# Some Thoughts on the Future of the University[1]

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## Summary

This white paper argues that universities need to become knowledge entrepreneurs, in the process embracing four ideas: design thinking, computational thinking, disruptive innovation and radical interdisciplinarity. I discuss these ideas in the context of higher education at a modern research university, and suggest how an "Innovator Works" might be created to foster these ideas from within the academy. The "Inworks" would draw together faculty and students from disciplines across campus who will work collaboratively to address problems of real significance to human society. In the process of engaging in this kind of human-centered problem solving, students will develop intellectual capacities that are needed to succeed in the 21st century.

## Introduction

Technological advances, especially in information and communication technology, have profoundly altered human society, interaction and enterprise on a global scale. This transformation has brought with it a new and complex set of societal challenges. New jobs and institutions have emerged that did not exist a decade ago. Many existing jobs have become obsolete, and long-standing institutions have been challenged to keep pace as they seek to maintain relevance in a radically altered landscape. The academy, for centuries a place where students came to receive imparted special knowledge and skills, is facing particular and profound challenges to its traditional roles.

The networked information age has also created rich new opportunities for research and scholarship, first, in the creation of technologies themselves, and second, in the understanding of how these technologies impact human society. That impact is profound, in part because the pace of technological change is so fast. One of the defining characteristics of the information age is the phenomenon of exponential growth. Virtually every metric used to measure the performance,

[1] This document is a slight update of a white paper of the same title written in November 2013. The white paper envisioned the creation of a collaborative interdisciplinary program called the "inSchool" (since updated to "inWorks," then "Inworks," because no one could remember how to spell "inWorks.") that has since found fertile soil at the University of Colorado Denver | Anschutz Medical Campus. The actual Inworks has already evolved beyond its envisioning document, but these differences have been left unchanged here. A shorter and more accurate version is available from jkb@ucdenver.edu.

adoption, and capacity of computing infrastructure (e.g., processor speed, memory size, number of World Wide Web users, number of Facebook users, capacity of Google, etc.) has grown exponentially for several decades. Human social systems have never in history had to cope with this rate of change. Our customs, laws, schools, businesses, and government - our citizens - are ill-equipped to cope with change at this pace.

The Internet, the proliferation of mobile devices, and more recently social networks such as Facebook and Twitter are examples of the pervasive impact of information and communication technology on modern society. We do not fully understand this impact, which touches nearly every area of endeavor, and we understand even less what is yet to come. Today's college graduates will likely have more than ten different careers during their lifetime, and half of those jobs do not exist today.

How should we prepare our students for careers that do not yet exist? Universities have long struggled with this question, and part of the answer is known: teach students how to be life-long learners. However, in an age that will be dominated by the ubiquitous presence of information and communication technology, new skills sets and new mind sets will also be necessary. In addition to the ability to adopt new ways of thinking, students will need to learn to think critically, creatively, integratively and transformatively; to develop solutions when the problems themselves are not well defined; to embrace innovation and entrepreneurship, to analyze and synthesize vast amounts of information; to have substantial qualitative and quantitative skills; to have both a global perspective and an eye for detail; to collaborate effectively in interdisciplinary teams; and to lead when leadership is called for. The education of such students should represent a key objective of the academy, one that can both distinguish a university campus and help chart its course. This document argues that universities approach this challenge by embracing four ideas: design thinking, computational thinking, disruptive innovation and radical interdisciplinarity.

**Design Thinking**

"Design thinking" refers to a human-centered process for creatively developing solutions to complex problems. Design thinking is a scaffold for innovation that integrates empathy, creativity, and practicality to match human need with feasibility. In the parlance of the Stanford d.School this process consists of five steps:

*Empathize* - The first step of the design process requires the designer to understand at a deep level the people for whom one is designing. Social scientists, especially anthropologists, have developed a variety of qualitative ethnographic tools for understanding values, peoples and cultures. Some of these tools can, in a narrow context, be employed effectively by non-specialists.

*Define* - The purpose of this step is to transform the understanding developed in the first step to an actionable problem statement.

*Ideate* - Ideation explores a wide range of possible solutions, usually deferring substantial evaluation until the best candidate solutions have begun to emerge.

