use of design thinking methodology to offer some definition and direction around these front end activities[11,12].

The design thinking approach starts with activities to build empathy[13,14] with stakeholders around a particular issue and then progresses to the definition of problems that may be worth solving. Students begin this activity with the identification of 'issues' that are real and motivating. Issue identification provides an initial opportunity for students to express their passion around making a contribution to a better world. Often the initial issues that are identified can be summed up in a few words such as 'climate change', 'sustainable energy', 'healthcare', and so on. Topically, these are very broad starting points around which students

often lack depth of understanding when it comes to the identification of specific problems to be solved or ways in which situational improvement can add value.

In McMaster's W Booth School, the first steps toward generating new business ideas starts with the coalescence of teams (self selecting and loosely knit) of students around these broad-based issues. The preliminary task for these teams is to build enough understanding of the issues under consideration to be able to identify potential problems. This preliminary work is focused on iterative self education with regards to the issues under consideration and is reinforced with studio-based divergent brainstorming sessions to identify issues and problems, followed by further self education, more narrowly focused on sub-issues or problems. Ultimately, these teams will converge on some specific problems of interest, but the work thus far in the process is devoid of stakeholder interaction and typically littered with untested assumptions.

Stakeholder interaction starts with the identification of relevant stakeholders. At this early point in the process, the term 'relevant' applies to anyone that could be expected to have insight into the identified problems around an issue. The idea here is for student teams to ***listen*** to stakeholders to gain perspective, which will ultimately help them to refine the team's understanding of the issues and problems. Initially, the idea of conducting a stakeholder conversation is problematic for most students. The tendency here is to try to 'pitch' the stakeholder on technological solution ideas rather than to listen to their perspectives. Inexperienced students (STEM students in particular) will typically be uncomfortable with the lack of framing of the issue/problem within the bounds of their technological background. Coaching here requires some conversation role play before the meeting with stakeholders to reinforce an active listening approach and to keep the tendency to pitch technological solutions in check.

These initial stakeholders will come from the community at large; it is vital for the School to be able to engage community to participate in such activities. In the experience of the W Booth School in Hamilton, Ontario, members of the community value the chance to 'give back' by helping to mentor students and therefore give freely of their time and intellect. Community members contribute the benefit of their experience around a particular issue/problem which is critical to grounding the work of the students in reality as they develop their problem definitions. These initial contacts also usually provide access to professional networks to find additional stakeholders that have experience around the issue/problem.

Student teams take what they have learned from stakeholders and use the information to refine their problem definitions around the particular issue. As the problems become better defined, it becomes possible for the students to converge on a single problem or set of problems on which they wish to focus. Educators at the W Booth School have found that this convergence is aided by using a tool that guides the information collected for problem refinement, as well as the selection of suitable problems that would merit their inclusion in an innovation process. This tool, the Universal Innovation Framework[15] is a simple descriptor that asks students to frame opportunities along three primary axes, the statement of the problem from the perspective of a particular audience, the statement of the solution, and the value creation model by which there is value add for the particular audience as a consequence of implementing the proposed solution to the problem. Previous to the use of this framework, students often had difficulty converging to problems that supported a value creation model.

Along the path to refine the definition of problems and potential solutions, a project team is formed. These teams are self-selecting and often involve one-to-one and many-to-one pitches of the project to fellow classmates to solicit interest in joining the team. Both, the informal and

formalized pitching is an opportunity to work on communication skills. It is also an opportunity to hear the perspectives of others as part of the refinement of the problem/solution idea.

As time progresses, the communication about the project becomes more structured around assumptions and the work to check the validity of assumptions. As the work plan is refined, it becomes possible for the team to start identifying the perspectives and experiences that they would like to engage from mentors. Formally, there are two types of mentors engaged in the new business creation process at the W Booth School, a technical mentor and a business mentor. As the names imply, the technical mentor is a person with expertise and experience in the technology of the project, while the business mentor is a person with expertise and experience in the market. It is the responsibility of a student team to identify suitable mentors (with the help of members of the school staff) and to engage members of the community to fill the formal mentor role (with faculty member approval).

The project plan is constructed around the work that needs to be carried out to meet the deliverables at the first milestone gate review. In the language of Steven Blank, the initial steps of customer discovery and customer validation are contained in the first two phases of the new business creation project. The work in these two phases is focused on the formulation and testing of assumptions around the deliverables list in Table 1. The work of formulating and testing of assumptions is the work of the entire innovation process, however the emphasis changes as the project team moves through the process as some assumptions become more 'fixed' while others are tested and reformulated.

As the project progresses from the 'Fuzzy Front End' to the Customer Discovery part of the Opportunity Identification phase (Figure 2), the deliverables for the Universal Innovation Framework becomes more focused on a specific customer type or segment. Hypotheses are formed around the deliverables that are represented in Table 1. Most of the information collected at this point is from secondary sources with a limited amount of stakeholder engagement in the particular customer segment. At the Concept Initiation Gate, the assumptions around business development are stated and tested, primarily using secondary market research. The emphasis here is on the Opportunity Identification deliverables in the light green box in Table 1 at the Concept Initiation Gate (Figure 2). Similarly, the other deliverables in Table 1 constitute the work in the corresponding phases and the deliverables at the corresponding gate. All of the deliverables are reviewed at the Business Development and Launch Gate.

In the Opportunity Development phase of the process, the project is worked in a interactive fashion as assumptions are put forth, tested with customers, and reformulated accordingly until there is evidence that the hypothesis are consistent with the real market situation.

Finally, the work in the third phase of the project is focused on Customer Creation and Company building.

Thinking and Doing Skills for Innovation

In this section, we discuss the core Thinking and Doing Skills for Innovation, outlined in the framework in Figure 1.

Abductive Reasoning

The process of innovation is highly dependent on the ability of the innovators to apply abductive reasoning[16]. What is abductive reasoning? The answer to this question is usually

well illustrated by considering the more familiar reasoning paradigms of deductive and inductive reasoning, which are reviewed here for the convenience of the reader.

