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BEYOND COLLABORATION: PREPARING HYBRID LEADERS THROUGH AN INTEGRATED EDUCATION

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ABSTRACT
Many companies strive to establish a culture of collaboration across disciplines, with the expectation that the result will be something of value such as process efficiencies, product or service improvements, or innovation. In the area of innovation having collaborative teams of smart and talented people doesn't necessarily enhance the chances of identifying a breakthrough that leads to a new market opportunity. Many factors can contribute to low innovation success rates with collaborative teams, including: composition of disciplines on a team; cross-disciplinary knowledge across the team; and organizational culture – all play a role in how significant the challenge is in working together towards successful outcomes.
The Master of Integrated Innovation for Products and Services program (MII-PS) at Carnegie Mellon University, USA, is known as a pioneer in interdisciplinary innovation focused education. Over the course of 14 years the program has evolved its philosophy and teachings around *integrated innovation,* defined as cross-training interdisciplinary teams, typically of engineering, design, and business students, in innovation thinking and methodology. This approach responds to the new thinking and practicing needs of industry, at the "fuzzy front end" of New Product Development, in addressing complex and difficult problems. The program leverages its unique partnership between three colleges; engineering, fine arts (design), and business to bridge the knowledge and cultural gaps in innovation education, and produce *elite innovators* defined as hybrid thinkers and doers. This paper highlights the philosophical distinction of the integrated innovation educational model and its goal to produce graduates better prepared to create impact.

Keywords: Integrated Innovation, Collaboration, Integration, Cross-Training, Hybrid Thinkers.

1 INTRODUCTION

Collaboration is method, a process, a goal, and sometimes a buzzword in today's academic and industry literature. Friend writes that her mental image of collaboration is ubiquitous; that the promise of collaboration has permeated every dimension of society including technology, advertising, entertainment, health care, and education sectors [1]. However, when this promise goes only as far as assembling what is believed to be the right combinations of expertise, and the expectation is they will work together and achieve innovative outcomes, desired results can be illusive. Cross, Robert L., et al proclaim that collaboration is at the heart of modern business processes yet "most companies are still in the dark about how to manage it". This is an opportunity that the Master of Integrated Innovation for Products and Services program (MII-PS) at Carnegie Mellon University, USA has been addressing formerly for 14 years but dates back 30 years. In 1986 we created the Integrated Product Development course (IPD) as a standalone class open to undergraduate and graduate students that brought together engineering, design, and business students and faculty to collaborate on the creation of innovative product and service concepts. In 2003, shortly after the publication of the successful Creating Breakthrough Products text by Cagan and Vogel, based in part on innovation methodologies developed in the IPD course, we created the MII-PS program (originally called Master of Product Development). The IPD course then became the capstone experience for MII-PS and more recently in 2013 inspired the creation of the Integrated Innovation Institute where MII-PS finds its home. From these evolutionary experiences in the classroom, and with industry sponsorship and insights over the years, we have established the position that integration rather than collaboration is the ultimate level of team functionality in support of innovation goals.

2 DISTINGUSING BETWEEN COLLABORATION AND INTEGRATION

There are numerous theories of collaboration that span across disciplines and topic areas; political, organizational, economical, and strategic are but a few examples. There are also many nuanced definitions but there is no unified definition for collaboration [2]. The consensus of the literature and common definitions explain that collaboration means *to work together*. Integration is an equally broad and encompassing term with theories that also span across numerous fields. While integration is associated with mathematical modelling, common definitions for integration include *to make-up, combine, or complete to produce a whole or larger unit* [3]. Perhaps because the definition of each term has variations where subtleties can imply similarities, they often are mistakenly used synonymous. Yet in the innovation process, it is important to make clear distinctions between the two in order to reduce confusion and potentially better inform the goals for team formation, conducting activities, enabling desired interactions, and producing goal outcomes. Following are three examples, from three different sectors, intended to illustrate some differences in types and levels between collaboration and integration.