*Prototype* - Current notions of design thinking bias toward concrete action. The idea is that it is better to try something now, get results, and try again than it is to stay on the drawing board looking for an optimal solution. Creating and testing several simple prototypes, which may only explore one aspect of the final solution, is likely to cost less in the long run than fully developing a single solution that may ultimately fail. In the entrepreneurial ecosystem, this principle has come to be called "fail fast."

*Test* - Testing is the process that informs the refinement of prospective solutions, and may cause all of the preceding steps to be revisited.

As a result of its generality and reliance upon what people actually want and need in their lives, design thinking has become part of the modern lexicon in engineering and business. It needs to be part of the lexicon of higher education. Design thinking highlights the critical role of creativity in every human endeavor. By helping to create experiences that allow individuals to encounter their own creativity, design thinking extends the design philosophy to things outside of products and provides a vocabulary for being intentional about the way we work together to solve significant problems.

In addition to the value of the solution itself, design thinking transforms its practitioners by providing a scaffold for learning how to innovate. For educators, this is critical. Our objective cannot simply be to create innovations, however valuable those innovations may be. If we also focus on creating innovators, our work will have a much greater and more lasting impact.

**Computational Thinking**

Today, information is ubiquitous, and anyone with Internet access can obtain a wealth of information on almost any subject. The challenge to today's students is not the acquisition of information, rather it is learning how to select, evaluate, integrate and synthesize information into purposeful knowledge. Citizens in the 21st century need to be technologically literate, globally aware, and prepared to employ new technologies as they emerge. In order to function in modern society, they have to understand networks, computing systems, and richly interactive software applications and tools. The required understanding is deeper than the ability to use a computer for day-to-day personal productivity.

What has come to be called "computational thinking" is increasingly considered one of the necessary components of a modern education. Computational thinking refers to the ability to create human artifacts of every kind – structures, art, music, medicine, aircraft, entertainment, entire worlds of imagination – using computing as the instrument of creation. Computational thinking frees us to go beyond what is physically realizable to what is computationally realizable. Engineers, artists, writers, pharmacologists, musicians, etc. can imagine and create artifacts that are impossible to realize by human endeavor alone. These forms of creative expression are not represented simply by the ability to use a set of computer applications, or even the ability to write computer programs. Rather, they represent a new way of thinking about what is possible, and using the computer as a tool to realize fully that vision.

Data analytics, sometimes called data science, is an emerging interdisciplinary paradigm within the domain of computational thinking. The basic idea is to find ways to take advantage of the huge volume of data generated as a side effect of the Internet age. Corporations and governmental agencies produce vast amounts of information regularly. Social networks produce millions of postings daily in which geolocated individuals self-report items of personal interest. These data, which are widely available online, represent a potential treasure trove of useful information about human social systems that can be used to improve education, health and government. For example, clinical researchers can examine treatments and outcomes from hundreds of hospitals, and use these data to refine treatment guidelines. Epidemiologists can track the spread of diseases like influenza by monitoring the twitter feed coming from different regions of the world. By mining social media

feeds, economists can gage consumer confidence, and retailers can track the success of new products.

However these same data, used inappropriately, also have the potential to undermine the foundations of civil society. The significant societal value of the information that can be gleaned from these data is in direct tension with the significant potential for negative impact on individuals from the associated loss of privacy and a diminishing "right to be forgotten[2]." This tension is itself an area of new scholarship as legal, ethical and social scholars explore the nature, value and ownership of personal digital information.

**Disruptive Innovation**

A disruptive innovation is one that changes the value proposition in an existing market to such an extent that existing market leaders are displaced by newcomers who have been early adopters of the disrupting innovation. Interestingly, case studies of disruptive innovation show that the existing market leaders are typically aware of the innovation in question, but reject its early adoption because of perceived lack of profitability, or competition for limited resources with sustaining (typically incremental) innovations. Thus market leaders tend to place insufficient value on the disruptive innovation to warrant its development, and competing newcomers are able to displace the market leader by being a first adopter of the disruptive innovation. By the time the established market leader is in real competition with the early adopter, its only option is to emulate and hope to survive, rather than to innovate and lead.[3]

For universities, a case in point is the emergence of massive open on-line courses (MOOCs). MOOCs are on-line classes with typically very large numbers of students (at least initially) and minimal direct involvement of faculty. Enrollment is usually open, costs to the student are negligible, and degree course credit is rarely given upon course completion. Some of the key intellectual ideas behind MOOCs include connectivism (learning is the connection of people to knowledge), distributed representation (knowledge exists in the network of learners) and negotiated meaning (the meaning of knowledge is negotiated in the network).