Deductive reasoning follows the most familiar logic pattern in which general rule assertions are combined to reach a specific conclusion. For example, simple mathematics is deductive:

If x=5
And if y=4
Then x+y=9

The assertions of X=5 and y=4 leads to the conclusion that x+y=9 by invoking the usual operations of mathematics.

In deductive reasoning, the first two propositions lead logically to the conclusion. If the propositions are true, then the conclusion is true. In other words, the conclusion depends on the soundness (true or false) of the starting premises.

The shortest wavelength of light is scattered most intensely in the atmosphere.
Blue is the shortest visible wavelength of light.
Therefore, the sky is blue.

If one or both of the propositions are false, one reaches a false conclusion.

The shortest wavelength of light is scattered most intensely in the atmosphere.
Red is the shortest visible wavelength of light.
Therefore the sky is red.

Although the logic in this last example is correct, the conclusion is clearly not correct because one of the propositions is incorrect.

This type of reasoning is extremely useful in that it allows for inferences based on observed knowledge. In other words, the reasoning process starts with known and established generalizations to produce valid conclusions. As long as the propositions are true, the conclusion is true.

However, what if the starting generalizations are not well established or well understood? This is the situation that is faced by the research scientist or engineer when trying to push the boundaries of knowledge. In this situation, the researcher is working with observations that they have collected and are trying to come to some concluding generalization that explains the observations. The usual pattern involves the researcher forming an hypothesis to explain the observations. The same researcher, or others, then tests the hypothesis by making a prediction, which is tested with a new, but related set of observations. Much of the scientific research literature is devoted to affirming, qualifying, or discarding hypothesis based on experimental observations.

In the following example of inductive reasoning, the propositions support the conclusion or hypothesis but do not guarantee it's truthfulness. Rather, the propositions support the choice of the conclusion or hypothesis. Ideally, the nature of the propositions would offer a high probability that the hypothesis is true.

It has been observed that dust particles suspended in air causes the scattering of light.
Light scattering is observed as light passes through the atmosphere.
This suggests that the atmosphere contains suspended dust particles.

The propositions is this example support the conclusion that the atmosphere contains suspended dust particles but, in the absence of further information, one cannot be conclusive that the dust particles are present. Further work might be done to test the hypothesis that the atmosphere contains suspended dust particles.

In many everyday situations, it is clear that the propositions, or observations are insufficient to come to a firm conclusion, but decisions or choices must be made using the incomplete information. Abductive reasoning begins with a set of observations that are clearly incomplete and then attempts the likeliest explanation for the observations.

For example, the jury in a criminal case will reach a verdict using the evidence at hand, presented by the prosecution and the defence. The verdict is the most likely conclusion based on the presented evidence. There is no guarantee that the defendant is actually guilty or innocent, only that the evidence presented leads to the most likely conclusion of guilt or innocence.

Another common example of the use of this type of reasoning is the diagnosis arrived at by a medical practitioner. The doctor or nurse have the observed symptoms as propositions, which do not describe with certainty the medical condition, and must come to the most likely conclusion using these incomplete observations. The conclusion, or diagnosis, may even fail to explain some of the symptoms, but is nonetheless the most likely conclusion.

In these examples both, the observations are incomplete, as are the conclusions. The uncertainty and ambiguity in this type of reasoning causes some practitioners a great deal of discomfort. Hence the managers in the business world who have problems making a decision without “all of the facts” (also referred to as ‘paralysis by analysis’). However there is an upside to this uncertainty. This situation allows the reasoner to come to creative conclusions among other possible conclusions, that may be inferred from the observations. It is this ‘opening’ for creativity that renders this type of reasoning critical to the process of innovation since it allows the reasoner to inject previously unthought of, or unimagined outcomes to the reasoning process[17].

The creativity allowed by this process often produces the ‘novelty’ in a new product or service, but is also critical to successfully navigating the ‘pivots’ in project direction that shape a product or service as the innovation process is worked to bring the new product or service to market.

University students in STEM-based education are, in general, unfamiliar and uncomfortable with abductive reasoning as a consequence of the pedagogical approaches in STEM-based education[18]. The typical undergraduate STEM learning scenario involves the use of deduction as a way to demonstrate competence in technical subject matter. In this framework, students are typically presented with well defined problems whose solutions involve progression through a well defined set of steps of deduction. The ubiquitous use of mathematics in many of these disciplines supports this deductive approach to problem solving. The teacher can offer well defined problems that have a single correct answer which efficiently simplifies the evaluation process.

Students will gain exposure to inductive reasoning in the upper years of their undergraduate program or in graduate programs that are research focused. The majority of STEM-based graduate thesis and publications are directed at pushing the boundaries of knowledge and, as mentioned above, the inductive reasoning process is central to the thought processes and analysis in this work.

Although, it would be misleading to say that the typical STEM student has no exposure to abductive reasoning over the course of their education, the bulk of their pedagogical experiences fall into the deductive and inductive categories. The use of abductive reasoning expands tremendously after the student leaves the campus and joins the work world. Contrary to their experience on campus, this new environment doesn't offer neatly packaged problems that can be solved by deduction alone, and the formalized approach to inductive reasoning is relegated to the research and development labs where the cost and timing required to set up the conditions for testing the hypothesis can be tolerated (although this is lately becoming less tolerated as well).

This lack of experience with abductive reasoning may be the source of some of the feedback from corporations, that incoming students are not well equipped to innovate. Our education system is leaving the bulk of these students to familiarize themselves with abductive reasoning while they are on the job.

Building the capacity to apply abductive reasoning is one of the first steps to building a skill set for innovation. It is not enough to explain the concept of abductive reasoning to a student, acquiring a level of skill is learned by practice. The educational approach needs to provide a structure that will allow the student to practice appropriate abductive reasoning in order to build competency and a level of confidence. As an example of this, the front end of Design Thinking methodology coincides with the 'Fuzzy Front End' of innovation in our Enterprise Project Process in Figure 1.