2.1 Social Networks (technology driven data sharing)

Contemporary work activities and the need to share information quickly and globally have been driven by technological innovations. This has meant that collaborative cultures and activities in traditional office environments are increasingly influenced by the promise of technology to improve knowledge sharing and productivity. This rise has seen technology shift from a supporting role to a primary role in a relatively short time. For example, in a 2005 survey of senior executives only 25 percent of the respondents described their organizations as "effective" at sharing knowledge across boundaries [4]. Efforts to address this challenge have fuelled a thriving industry of experts who continue to provide general and tailored service offerings aimed at effectively measuring and improving the efficiency of people and organizations. Such efforts range from human resource training (people to people), to social network technologies (software management and systems tools). In a more recent 2012 survey, as reported by insight.com [5], senior executives forecasted that online collaboration tools would be important to 86% of organizations by 2015 [6]. Cross et al in discussing collaborative networks write "many companies have responded by spending heavily on collaboration software in hopes of disseminating best practices and sharing expertise. Technology, though, at best fails to deal with the underlying problem and at worst becomes a source of information overload that undermines effective collaboration." They described the problem further as a "poor job of shedding light on the largely invisible networks that help employees get things done across functional, hierarchical, and business unit boundaries. Additionally, it was unclear to them whether efforts to enhance networks promoted productive collaboration or just consumed money and time.

2.2 Applied Sciences

Peter Beck, Senior Fellow of the Design Futures Council, and member of the AEC (Architects, Engineering, and Construction association) provides a useful distinction of collaboration and integration. He writes, "Collaboration is a data-centric activity wherein each discipline contributes data information to other disciplines for processing to achieve common objectives… By contrast, integration is a knowledge-centric activity wherein each discipline contributes knowledge" [7]. He goes on to say that unlike collaboration, integration relies on participants sharing their knowledge. This is a notable distinction – the determination that collaboration and integration have particular purposes in this context, data-centric and knowledge-centric. While he states they both serve in the act of contributing, for collaboration this assertion would be consistent with common definitions of working together (often along side of), however, we argue integration is as an act of intentionally combining knowledge that benefits the whole.

2.3 Health Care

Literature in health care offers a range of perspectives with regard to the collaboration versus integration. Health care has developed a greater understanding of the need for holistic patient focused care. Boon et al [8] describe that the complexity of this approach requires "the involvement of individuals with disparate expertise collaborating in multidisciplinary teams to provide the best patient care. The integration of different health services has been highlighted as a common strategy to address the delivery of effective and cost-effective comprehensive care." This was the impetus for Boon et al

to conduct a study specifically to explore the terms collaboration and integration and what they mean for practitioners in multi-professional health care teams. They and others note there is little consistency in the use of the terminology *integrative health care, collaborative care, and interdisciplinary health care* other than "working together" for the good of the patients. They cite numerous examples from literature, examine arguments, and conclude collaboration and integration should not be used interchangeably. They go on to discuss that there are levels of collaboration that increase based on the levels of what they refer to as interprofessional interaction. One approached in particular describes differentiating by what they call "increased levels of interprofessional interaction", which includes the nature of the organizational structure and processes. They explain that these different levels range from "parallel practice to collaboration to integration, with collaboration falling in the middle of the continuum." They write "the continuum of Boon et al identifies 'integration' rather than 'collaboration' as the ultimate goal of teams working together to solve complex patient care problems." Additionally, Boon et al performed qualitative content analysis of definitions in the literature and defined "a working definition of integration as a goal or ideal type." They describe that integration:

- Seeks, through a partnership of patient and practitioner, to treat the whole person, to assist the innate healing properties of each person, and to promote health and wellness as well as the prevention of disease (philosophy and/or values).
- Is an interdisciplinary, non-hierarchical blending of both conventional medicine and complementary and alternative health care that provides a seamless continuum of decision-making, patient-centred care, and support (structure).
- Uses a collaborative team approach guided by consensus building, mutual respect, and a shared vision of health care that permits each practitioner and the patient to contribute their particular knowledge and skills within the context of a shared, synergistically charged plan of care (process).