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[2] The Right to Be Forgotten, Jeffrey Rosen, *Stanford Law Review*, 64 Stan. L. Rev. Online 88, February 13, 2012.
[3] *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Clayton Christensen, 1997.

Although still very much in their infancy, and there are valid reasons to be skeptical, MOOCs raise important questions about the future of university education, the future value of a university degree, and the effect technology will have on how the academy operates. The current environment is not sustainable: job candidates are increasingly evaluated based upon actual competencies rather than educational pedigree; costs to attend a brick and mortar university are increasing at a rate far outpacing other costs of living; and for two-thirds of the world's population, a traditional university education is simply out of reach. It is no wonder that students are eager to try lower-cost alternatives and the academy is increasingly under attack for producing graduates who are not ready to practice their chosen profession, e.g., engineering graduates who are well-grounded in theory but who are not ready to join a design team; law graduates who are not ready to practice law; and liberal arts graduates who cannot communicate effectively, either orally or in writing.

Most of the MOOC curricula offered today relates to technology, in part because it is easier to construct course materials for objective subject matter. In addition, the majority of existing courses focus on transferring knowledge that is relevant today, with little thought given to the preparation of students for tomorrow. We also continue to apply old values to this process: how to monetize the transfer of knowledge; how to credential the result; how to address issues of academic integrity. Universities should be engines of disruptive innovation, not its unwitting target. Further, we need to remember that there are significant cultural and generational issues between faculty and students. Our students matriculate profoundly conditioned by modern culture in ways not generally anticipated or well understood by the faculty. Students today represent the first generation of what Prensky calls "digital natives." "Today's students are no longer the people our educational system was designed to teach."[4] Both our curriculum and our pedagogy must be responsive to the ways in which our students best learn.

For example, a different approach to MOOCs would focus upon single core value: enabling the acquisition of purposeful knowledge. Purposeful knowledge draws from the work of Malcolm Knowles in self-directed learning (students tend to learn more from the necessity of accomplishing real tasks, rather than from an abstract desire to know more, thus learning should be task-centered,

[4] "Digital Natives, Digital Immigrants," Marc Prensky, *On the Horizon*, MCB Univ. Press, Vol. 9 No. 5, Oct. 2001.

instead of subject centered)[5,6] and from the constructionist learning model of Seymour Papert (building something real in the world builds knowledge in the mind)[7]. The common thread of problem-based, hands-on learning is that the process of building something, of accomplishing a real task, is transformational to the student, in addition to the intrinsic value of the accomplishment.

**Radical Interdisciplinarity**

The way the academy structures knowledge perpetuates disciplinary silos and helps create profound social barriers among both faculty and students. This is increasingly counterproductive, for several reasons. First, solutions to hard problems, especially those that confront modern society, generally require more than one kind of knowledge. In an age where everything is connected to everything else, the knowledge needed to solve a problem is often to be found in a completely different domain than the problem itself. Interdisciplinary innovation is thus an essential tool for solving challenging problems, and an essential skill set for people entering the future workforce.

This is hard, and made harder by the self-imposed barriers to interdisciplinary work common at most universities. Consider bioinformatics as a concrete example. At most universities, faculty and students working in this area might be found in Computer Science, Molecular Biology, Philosophy (ethics), Law, Biological Engineering, Business and Medicine. While successful interdisciplinary research collaborations likely already exist in bioinformatics, any faculty member or student seeking to work in this area must typically align her/his activities with respect to advancement along dimensions defined by a particular home department. This makes it difficult to build strength at the center of the field, and represents a particular challenge for new tenure-track faculty.