Design thinking methodology provides a structure that allows students to grapple with the application of abductive reasoning[15]. A typical design thinking approach starts with the building of empathy of the design team for stakeholders around an issue. In this approach, the student is immersed in the complexity of a theme issue and the multitude of related knowledge observations. Knowledge includes first hand observations from secondary sources such as the scientific literature, popular media, trade literature, etc., as well as experiential and emotional knowledge from interaction with stakeholders that are relevant to the issue. Of course, the collection of knowledge in itself does not constitute practice of abductive reasoning until a direction is provided. In other words, the collection process is only part of a process that demands the identification of an output. It is the desired output that drives the nature of any synthesis that must take place.

A typical desired outcome of the design thinking process is first, the definition of problems and issues to be explored. For students, problem definition will begin through building familiarity with a broad base of subject matter around a particular issue. In order to develop an intellectual understanding of the issue subject matter and to form some preliminary hypotheses around potential problems and issues that need resolution, students must conduct considerable secondary research. This preliminary research provides the student team with an initial understanding of subject matter from which brainstorming exercises can be conducted to formulate possible problem hypotheses. In an innovation process, the initial immersion in knowledge around an issue includes observations related to value creation, not just for stakeholders, but also for the solution providers.

Building a knowledge base around an issue is a critical first step in the problem formulation/ definition process. Without this step, if students are presented with the task of problem definition, the trend is to select familiar subject matter with which they have had firsthand experience (i.e. finding housing accommodations, food procurement, food processing, transportation, communication with friends, etc.) that are typical concerns within the paradigm of campus life. An alternative to these types of problems are those that have been experienced as a consequence of an internship or co-op placement.

The problem hypotheses that are synthesized from secondary research are typically devoid of real stakeholder insight and are highly dependent upon the student's paradigm of the problem/issue from an outsider perspective. The problem definition from this stage needs to be informed by interaction with stakeholders that have some ownership of the problem/issue. In the context of design thinking, this is the step in which empathy is built with stakeholders so that a student can progress the problem definition from that of an 'outsider' to that of an 'insider'. This involves identifying and talking to relevant stakeholders with the intent of harvesting their knowledge based on an individual's experience of the problem/issue. It is not just the stakeholder's intellectual understanding of the problem/issue that is needed here, but also an understanding of their emotional perspective. The emotional perspective is an important consideration in the development of the problem definition, since it can be a key driver with respect to identifying the path to value creation. The world is replete with solutions to problems about which nobody cares. These often arise as a consequence of a lack of understanding grounded in experience, or an underdeveloped level of empathy in understanding the extent to which a stakeholder cares about any proposed value add.

Stakeholder observations are used to test and further refine the hypotheses from the students secondary research. The assumptions that were used to formulate these initial problem hypotheses are either supported, or not, by stakeholder observations. Recognizing that the observations are incomplete (interaction with a limited number of stakeholders is all that is possible) the students must abductively refine and reformulate their problem hypotheses. This refinement step is usually the first 'pivot point' in a series of many pivot points that will be experienced in the course of delivering innovation through value creation.

Paradigms

An important learning outcome for the student at this stage involves the recognition that the paradigm or 'mental model' that they have of the problem/issue may not represent the reality that is experienced by others. The process of building empathy with stakeholders should lead to a comparison of one's own paradigm to that of others. Central to successful problem definition is the self awareness needed to recognize the potential limitations of one's own paradigm and/or the paradigms of others (stakeholders and teammates). In order to progress in the problem definition process, students must be open minded and be willing to adapt their own paradigms and mental models to accommodate the perspectives of others.

In the formulation of the path forward students need to exercise significant intuition. Recognizing the paradigms and perspectives of others is important to problem definition refinement, but doesn't necessarily support a wholesale change to holistically incorporate the stakeholder viewpoint. Often value creation through innovation occurs as a consequence of 're-imagination' of the problem situation. Stakeholders that are closest to the problem often have a perspective that is distorted by familiarity, and are too immersed in the issue to see alternative points of view. Accordingly, care must be taken to avoid constraining the hypothesis formulation based solely on the current paradigms (Steve Jobs could not have asked someone about their need for an iPhone before the iPhone was available). The problem definition step is one of the key opportunities to exercise creativity that might lead to value creation and the intuitive process here includes an analysis of perspectives to exercise judgement around the extent to which the collected observations will influence the refined hypothesis. As with all abductive reasoning, the expectation here is that the refined hypothesis or hypotheses will remain cogent with the bulk of the new observations.

Creative processes

The description of activities thus far takes us to the ideate phase of the design process in which ideation is focused on potential solutions to the defined problems. There are multiple ways in which the ideation process can be approached, but ultimately a best practices approach will involve a group or team-based brainstorming session. The brainstorming session might be held at the front end of the solutions ideation process, or after some initial individual reflection on the defined problem(s), or any combination of these. Despite productivity related criticisms of group brainstorming processes with regards to the quality of generated ideas[19], the group process remains the best way to efficiently use the multitude of brainpower, experience, and perspectives of the individual members of a team when carried out in such a way as to maximize divergent and convergent thinking[20]. This activity also offers further opportunity for team building, which is essential if a team is to ultimately be successful in delivering value by implementation.

Personal and group-based creativity have as significant a role to play in this part of the process as in the definition stage. In terms of student development, a focus on personal creativity enhancement offers the opportunity for practice during the definition and ideation steps. This focus on personal creativity starts with building self awareness around personal paradigms and the need to explore outside of the everyday set of experiences[21]. This is often referred to as "getting outside of your comfort zone", and need not be dramatic in action. It can be as simple as engaging in a different set of new mundane experiences in everyday life (getting to school a different way, trying a new food, talking to people that the students might not ordinarily interact with, etc.) to engaging in activities which might challenge personally held beliefs and values.

The comfort zone for the average STEM (science, technology, engineering, and math) student typically revolves around the technical content of a proposed problem or solution. Unfortunately, most STEM-based undergraduate education offers little opportunity to explore perspectives and paradigms that fall outside of the scope of specific program technical subject matter. Opportunities to explore "other" knowledge comes in the limited opportunities offered by non-technical electives, participation in clubs or student government, attending non-technical talks, in the social activities that are a part of personal interactions of the individual (often time-limited by a highly demanding technical academic schedule). Escape from an individual's 'comfort zone' provides an opportunity to add to their experience repertoire and enhances a flexibility of thought processes needed to imagine and re-imagine. Reflection here is critical to building the self awareness required to assess one's own creative instincts and the activities that might enhance personal creativity[22].