We have found that the Boon et al description of integration, and its philosophy, values, structure, and process to be a useful structure for describing our MII-PS program. Our approach to integration is mapped to theirs and expressed in the following way:

- Seeks, through interdisciplinary partnerships, to holistically investigate problem spaces while keeping forefront human-centred research and design approaches in consideration of all stakeholders (philosophy and/or values).
- Is an interdisciplinary, non-hierarchical cross training of conventional, complementary, and alternative knowledge in order to inspire and support a seamless continuum of learning, sharing, questioning, decision-making, and teamwork (structure).
- Uses a collaborative team approach guided by consensus building, mutual respect, and a shared understanding of the process of innovation that permits each student and faculty to contribute their particular knowledge and skills within the context of a shared, synergistically charged plan of learning (process).

These three examples illustrate the broad ways the terms collaboration and integration are used within and across domains. They identify the need for clarity and consistency of use to support the sharing of data-centric and knowledge-centric information. We also learn a useful hierarchical structuring of these terms from Boon et al where on a continuum parallel is a starting point for shared activity, collaboration is the next higher level, and integration is the highest and ultimate goal. The next section describes how we have developed a program and curriculum around the integrated innovation learning philosophy.

3 THE MOTIVATION FOR INTEGRATED EDUCATION

The decision to create an integrated education model and differentiate it from collaborative models was in response to changing product development dynamics and near-term and long-term hiring needs of industry. We saw an opportunity to prepare graduates who can contribute to organizations with established interdisciplinary cultures (ideally who are integrated), or within organizations that desire to evolve such cultures. Companies already desire graduates who can function in high-performing interdisciplinary teams and who have the skills to contribute to, if not lead the innovation process of, opportunity identification, understandings the opportunity, conceptualization solutions, and the ability to shape and realize holistic feasible and compelling arguments. These skills, which command greater

knowledge across discipline domains, are becoming essential for generating insights that lead to innovative outcomes.

We acknowledge that this is a change in thought and language for how many companies currently understand the value of teamwork in the context of innovation. In some cases our education is out front of traditional organization models and requires potential employers to be educated about the distinct values of our graduates and fit within rigid organizational cultures. While our graduates are prepared to make immediate contributions to companies as integrated innovators and have on multiple levels, some are more challenged to overcome obstacles depending on what industry they desire to work in. For this reason career planning is an important part of their education in order to develop their unique value proposition.

In our work we have seen that successful integrated teams are the benefit of an organization that has a supportive mindset and structure. We learn from our applicants, students, alumni, and from industry relationships that the clear awareness of the value of an integrated culture, outside of some leading organizations of which many are design practices or departments, is limited. As more organizations push their collaboration goals towards what we believe will be integration goals, there will be a greater need for skilled hybrid thinkers capable of functioning in high performance innovative teams. However, chance work experiences cannot be relied on to prepare employees with such knowledge. In fact, such occasions may not exist unless they have the foresight to strategically move within a company or across companies, which can take years and luck to accomplish. Addressing this opportunity was also our motivation for creating our program and institute.

4 STRUCTURE OF AN INTEGRATED INNOVATION FOCUSED MASTERS

MII-PS is a professionally focused program offering two study options, a 9-month degree and a 16-month advance degree. The program is located within the Integrated Innovation Institute, which is a unique entity representing an equal partnership between three highly ranked colleges within the same university, each a core discipline of innovation: engineering, fine arts (design), and business. Highly ranked as well, the mission of MII-PS is to bridge the knowledge and cultural gaps in innovation education and develop graduates who are skilled and tested in applying innovation methodology to open-ended industry challenges, producing valuable outcomes, and becoming elite innovators in the process. The creation of the MII-PS program has provided a platform for evolving an innovation focused curriculum of which we are able to refine core courses, create new ones that expand the broader thinking and activity of innovation learning in areas such as Commercializing Intellectual Property, Innovation and Entrepreneurship, and Designing for the Internet of Things, and cross train students in the fundamentals of the core disciplines of innovation.