We cannot address these issues by simply throwing people from a host of disciplines into a room and hoping for the best. We are creatures of habit, and, absent intervention, we will fall back upon old habits when confronted with new situations. We need a shared vocabulary of collaboration that honors different expertise; we need to understand and be intentional about team dynamics; we need

[5] *Self-Directed Learning*, Malcolm Knowles, Chicago: Follet, 1975.
[6] *Andragogy in Action*, Malcolm Knowles, San Francisco: Jossey-Bass, 1984.
[7] *Constructionism*, Idit Harel and Seymour Papert, Ablex Publishing Corporation, 1991.

to avoid needless hierarchy, and recognize that innovative leadership is not about creating goals and incentives, rather it is a process of giving direction that promotes creative problem solving.

Finally, we need to consider carefully how physical space contributes to collaborative problem solving, and provide a collaborative environment that positively biases the design process: open floor plans, round tables, shared space for interaction and prototyping, etc.

**Values and Value**

These ideas are generally not part of the culture of most universities, but they are not new. In one form or another, these ideas have been part of entrepreneurial practice for some time. If we are to remain relevant, universities need to embrace these ideas and become "knowledge entrepreneurs." We need to be willing to take risks, to try ideas that we know might fail, and to be willing to stop and do something else when an idea fails. Most importantly, we need to broaden our focus on creating innovation to include the creation of innovators.

Universities are increasingly called upon to demonstrate value to the communities that they serve: their students, their geographic locale, the state, the nation and the world. Our responses often point (reasonably) to the quality and volume of the basic research conducted by our colleagues, expecting our audience to see a clear link between basic research and community benefit. This may not be the case. The path from research result to demonstrated benefit can be long, and the links tenuous, especially to a non-specialist. This problem is exacerbated by a prevalent distain for applied research and development found on many campuses.

Basic research is clearly a large part of what we do, but if we want to create innovators as well as innovations, we need to also seek solutions to tough problems that have direct societal benefit. We must also deliver clear value to our graduates. They have an interest, and a right, to expect to be really good at something when they graduate. So how might we accomplish these objectives when we know that change is hard? One approach is to create a "skunkworks."

During World War II, Lockheed's Advanced Development Projects Division created a small, carefully selected design team, gave this group a fair degree of autonomy from routine organizational procedures and bureaucracy, and demanded rapid results. This experiment was successful, and the term "skunkworks" has come to represent any project developed by a small and

loosely structured group of people charged with the creation of something radically new. If successful, the results of skunkworks projects are often adopted into the core values of the larger enterprise.

What would an academic skunkworks look like? First, it should not be, in perception or reality, the place where the bright, creative people go, to the detriment of the rest of campus. It should be a partner, not a competitor, with every other academic unit on campus. In the words of George Kembel, Stanford d.School cofounder, it should be a "school crossing," not a school. It would likely not offer its own undergraduate degrees, but it could offer minors, certificates, and easy participation, what we might call "access to the machine shop of innovation." Strong industry engagement would be critical: what do they need in our graduates? What are the really tough problems they need solved? The home of the skunkworks has to support the kind of intense innovation, collaboration and experimentation needed.[8] Imagine an open floor plan with few (if any) private offices – we all have skills and experience to bring to the table; many areas for collaborating; maker space (flexible prototyping facilities); excellent computing facilities; lots of room for visitors and squatters; small and large meeting spaces; and readily available tools and materials for creating prototypes – cameras, digital pens, recorders, foam core, 3D printers, etc.

**Taking the Leap**

Change is not easy for any institution; nowhere is this truer than within the modern academy. Universities, sometimes derided for their liberal leanings, can be remarkably conservative and stunningly risk-averse. In his 1908 treatise on academic politics, *Microcosmographia Academica*[9], Cambridge scholar F. M. Cornford introduced the "Principle of the Dangerous Precedent," in which he cynically concludes that at a university "nothing should ever be done for the first time." Louis Menand, in *The Marketplace of Ideas: Reform and Resistance in the American University*[10], speaks of the need for prospective reformers to avoid at all costs triggering the university's innate "auto-immune response" to change. Menand goes on to argue that the present day academy's defense of its nineteenth-century approach to education threatens to undermine its very foundations.

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[8] *The Art of Innovation*, Tom Kelly, Doubleday, 2001.
[9] *Microcosmographia Academica*, F. M. Cornford, 1908.
[10] *The Marketplace of Ideas: Reform and Reaction in the American University*, Louis Menand, W.W. Norton & Company, 2010.