Team Processes

Productive group creativity processes can synergistically harness the contributions of individuals to produce ideas that are outside of the bounds of that which may be produced by a single individual. This ideal requires not only the equitable contribution of all members of the team, but also the development of trust among group members to allow for the sharing and manipulation of thoughts and ideas. Individual awareness of one's own contribution and the impact on the contributions of other team members is central to developing trust and maintaining a healthy team environment that fosters creative contribution. The ability of an individual to contribute to group creativity, and to teamwork in general, is dependent on the self-awareness of that individual regarding how his or her behaviour contributes to, or limits, the work of the group as a whole. This self awareness is generated over time through both personal introspection and the use of feedback from faculty members and instructional assistants, but most importantly, peers that interact with the individual on a regular basis.

One-to-one, or many-to-one conversations about individual behaviour can only take place if a level of trust exists between individuals which enables the giving and receiving of feedback.

This trust takes time to develop and is dependent on the frequency and quality of interactions amongst team members. The process of developing trust in a team setting is well expressed by Tuckman's stages of team formation[23,24]. A quick progression to the performing stage of team formation is supported by the ability of team members to provide feedback to each other about performance enhancing behaviour. Preserving the level of trust that has developed in the team requires the realization and acceptance of each team member that they are in a learning environment in which behavioural feedback is expected. It also requires some coaching with respect to the delivery and acceptance of constructive feedback[25] in order to avoid destructive negative emotional impacts.

A useful approach to generating individual self awareness from peers is the 360 Degree Review that is commonly used in many business organizations. When implemented in an educational setting[26] (Exhibit 1) in which significant interaction with peers is required, this approach can provide an individual with peer feedback with respect to their behaviour in group work. The self evaluation that is inherent in the 360 Degree Review allows the individual to compare their own perception of their behaviour to that of their peer's. Differences in perception allow the individual to identify and select specific behavioural attributes to focus on for improvement. 360 Degree Reviews are a valuable resource for personal development goal selection.

Peer mentorship[27] is an additional approach that is valuable in the context of identifying and developing the behaviour and learning of the individual in a team setting. The advantage of formalizing peer mentorship relationships in an educational setting is that an enhanced level of trust can be developed over time, particularly when such relationships are self-selecting. Peer

360 Degree Review Items
Leadership for Innovation course

Adaptability
How adaptable is the individual in the face of change?

Collaboration
How well does the individual display collaboration supporting behaviour?

Communication
How effective is the individual as a communicator?

Conscientiousness
What is the level of commitment to contribution displayed by the individual?

Creativity and Innovation
How effective is the individual at supporting creativity, risk taking, and persistence in problem solving?

Initiative
To what extent does the individual drive the work that needs to be done, anticipate problems and issues, and aids in the selection of alternatives to support goal achievement?

Interpersonal Skills
How well does the individual interact with others on a personal level?

Meeting Participation
To what extent does the individual effectively support the meeting process?

Teamwork
To what extent does the individual make an effective contribution to teamwork?

Time Management
How effective is the individual at prioritizing, organizing, and scheduling?

Vision
To what extent does the individual support the long term view, develop meaning for change, and support the direction of change?

Exhibit 1

mentorship has the added benefit of providing the mentors with experience in the development of people, a key deliverable for aspiring leaders.

Much of the early teamwork of students in the innovation process involves the use of brainstorming activities. It is easy for student teams to lose their focus in these activities. While divergency is an important step in any brainstorming activity, focus is essential in developing any content that can be converged productively. To this end, it is useful to frame brainstorming exercises in both the definition and ideation phase, in the context of generating value added innovation. As mentioned previously, the "Universal Innovation Framework"[15] generically provides a description of innovation in the context of stakeholders, the "Audience Needs", the proposed "Solution", and the value to be added, the "Value Creation Model". Data has shown that students find this framework tool to be most useful in understanding the orientation of these front end creativity processes.

The use of a framework tool, such as the Universal Innovation Framework has the distinct advantage of integrating the design thinking process into an innovation process. In the case of entrepreneurship, the appropriate innovation process is a new business creation process. This integration is critical from this perspective because the design thinking process on its own is not meant to deliver new businesses. The rigour of a new business creation process ensures that the development of the emerging innovation is benchmarked against deliverables critical to successful business development (as previously mentioned, this also reduces risk). These two approaches are easily merged if the design thinking process is executed in the context of generating innovation that is meant to support the development of a new business. Even with this constraint in place, design thinking does not test the emerging concept in the context of viable new business development. This rigour belongs to the innovation process for new business creation.

The integration of the the two processes is depicted in Figure 1. Both processes are meant to be iterative and require abductive reasoning to sift through the assumptions inherent in any emerging value creation model. The sifting process uses abductive reasoning to test the inherent assumptions, or hypotheses, with observations related to value creation delivery. The hypotheses, or assumptions, are reformulated in ways that are cogent with the observations. This reformulation is often referred to in entrepreneurial circles as a 'pivot'. Successful entrepreneurs are constantly pivoting the emerging value creation model to accommodate the observations that are collected as they work the creation of their new enterprise.

In the integration of the design thinking process with the new business creation process, these iterations first occur during the empathize-define-ideate steps at the front end of the design thinking process. The outcomes from these early phases include problem solutions upon which it may be possible to build a value creation model. The outcomes feed the new business creation process where proposed solutions are tested more rigorously against deliverables for new business creation.

Leadership for Innovation

Introduction - Why leadership for innovation?

The onslaught of change brought by the adoption of technology in recent years has not only increased the focus on leadership skills, but has aided the adoption of the notion that these skills should be part of the core teachings in any higher educational program[28]. It is quickly becoming clear that the value of the educational institution as the keeper and developer of

knowledge is diminishing with the ubiquitous access to information that is now enjoyed by the average citizen. Given the rate at which change is happening in all facets of human existence, forward thinking educators are asking the question "What should be the key learnings from the higher educational experience that the student will find useful for life?". Leadership skills keep emerging as a partial answer to this question[29].