4.1 Training Across Disciplines

We seek to admit a balanced class of students representing each of the three disciplines. Having a solid foundation in engineering, design, or business provides a strong base for building knowledge and connections across the other disciplines. Our integrated culture builds from the first day of orientation and over time strengthens as experiences are enlightened through coursework and informal peer-to-peer learning through varied interest. Cross training disciplines in the fundamentals of the partnering disciplines happens immediately where students are required to take fundamental courses in the other disciplines. For examples, engineering students are required to take fundamental design and business courses. Multiple team experiences in other courses provide opportunities for new compositions where each of the three disciplines are represented in balance whenever possible. The sequence of courses and tailored electives are designed to support higher-level goals in addressing the inherent gap in discipline perceptions, build higher value between disciplines, enhance diverse thinking, broaden perspectives on the challenges and opportunities of any given problem, and ultimately become elite in their innovation thinking and methods. The IPD capstone course, taught jointly by an integrated faculty team representing engineering, design, and business, is where we see this demonstrated most clearly. See figure 1 for a visual overview of the program philosophy, structure, and value proposition.

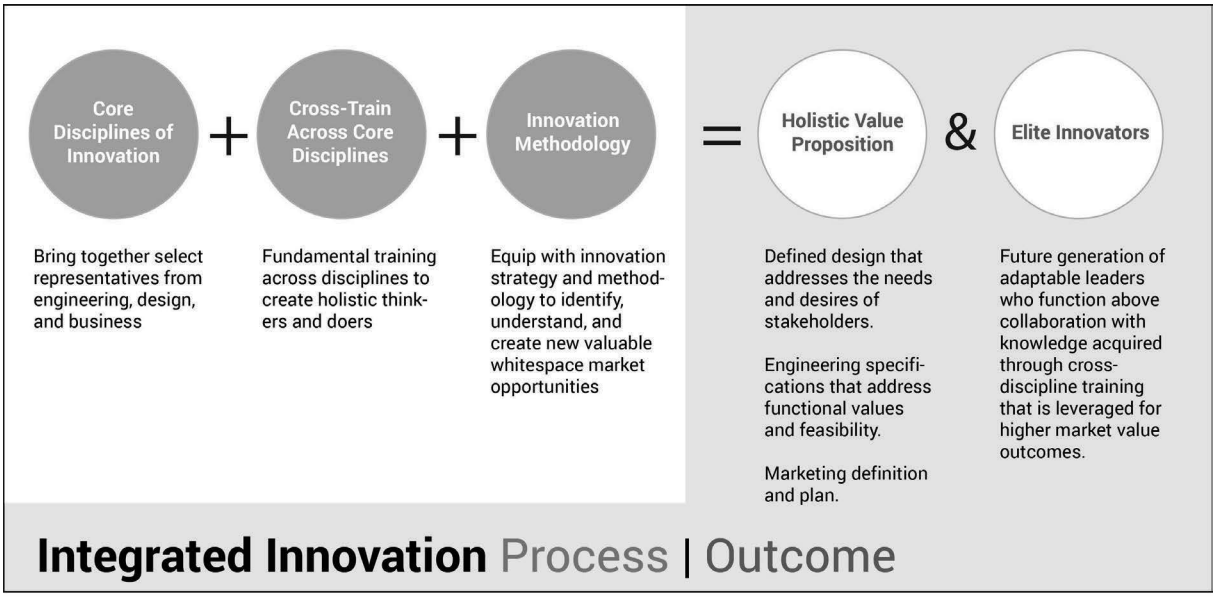

Figure 1. Integrated Innovation Process: Creating a Holistic Value Proposition

4.2 Challenges and Insights

The creation of an integrated culture for a professional masters degree has taken time and continues to develop in response to each new class and sponsor challenges. Mechanically not much would appear to be different from running a typical masters program in the USA. Master students adapt quickly to scheduling routines and in time engineering and business students adjust to the studio-learning model and workflow, which is often an unusual educational experience in structure and duration. We learned it was important to create an environment that quickly cultivates a sustained sense of shared knowledge, beliefs, artefacts, morals, and customs through experience and relationship building – student to student and student to faculty and staff, as Tylor writes [9]. At minimum we want students to value their experiences while students and cherished it as alumni. For this reason we work continuously to make the day-to-day experiences of students part of our goal culture and not episodic as Bushe writes [10]. Achieving this is no easy feat. It requires having leaders and staff who live the philosophy of integrated innovation. Students and others witness this in a variety of ways including: through the shared engagements and responsibilities of the is a team of three interdisciplinary and integrated faculty); personnel on all levels follow an integrated mindset in program support, communications, engagement with institute students and the greater university; and through student learning, which is often structured in interdisciplinary teams.

4.2.1 The Shifting of Attitudes

The co-directors and faculty of MII-PS routinely assess knowledge and skill building courses in the curriculum. As we have intentionally worked to shift our culture from what began years ago as a collaboration of disciplines to now an integrated holistic approach and mindset, we have witnessed this positive attitudinal change in our students. This change is evident for most students within their first 15-week semester. Non-scientific surveys and interviews at the beginning of their study show clear discipline distinctions in how they present themselves and function, which is not unexpected. When asked