The challenge we face is how to constructively incorporate new ways of thinking into our teaching, scholarship and practice. The problems confronting human society are incredibly complex, and they are legion. Interdisciplinary work has led to significant advances in new directions, and in many cases has resulted in the creation of entire new disciplines. In spite of these advances, many university faculty and administrators remain uncomfortable with interdisciplinary research and teaching. How can a university create an environment that facilitates and promotes far-reaching intellectual diversity? First, faculty and students need to be able to readily interact across traditional disciplinary boundaries. Second, faculty need to be able to engage in interdisciplinary research without endangering their careers. Third, since interdisciplinary interaction is not our natural way of doing things, we need to create a catalyst on campus that facilitates such interaction by providing space, facilities, and programs that foster creative innovation. Finally, we need administrative commitment to make this happen. Few universities have the institutional courage and vision to commit to revolutionary changes of the fundamental ways in which they work; it is far easier to continue to make incremental changes to old models. However, it is becoming increasingly clear that we cannot increment our way to excellence.

We therefore need a new academic unit that actively facilitates interdisciplinary collaborations among faculty and students from many disciplines, creates innovators, promotes innovation and entrepreneurship, and encourages risk-taking and leadership. For now, call this new academic unit the "Innovator Works" or "Inworks."

**Some Thoughts on Implementation**

Educational Objectives

When employers are asked what they look for most when making hiring decisions, they describe, in addition to solid preparation, the ability to work in collaborative teams and the ability to communicate effectively. They want creative "idea people," individuals who are capable of synthesizing available information into actionable alternatives; they want graduates whose education went beyond the classroom – people who have gone abroad, interned with a company (or started their own company!); and they want graduates whose education involved experiential learning projects, in which students engaged in "hands-on" activities that challenged their creativity,

adaptability and entrepreneurial skills. Such people are capable of learning new skills, adapting to changing circumstances, and will be learners for the rest of their lives.

Tim Brown, the President of Ideo, summarized the five characteristics of what he calls "design thinkers" (Brown has also called such individuals "T-shaped people") as follows:

> **"***Empathy* - They can imagine the world from multiple perspectives—those of colleagues, clients, end users, and customers (current and prospective). By taking a "people first" approach, design thinkers can imagine solutions that are inherently desirable and meet explicit or latent needs. Great design thinkers observe the world in minute detail. They notice things that others do not and use their insights to inspire innovation.
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> *Integrative Thinking* - They not only rely on analytical processes (those that produce either/or choices) but also exhibit the ability to see all of the salient—and sometimes contradictory—aspects of a confounding problem and create novel solutions that go beyond and dramatically improve on existing alternatives.
>
> *Optimism* - They assume that no matter how challenging the constraints of a given problem, at least one potential solution is better than the existing alternatives.
>
> *Experimentalism* - Significant innovations don't come from incremental tweaks. Design thinkers pose questions and explore constraints in creative ways that proceed in entirely new directions.
>
> *Collaboration* - The increasing complexity of products, services, and experiences has replaced the myth of the lone creative genius with the reality of the enthusiastic interdisciplinary collaborator. The best design thinkers don't simply work alongside other disciplines; many of them have significant experience in more than one. At IDEO we employ people who are engineers and marketers, anthropologists and industrial designers, architects and psychologists."[11]

Intellectual capacities conducive to innovation have been similarly categorized by Dyer, Gregersen and Christensen as *associating*, *questioning*, *observing*, *experimenting* and *networking*.[12] Wagner summarizes the essential qualities of a successful innovator as follows:

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[11] "Design Thinking", Tim Brown, *Harvard Business Review*, June 2008.

[12] *The Innovator's DNA: Mastering the Five Skills of Disruptive Innovator*s, Jeff Dyer, Hal Gregersen and Clayton M. Christensen, Harvard Business Review Press, 2011.

- "curiosity, which is a habit of asking good questions and a desire to understand more deeply
- collaboration, which begins with listening to and learning from others who have perspectives and expertise that are very different from your own
- associative or integrative thinking
- a bias toward action and experimentation"[13]

Wagner importantly goes on to observe that "...what I find most significant in this list is that *they represent a set of skills and habits of mind that can be nurtured, taught and mentored*" [emphasis added].