Change is driven by the desire to improve peoples lives. This simple sentence is also the motivator for innovation. In fact, as change accelerates due to the adoption of technology, it becomes more and more important for the average person to be capable of engaging in the work of innovation. Many believe that the process of innovation will become an even more important key activity in any future workplace. There is already recognition in corporate and government circles of the importance of this activity as a driver of economic success and competitiveness[30].

Leadership in an innovation context is different from leadership in general. Readers that are familiar with the process of innovation and the leadership literature will intuitively understand this statement. The authoritarian leadership style might be a necessity on the military battlefield, but certainly does not support the innovation process or the establishment of an environment in which innovation can flourish. The social process of innovation requires the ability to collaborate and engage others in an open minded way.

Soft skill development is a subject of high level interest among educators in the STEM disciplines[31]. As previously mentioned, there has been feedback from the corporate sector for a long time regarding the deficiencies of recent higher education graduates with respect to their abilities to effectively contribute to the work of the corporation because of a lack of soft skills[1]. Indeed, STEM alumni of higher education programs often question this missing element in their studies. Academics in the STEM disciplines are aware of this issue and there are many initiatives underway to enhance the mix of higher education programming to place more emphasis on the development of such skills[32].

What are the soft skills that are relevant for today's higher education graduate? Broadly speaking, the so called soft skills fall under the umbrella of leadership education[28,29,31]. They are the skills that allow an individual to effectively manage oneself, and to interact with others in an effective and purposeful way, particularly in the workplace, but also in society in general. In the Engineering profession, leadership skills have moved to the foreground in the conversations that engage educators and other members of society around the emerging curriculum. 'Engineering leadership' is considered to be both a much needed ingredient to successfully sustain the profession, and a key element of the contribution of the Engineer to society at large.

This viewpoint is not novel, but has re-emerged as a pressing topic as a consequence of the increasing impact of technology on society. The adoption of technology often results in a positive improvement to society member's lives, but there are also many examples demonstrating the dystopian consequences that can arise from a lack of leadership by those most familiar with technology. A case has been made that the Engineering profession in particular, has abrogated its leadership responsibilities since the end of the second world war[32]. Many academics, and others that are prominent in the profession, now advocate for the accelerating need to re-introduce leadership capacity to the profession in revamped curricular and non-curricular programming.

What then, are the leadership skills that are relevant to the process of innovation and how might they be taught to students of higher education? This question is important because it

speaks to the heart of the ability of the innovation practitioner to actually practice. An individual might understand the intellectual requirements for innovation and entrepreneurship, but effective practice will also require the character traits needed to drive and support practices. This is particularly relevant in the context of any innovation process since innovation is a social activity. It is connections and interactions with others that drive the innovation process, and the ability to effectively navigate those connections and interactions a key to success. It is the inability to navigate the social connections with purpose that is the essence of the complaints of corporate leaders when they talk about the abilities of recent graduates to effectively contribute to the work of the company[1].

The next few paragraphs attempt to describe personal character traits, relevant to the innovation process, that can be developed by the individual. From a performance perspective, the cultivation of these traits enable the individual to effectively participate in the innovation process[2]. From the educator perspective, building an awareness of the value of these traits allows the student to work on his or her development through the innovation process and interactions with others.

Broadly speaking, the development of relevant leadership skills can be thought of in three contexts. The first two of these were identified in Stephen Covey's 7 Habits book[33]. Here I refer to them as 'Personal Leadership Skills', representing the ability to lead oneself, and 'Interpersonal Leadership Skills', the skills necessary to effectively interact with others. The third context is the organizational context, which I will call "Organizational Leadership Skills', focusing on the development of skills related to leading a group of individuals in an organized context such as a team.

Personal Leadership Skills (Managing One's Self)

In order to effectively participate in an innovation process and develop leadership qualities, it is critical to understand and embrace the perspective of others. The individual must understand multiple, sometimes conflicting, viewpoints of stakeholders around an issue or problem. Primary stakeholders might be the potential customers or audience for whom the value add is important, but indirect stakeholders such as regulators, as well as one's own team members, will also contribute value, particularly during the many pivots that may ensue to bring an idea to fruition.

An openness to understanding the mindsets of others starts with a self awareness of the limitations and ambiguities of the one's own limits to understanding and interpretation. A good starting point here[33] is the exploration of the concept of a 'personal paradigm'. Many people never stop to consider the idea that their interpretation of the world is bound by their own mental model of 'how things work'. Our simplified paradigms of the world around us allows us to operate effectively, however, without the recognition of the limitations of these models, the acceptance of validity of other viewpoints is stifled.

The openness to undertake a comparison of different mental models allows an individual to acquire alternative perspectives. In the innovation process, this is relevant not only to the work of defining the issue/problem through stakeholder empathy, but also in the work to propose solutions and later to pivot as assumptions are tested.

Building self awareness of the personal paradigm is not that difficult in an educational program. A simple starting approach involves orchestrating a session in which personal paradigms are deliberately challenged. For students from a STEM background, it is often easier to start with a discussion of historical science or technology-based paradigms and their implications.

Familiar examples might include the heliocentric universe, the digital camera, and others in which a paradigm shift is evident. It is worthwhile to discuss these examples in the context of Barker's paradigm principles[34]. Once a comfort level has been built with examples of technological innovation, the power of paradigms can be demonstrated by deliberately invoking a well known stereotypical paradigm with an example, and then taking elements of that paradigm to a different context (a common example that I use is the wheelbarrow paradigm, which I learned from Dr. Blair Miller[35]). The switch in mental models will drive home the importance of paradigms in how we chose to see the world around us.

These activities are a bridge to understanding the importance of personal paradigms when interacting with people. Further group exercises using examples of human behaviour in different circumstances followed by a discussion of interpretation of the behaviour helps to emphasize the role of paradigm choice in personal interactions. The most effective examples are those in which it is possible to have several alternative interpretations of the behaviour. The exercises emphasize the importance of paradigm choice on the subsequent interactions between individuals.