near the conclusion of their first semester, these attitudes are softened as students embrace their education and become more holistic as evidenced by their team and individual work. They also begin thinking about what role they desire to perform as a professional, which is often a different profile than when they entered. As a point of mindset comparison, the program admits business students directly who begin with all other students of the program. The program also has a partnership with the business college where there is an innovation track for MBA students. Several of these talented students are part of the IPD capstone course. While these students contribute much needed value to their teams, they have a mindset of a discipline contributing to a team and not an integrated mindset, as have the other students. At times this can be a challenge but is manageable.

4.2.2 Monitoring Team and Program Development

Using MII-PS as an active platform for study continues to prepare students well for the IPD capstone experience, and has allowed the course to take on a broad range of challenges. For example, in a single course teams have focused separately on diverse and challenging open-ended industry sponsored projects ranging from infant products for Nuk, to new member experiences for Emirates Airlines, to road construction safety products and systems for Volvo Construction Equipment. We monitor the IPD course closely for quality changes in team dynamics, process work, and overall outcomes. Student teams participate in anonymous phase performance reviews of their members and these assessments have proven valuable feedback for mentoring teams and helping them self-correct if needed. We have witnessed several positive aspects to our program. One is the consistent high value outcome in response to challenges that have become more complex and difficult. We see this as reflecting the strength of the process and the ongoing adjustments. Another is the development and now high-level consistency in team performances – an integrated mindset versus a discipline one. We understand from our own review of other similarly focused programs in the USA, and from external opinions, that our program has some distinction in the following ways: 1) our focus on an integrated innovation rather than collaboration 2) our philosophy and culture where leadership and focus, representing the partnership of three colleges, is shared equally, and 3) a requirement that students take, at minimum, fundamental courses in two of the three disciplines that are not their own. While other programs have partnerships between different disciplines, it is rare to have the discipline of engineering, design, and business in one university. There are programs grounded in a discipline, such as engineering, which supplement design or business experiences. However, we are not aware of others in the USA that has integrated the disciplines as we have or its outcomes. We have not surveyed programs internationally.

5 CONCLUSION

At a time when leading companies are working to create integrated discipline cultures in response to design challenges that are now routinely complex and larger scale, our program has been working in parallel developing and refining our curricula model to meet the current and future needs of professional practice. Our goals are to create elite innovators through cross-training students in the fundamental knowledge of our partnering disciplines (engineering, design, and business), to teach innovation and entrepreneurship methods, and to demonstrate the value of an integrated culture. We see these as necessary to bridge knowledge and cultural gaps in education and for preparing graduates who can add immediate and lasting value to industry through participating, if not leading, high-functioning innovation teams.

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