The Inworks should thus offer programs, available to students from any major on campus, which helps students develop and practice these skills.

Professional Practice

We should embrace as part of our educational mission the preparation of professional practitioners. However lofty and well-intentioned our educational objectives, in the end, our students rightfully expect to be able to find gainful employment. Critical thinking, and other traditional academic foci, can, and should, exist in tandem with professional preparation. We should unapologetically seek to prepare our students for careers, and give them the experiences and skills to succeed throughout those careers.

Curricula

In *Creating Innovators*, Wagner argues that a curriculum built around innovation needs to integrate play, passion and purpose. In play, we "explore, experiment and imagine new possibilities." With passion, we are driven to persevere and to "explore, to learn something new, to understand something more deeply, to master something difficult." Purpose is what drives us to "make a difference." Wagner sees a natural progression from play to passion to purpose. Students first discover how to think creatively; then they find subject matter that draws them in; and finally, they look for a way to make a real difference. Helping students find and follow this path are key objectives of the Inworks. The idea is to draw together faculty and students from disciplines across

[13] *Creating Innovators*, Tony Wagner, Schribner, 2012.

campus who will work collaboratively to address problems of real significance to human society. In the process of engaging in this kind of human-centered problem solving, students will develop intellectual capacities and habits of mind that support collaborative innovation.

The Inworks curriculum cannot be self-contained. It must exist within, contribute to, and be supported by other academic units across campus. While there are examples at other institutions of how to do this, it is essential to draw upon, take advantage of and build upon unique campus strengths. For example, the Inworks should create strong ties to public health (where many important and complex problems are to be found), as well as computer science, materials, energy, medicine, business, arts, media and entertainment.

Faculty and students of the Inworks should conduct leading-edge practice-based research on the use of technology to facilitate learning at every scale. Online education, including MOOCs, should be a major focus of these efforts. The Inworks should also actively practice in this space. Where appropriate, Inworks content should be made available online. A "merit badge" reward system that is unlinked from credit or revenue, i.e., focused solely on the acquisition of purposeful knowledge, may facilitate engagement by a global audience. For revenue-generating online courses, the Inworks should consider a per-course threshold, instead of a per-person threshold. This is the "Kickstarter" model applied to education: if enough students sign up who are willing to cover course costs, the course should be offered. For example, if a course costs $6000 to offer, and either 10 students are willing to pay $600, or 600 students are willing to pay $10, the course should be offered.

The course offerings of the Inworks will evolve over time, and will center around the four underlying principles: design thinking, computational thinking, disruptive innovation and radical interdisciplinarity. Some of these courses may already be offered in existing academic units. With respect to its own courses, the Inworks should actively promote excellence in teaching as a foundational value. For both pragmatic and programmatic reasons, diversity (of gender, socio-economic status, experience, veteran status, etc.) should be built into the Inworks DNA from the start. Because one-on-one instruction is demonstrably superior for most students (Bloom's "two sigma problem")[14] the Inworks should provide peer academic support by embracing both

[14] "The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring," Benjamin Bloom, *Educational Researcher*, Vol. 13, No.6. (Jun. - Jul., 1984), pp. 4-16.

supplemental instruction[15,16,17] and a "see one – do one – teach one" model in which students tutor other students according to their experience and abilities. Finally, the Inworks' educational approach should expect and demand excellence; to paraphrase Goethe: "treat people as if they were what they ought to be and you help them become what they are capable of being."

Structural Issues

To realize these ambitious programmatic objectives, a supporting academic structure is required that will facilitate highly innovative interdisciplinary research, education, outreach and creative work. Structure provides stability, but it can also impose inertia. The external and internal structure of the Inworks may need to differ in order to be sufficiently flexible to support the desired agility. The Inworks needs to facilitate active collaboration between people and organizations inside and outside the university, and it needs to create an inclusive and diverse environment for such collaborations to take place. The Inworks should promote innovation and entrepreneurship, and exhibit the flexibility and agility needed to quickly respond to the pace of technological and social change. With respect to the campus administration, and to the colleges and schools on campus, the Inworks should probably look like a recognizable academic unit. The leadership of the Inworks should be able to readily interact with the leadership of existing academic units on campus, for example, by having a similar reporting relationship. Internally however, the Inworks should be structured to facilitate the rich interdisciplinarity and agility necessary to support its programmatic objectives.