The experience of making paradigm choices, in a behavioural context, is a convenient lead-in to the concept of proactivity. As defined by Stephen Covey[33], proactivity is about understanding and using the ability to choose. According to Covey, exercising the choice between a reactive response and a proactive response is unique to human beings. The ability to choose one's response to external stimuli is important in being able to pursue a personal vision, as well as in taking the initiative around the development and creation of goals. Visioning and goal pursuit are critical to interaction and progress in the innovation process.

The concept of personal visioning is of critical importance to the success of entrepreneurship students and entrepreneurs in general. If these individuals do not think of themselves as successful business owners that contribute to solving societal problems, the passion and motivation needed to carry out the hard work of creating a business will be lacking.

Choosing to take initiative is also critical to personal development in general. One must choose to work on the development of leadership skills and the development of skills related to the process of innovating. To the individual, personal development work is typically not an urgent process and is often relegated to 'spare time' when the urgency of looming deadlines does not interfere with the allocation of time. As Covey points out[33], this mindset leads to a significantly diminished focus on personal development if left unchecked. It is important for an individual to adopt habits that allow for a focus on the non-urgent, enabling both personal development and life long learning.

One of the keys to successful participation in an innovation process is an individual's propensity for personal creativity. Although we are all born with an inherent ability to be creative, the pressures of society have a tendency to diminish our creativity. Taking the initiative to enhance one's personal creativity can produce a tremendous boost to one's performance level with very little effort[21]. The enhancement involves deliberately placing oneself in situations that are outside of one's everyday experience (sometimes referred to as 'getting outside of your comfort zone'). The action allows for observations and experiences that are new and may challenge personal paradigms. Skills of observation are cultivated this way, particularly in the context of understanding the perspectives of others, as is the flexibility and mental gymnastics needed to grapple with internalizing such experiences and observations.

Personal development also relies on the cultivation of self awareness by reflection[33]. An individual must choose to take action to ensure that they are in a position to reflect as part of their normal routine, rather than leaving this activity to the randomness of free time in a

schedule. Covey's teachings integrate this as part of one of the seven habits that he calls "Sharpening the Saw", and refers to this as the habit of self renewal because these activities balance the ability of the individual to 'produce' with their 'capacity to produce'. Reflection is part of building the 'capacity to produce' because it ultimately leads to actions that develop skills needed to make a contribution to life. This is about scheduling the personal time needed to ensure the needs of the body, mind, spirit, and emotional state are met, as well as to build personal understanding of one's self and one's development direction.

Clearly, a key to self development is a time management ability that goes beyond the usual scheduling applications used by many. This is emphasized in Covey's teachings with a time management approach that balances the 'urgent' with the 'not urgent'. His approach emphasizes the inclusion of reflection and development activities as part of the individual's scheduling framework.

Interpersonal Leadership Skills (Interacting With Others)

Innovation processes are team based and successful navigation of these processes rely heavily on successful team performance. Relationships are important in any team context and the interpersonal skills that promote relationships are therefore critical to effective team performance. Trust among team members is key to the high performance functioning of any team and an understanding of how individual behaviour contributes to trust building allows an individual to develop practices that will build trust in interpersonal relationships.

Trustworthiness requires the development of emotional intelligence through self-awareness. Students are typically able to articulate the foundations of gaining trust, such as honesty, integrity, and respect, but will indicate that they are not thoughtful about the extent to which they practice these foundations. In many cases, personal perceptions of emotional intelligence are challenged when feedback is provided by their peers regarding their performance. This experience can be transformative, not just within team member relationships, but with all of their relationships.

Many institutions in our society are grounded on the win-lose dynamic of personal interaction. High performance teams consist of individuals that are able to overcome the mentality of win-lose, at least within the confines of the team environment. Stephen Covey's[33] fourth habit of 'Thinking Win-Win' is especially relevant to the development of high performance teams. The ability to collaborate is dependent upon a mentality of abundance thinking, but students are often conditioned by our educational system and its evaluation processes, to cultivate a scarcity mentality[36]. "The people with the 'good' grades get the high paying job at graduation", "x percentage of the class will not be here after the end of the year", or actions by peers to limit access to needed resources for assignment completion, are all examples that cultivate scarcity mentality in our education system.

Cultivation of an abundance mentality starts with examination of the scarcity paradigm. Particularly of interest for STEM students are the Malthusian pronouncements of the past and their avoidance through the use of technology[37] ('peak oil' for example). Extending this to a more personal level through examination of outcomes in life situations is an approach to the extension of personal consideration of win-lose and win-win outcomes. Initial awareness of win-win thinking and behaviour is reinforced with role play in a group, in which behavioural choices can later be examined in the context of win-win or any of the other relationship dynamics.

Deep understanding of others is important to the development of a high performance team, collaboration in general, and in order to truly understand the input of stakeholders and potential customers, suppliers, and so on. Deep understanding of others involves more than an intellectual understanding of communication. A developed skill in empathic listening[33] allows the listener to build a comprehension of the emotional disposition of the stakeholder or team member with respect to the intellectual subject matter. As Daniel Goleman points out, our emotional selves drive much of the personal decision-making in our everyday existence[38].

Empathic listening is developed through practice and individuals that make time to practice empathic listening quickly become better at truly understanding the messages of the people with whom they communicate. Students in a safe environment are in an ideal situation for the cultivation of this skill and are also in an ideal position to get feedback from those with whom they communicate in order to assess their listening and understanding skills (no corporate job performance appraisal that might impact future promotions and compensation).

Listening is one part of the act of communicating, expressing oneself effectively is just as important in a team environment, and in life in general. Although there are plenty of opportunities to improve individual communication skills in the program, of particular interest in team work is the courage to express oneself[33]. Difference of opinion is the lifeblood of effective teamwork and suffers if one or more team members are unable to effectively contribute either because of a lack of self confidence, opportunity, or skill in negotiating the team dynamic.