The primary purpose of the Inworks is to provide an intellectually diverse, richly creative and highly supportive environment in which faculty and students from across campus can collaboratively interact. From an external viewpoint, the Inworks will likely look much like other academic units: academic and budget autonomy, control of university resources; a small number of faculty positions for core faculty; leadership with the usual administrative responsibilities related to appointments,

[15] "The Impact of Supplemental Instruction on Teaching Students 'How' to Learn," S.Y. McGuire, *New Directions for Teaching and Learning*, No. 106, pp. 3-10, Sum. 2006.
[16] "Breaking the Attrition Cycle: The Effects of Supplemental Instruction on Undergraduate Performance and Attrition," R.A. Blanc, L. DeBuhr & D.C. Martin, *Journal of Higher Education*, 54(1), 80-89, 1983.
[17] "Supplemental Instruction: Increasing Student Performance and Persistence in Difficult Academic Courses, R.A. Blanc & D.C. Martin, *Academic Medicine: Journal of the Association of American Medical Colleges*, 69(6), 452-454, 1994.

promotions, curriculum, advising, development, and budget matters. The Inworks should be represented appropriately in campus decision and administrative processes.

The Inworks may serve as the tenure home for a small number of core rostered faculty, and as the degree home for a small number of interdisciplinary graduate degrees, providing infrastructure as necessary to support these faculty and degree programs.

Whatever the structure, the Inworks needs to be enabling, not forcing. Faculty and students should engage with the Inworks because they see opportunity, not coercion. Faculty and students should be able to engage with and benefit from Inworks activities without having to leave their existing academic home.

External Relationships

The Inworks should provide structure that facilitates active collaboration between people and organizations inside and outside of the University. In addition to its interactions with industry and government, it should engage with K-12 and community college educators in meaningful ways related to pedagogy, pipeline development, diversity, educational technology, and teacher training. It should also create broad opportunities for lifelong learning - speaker programs, workshops and other programs that bring together people from radically different backgrounds to consider issues of importance to human society.

As an academic unit focused on purposeful innovation, the Inworks needs to actively engage with the industries that create the foundations of these endeavors, as well as the professionals who practice them on a daily basis. At most universities, existing models for engaging with industries divides this engagement into (at least) four components. Research collaboration falls within the province of the faculty, working with an Office of Contracts and Grants (or similarly named entity). Corporate philanthropy is managed by a separate development organization. Potential employment and internships are managed by a Career Services Office (usually found within Student Affairs). Finally, an Office of Technology Transfer manages interactions with industries seeking to employ technologies created at the university.

When the pace of change is fast, and the need for responsive interaction a key programmatic objective, this division of responsibilities is problematic. Within industry, interactions with universities are typically centralized in order to ensure that the company's interactions with various

universities are well-managed in a manner consistent with corporate mission objectives. The Inworks needs to manage its interactions with industry in a manner that mirrors this organization. For example, the Inworks could have a Director of External Relations (DER) that would coordinate and integrate efforts to secure funding for the Inworks with efforts to engage in other forms of collaboration. A strong DER would understand the students of the Inworks, their skills, and the value they offer to companies and society as a whole; *and* the nature and needs of the industries with whom the Inworks engages. The DER would provide a single point of contact for industry to interact with the new Inworks, with respect to internships, employment, research collaboration and philanthropy. The idea is not to duplicate functions provided elsewhere, rather to integrate their interaction with industry in a way that benefits all concerned. The DER would be responsible for having close relationships with entrepreneurs, venture capitalists, local businesses and national corporations. She or he would integrate elements of corporate giving and career services to effectively address the needs of companies, students, and the university as a whole. In addition, an effective DER could help inform curriculum development within the Inworks. With a better understanding of the job skills most needed in industry, the Inworks can keep its curriculum relevant. The Inworks can also stay abreast of opportunities for evening classes and certificates targeted at working professionals – a potential revenue stream that is often underdeveloped.

The Inworks leadership should perform these functions during startup, and should continue to be directly involved after the DER is in place.