Many individuals will avoid controversial or conflict subjects during teamwork in order to ‘keep the peace’. This avoidance ultimately leads to dissatisfaction in the work of the team for one or more of the members and, left unsaid, leads to a full blown conflict situation or even team dissolution.

Ideally communication around contentious issues takes place before conflicts become critical, but sometimes conflicts will arise even with good communication and this is to be expected. Team success is dependent on the knowledge and skills of the team in resolving such conflicts to everyone’s satisfaction.

Conflict focused on the work of the team, as opposed to the personalities of the team, supports the achievement of novel value adding solutions in the work of an innovation process. Resolution of this type of conflict produces superior outcomes when team members take a win-win attitude and try to achieve outcomes that are better than any of the solutions associated with a particular opposing viewpoint. This type of solution will typically involve pushing the boundaries of paradigms that are sometimes personal, and sometimes more broadly held, or even societal constructs.This type of conflict resolution tends to produce superior results in an innovation process.

Learning conflict resolution is enhanced by initially practicing role play followed by reflection. Respect for individuals, trust building, integrity, and honesty, are conceptually easy to understand, but recognizing how these elements translate into practice is best achieved through experience. In conflict role play, students have a tendency to resort to ingrained behaviours that may not support synergistic outcomes. Reflection on this behaviour and consideration of behaviours that might support desired outcomes leads to awareness and development.

Organizational Leadership Skills (Deliberate Team and Organizational Processes)

The word 'organizational' here refers to groups of people in a purpose driven interaction. The simplest version of this is the project team. Also considered here with respect to the innovation process are some of the complexities of larger collection of people that might be organized in the familiar departments or functions of a large corporation, or some of the other emerging organizational types, such as the decentralized team model.

Skill development that falls under this topic is intended to support new business creation within the context of the program, while developing skills that are transferable to the innovation work environment of a large organization.

Some of the topics covered here are relevant to any work within the modern corporate environment, for example, the team formation process and the development of team facilitation skills, while others have more relevance to the process of innovation.

It is important for students to understand that teams don't just come together and instantly produce superior results. The phases of team formation according to Tuckman[23,24] are used to set the stage for understanding the drivers and processes for the progression of a collection of people to the point where they function as a high performance team. The awareness developed builds on the previous work around interpersonal conflict and the elements of building trust. Students are also made aware of one of the major sources of interpersonal conflict, team role styles[39], by having their own team role style characterized using an online tool[40]. The results are discussed in the context of the importance of diversified team role styles in the process of innovation. Students are encouraged to form diversified project teams that are deliberately constructed to include members from each role style.

Most students typically have little familiarity or experience with facilitation, however, it is an important facet of effective team work. Students are introduced to facilitation best practices[41] and some initial workshopping around best practice implementation sets the stage for practice in actual project team settings. Students are required to share the facilitator role as they engage in project meetings with each of their team members providing constructive feedback with respect to their use of best practices and effectiveness as a facilitator.

Students explore organizational paradigms associated with leadership style archetypes[42] and then consider the impact of leadership styles on the process of innovation. Consideration of the personal behaviours associated with different leadership styles builds awareness of the relationship between behaviours, archetypes, and innovation performance. This work builds on all of the previous understanding of personal character traits as it relates to the process of innovation and is also a natural lead-in to a discussion of different organizational cultures and the impact of culture on the innovation process.

Also considered here are the elements of a high performance organization and the relationship between those elements, leadership, and the process of innovation. The model of the high performance organization practiced at DuPont and described in David Colcleugh's book[43] 'Everyone a Leader' is conveniently used to approach this topic from the perspectives of disciplined work processes, the culture of the organization, and ethical considerations as the organization contribute to society. Workshopping activities explore some of the tools that are typical in such an organization, as well as the nature of leadership in an innovation context as it relates to the management of change. These activities are designed to illustrate the importance of the organizational elements to the innovation process, as well as the contribution of the innovation process to outputs to other processes such as corporate social responsibility.

The Mechanics of Teaching and Learning in the Leadership for Innovation Course

The design of the Leadership for Innovation course uses a flipped classroom approach to build awareness of leadership practice and skills and then to provide preliminary introduction to the practice of the skills. Assigned readings, videos, courseware, etc., are reviewed by the students prior to formal class meet times. The meet times are used to test understanding of the assigned content, but mostly to experience practice related to the content with workshop sessions. The activity in these workshop sessions depends on the nature of the content and involve combinations of large group discussion, small team exercises, and individual exercises. Typically, exercises involve some role play, either in an in-role format (students assuming a particular role), or with a team of students analyzing the role of an imaginary player in a specific situation.

The course content is presented in such a way so as to be progressive in skill development and complementary to work that is concurrently taking place in the other program elements, such as the Innovation Studio, and the in the Innovation Process work (Enterprise Project and related courses).

The course curriculum starts with a focus on the development of personal management skills, progresses to interpersonal skills, and then to an organizational framework. Each section of the course builds on the last. An idealized flow of the course is found in Table 2. The first four weeks of the course are focused on Personal and Interpersonal Leadership Development, the next three weeks on Thinking and Doing Skills for Innovation, and the last four weeks on Organizational and Societal aspects of leadership.

Table 2: Leadership for Innovation Course Schedule

Week	Main Topic	Hour 1	Hour 2	Hour 3	Assignment
1	Course Logistics, Introduction	Course Logistics & Team Assignments	Leadership Framework	Paradigms	Reading
2	Balancing Production/ Production Capability	Artifact Ice Breaker (Large Group Exercise)	Review Concepts, Emotional Bank Account Exercise, Paradigm Shifting Exercise (Team Exercise)	Giving and Receiving Constructive Feedback (Large Group Discussion, Team Exercise)	Reading,
3	Proactivity, Visioning, Personal Time Management	Proactivity Case Study - Promotion Scenario (Team Exercise)	Personal Mission Draft, Roles & Goals (Individual Exercise)	Time Management Exercise. (Team Exercise)	Reading, Basadur Profile, 360 Degree.
4	Win-Win, Listening, Synergy	Negotiating Win-Win Agreements (role play Team Exercises)	Empathic Listening Workshop (Large Group Exercise)	Synergy Exercise using the Win-Win Analysis Form. (Team Exercise)	Personal Leadership Development (PLD)Plan, Complete Conflict Negotiation Survey.
5	Team Formation & Team Roles	Lecture: Facilitation Skills	Workshop Facilitation (Team Exercise)	Conflict Style Analysis Discussion	Initial PLD Plan Due. 360 Degree Reflection Due.

Week	Main Topic	Hour 1	Hour 2	Hour 3	Assignment
6	Negotiation and Conflict Resolution	Workshop Conflict Resolution (Team Exercise in Large Group Format)			
7	Personal Creativity, Ideas & Idea Analysis	Lecture: Ideas and Adjacent Possibilities	Workshop Analyzing an Idea (Team Exercise)		Idea Assignment, Reading
8	Leadership in the Organization	Lecture: Concept Review	Workshop: Case Study Leadership Styles (Team Exercise)	Lecture: Review of the Business Process Approach	PLD Plan Checkpoint
9	Leadership in the Organization	Workshop: Developing a Business Process Flow (Team Exercise)		Lecture/Discussion: What are Corporations for?	Reading
10	Society: Corporate Social Respons-ibility	Lecture: Review of LCM	Workshop: Applying LCM Case Study (Team Exercise)		Reading
11	Life Long Learning, Next Steps.	Course and Program Reflection to date. (Large Group Exercise)			PLD Plan Checkpoint
12					Idea Assignment due, 360 Degree
13					Plan Checkpoint, 360 Degree Reflection and PLD Plan Due

After an introduction to the course, Week 1 is delivered lecture style to provide an initial framework for leadership that is referenced throughout the course, as well as an introduction to the concept of paradigms, to be built on experientially in a workshop in Week 2. Students experience icebreaker exercises as part of their overall program, but an additional icebreaker exercise is included as part of the course. The icebreaker exercise in Week 2 is intended to help students to start to get to know each other to build trust relationships. They will be helping each other to develop leadership skills during the course and so it is important that they start to build trust relationships with others in their cohort. In this icebreaker exercise, students are asked to bring a personal artifact to the meeting that they are willing to talk about for 5 minutes in front of their peers. With the room organized in a 'sharing circle' the students take turns talking about their artifact. The order of speaking is on a voluntary basis and there is an additional requirement that a ball of string is passed from speaker to speaker with each speaker retaining their hold on the string. As the ball of string in unfurled during the exercise, all of the students become connected by a web of string. This simple symbolism starts building an amazing amount of community and inclusiveness in a very short period of time.

From this point, Weeks 2 to 4 are heavily focused on Stephen Covey's teachings from his book "7 Habits of Highly Effective People"[33] . Weeks 8 to 10 build on Covey's teachings using David Colcleugh's teachings from his book 'Everyone a Leader'[43]. The intervening weeks 5 through 7 are built on material from various sources and include a Basadur Team Role Profile[40], a Conflict

Negotiation style survey[44], a multi-team based role play exercise in Conflict Negotiation[45] and a focus on personal creativity, and Idea Analysis[46].

The workshop activities practiced during the class meeting time, are further reinforced with practice assignments that are customizable by each student to focus on the development of skills that they feel are most compelling. These assignments include two sets of 360 degree evaluations (3 months apart), and associated reflections, based on the criteria in Exhibit 1, a reflection on individual and team behaviour during the conflict negotiation workshop exercise, a team-based exercise in idea analysis in which facilitation skills are practiced and peer evaluated, and a Personal Leadership Development Plan (PLD) assignment.

The PLD Plan assignment asks each student in the course to select three leadership related personal development goals that they would like to work on over a two month period. For each goal, students are required to put together a plan to achieve the development goals chosen, and to select a peer mentor for each goal. Therefore, each student in the course will be working his or her own PLD Plan and mentoring three other peers in the execution of their PLD Plan. Each student creates a Personal Leadership Development Portfolio in McMaster University's Learning Portfolio System (Pebble Pad) and is asked to record his or her plan, provide evidence of their plan execution and reflections, and include a final reflection at the end of the plan period. Peer mentors for each goal are required to provide informal mentorship to aid their mentee in the achievement of their goals over the plan period. The work and input of peer mentors is partially captured by a requirement that they provide formal comment to their mentees portfolio every two weeks.

In addition to their contribution to mentees' portfolios, an additional assignment asks peer mentors to reflect on their contributions and experience with their role as a mentor for each of the three peers they are mentoring over the plan period.

The combination of these two assignments, not only allows a student to develop personal leadership skills, but also to experience leadership in the context of developing other people - a key responsibility of leadership.

The PLD Plan goals will often be related to the feedback obtained by each student from his or her peers through the 360 Degree feedback exercise. Other goals will come from the Covey teachings as students become aware of the content of habits and practices that they may not have been previously exposed to, or that they may have never taken the time to practice. Popular PLD Plan goals include developing a personal mission statement, exercising proactivity, developing time management skills, developing a win-win attitude, developing empathic listening skills, enhancing one's collaboration in meetings, working on facilitation skills, developing a balance between personal care and work life, and more.

Much of the plan execution will take place through team work that is done to progress the work of the student in the Innovation Studio[47], which will typically require student teams to meet on their own time in order to achieve the work of the Studio.

The course also contributes to the work of the Studio by providing 'just in time' skill awareness for activities that are emerging during the Innovation Studio. For example, the work on giving and receiving constructive criticism in Week 2 is important to the activities in the Studio as the students begin to give each other feedback on their ideas and work in the Studio.

This coordination between program courses is at the heart of enabling the delivery of experiential based education that is practiced based. The amount of practice that is needed for leadership skill development far exceeds what can reasonably be delivered in the context of a single course. The work in multiple courses provides students with many opportunities to

work on their development goals in a working environment and context. The overall construct requires that instructors responsible for each course recognize the value of this overlap and be willing to collaborate and coordinate with each other so that the necessary connectedness of the curriculum is realized to enable the student learning. Instructors delivering courses simultaneously need to meet and coordinate on a regular basis in order to drive program based learning outcomes.

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