Faculty and Student Entrepreneurship

The Inworks should work to ensure that its encouragement of entrepreneurship extends to faculty and students. Typically, a tenured or tenure-track faculty member who wants to start a company faces a difficult choice between remaining an academic or becoming an entrepreneur. Universities should actively encourage entrepreneurial activity among their faculty, and reward this activity in its consideration of more traditional measures of faculty performance. There are excellent models that suggest how this can be done without adversely impacting other programmatic objectives.

Undergraduate and graduate students are also often entrepreneurial. Many of the most successful companies of the internet age were founded by students while they were still in school. Sadly, many

of these individuals found pursuit of a formal education incompatible with staring a company. This need not be the case.

Many universities have been the beneficiary of substantial gifts from their entrepreneurial faculty and students. We should support, not discourage activities that can contribute to that result. The Inworks is a natural campus resource that can help ensure that entrepreneurial faculty and students are able to, and encouraged to, remain active members of the campus community by providing support and incubator space in which such activities take place.

Core Faculty

While most of the faculty who affiliate with the Inworks will be homed in other units, the Inworks will need a small core faculty to direct and deliver its academic programs. These faculty will be drawn to the Inworks by its mission, challenged by the ambitiousness of its objectives, and excited by the opportunity to create a new kind of academic unit. Such people will come from varied backgrounds, but it is likely that some of these individuals will either already have tenure at another institution, or they will see the tenure track as an essential element of their career path. While it may be possible to build a highly successful set of programs in a tenure-less environment, it seems unwise to write off this possibility from the start. For that reason, the administrative and academic structure of the Inworks should make it possible for the Inworks to serve as a tenure home, should circumstances warrant that step.

In addition to faculty, visitors from industry, government and other universities will bring new ideas, unique expertise and experience, current challenges, and real world relevance to the Inworks. Visiting faculty, designers, entrepreneurs, and leaders of government and industry will spend a few weeks to a year working as "Mentors in Residence" on one or more projects with faculty and students of the Inworks.

Since most of the faculty engaged in the work of the Inworks will be faculty members of other academic units on campus, faculty engagement and participation from many other units is essential to the success of the Inworks. Similarly, it is important to the success of the Inworks that no single discipline dominate the Inworks' academic agenda. The Inworks should have porous boundaries to interaction, i.e., it should be easy for a faculty member from any unit on campus to engage with the Inworks, without any negative impact on the participating faculty member, or their home unit. One

possible approach is the one taken by Cornell, and elsewhere, where faculty members are formally rostered in one unit, and "virtually" rostered in another. This arrangement would allow faculty members to be a visible part of Inworks while remaining actively engaged with, and administratively visible within, their home unit.

Staff

A capable and supportive staff is essential to the successful operation of any academic unit. This is particularly true of units seeking to innovate. The (small) staff of the Inworks will be regularly challenged with finding ways to accomplish potentially unfamiliar objectives while adhering to existing guidelines and policies. Inworks staff will routinely face new and unanticipated challenges, and they will have many cross-cutting responsibilities. The Inworks will need staff who find such an environment exciting and rewarding.

Staff form the backbone of any university organization. Just as they need to be supportive, the staff also needs to be supported. Administrators, faculty and students need to understand and appreciate the pivotal role of staff, and actively endeavor to support that role. Staff of the Inworks will need ready access to all of the technological tools that can aid their work, and these tools must be kept up to date.

Space

Physical space has a profound impact on human behavior. It can facilitate and support the activities of its occupants, or it can challenge and limit those activities. Architects have long understood this relationship. Thus, it is perhaps surprising that so many buildings on university campuses still contain long hallways of small individual offices. What open spaces do exist are typically sub-divided into small sterile cubicles. These layouts communicate that people are supposed to work alone, and that personal status can be measured by office size and location.

It is critical to the success of the Inworks that it be housed in space that supports communication, collaboration and experimentation. Such space is likely to be characterized as "studio space," with high ceilings, a visible abundance of natural materials such as brick and wood, large open areas, good natural lighting, and warm artificial lighting. It should not only be easy to collaborate with others, it should be hard not to!

The physical space of the Inworks has to represent one of the tools used to bring people from different backgrounds together. It needs to be warm, inviting and supportive. People should want to spend time there, and it should be possible to spend large amounts of time at the Inworks comfortably. There needs to be a place to prepare a light meal, to relax, or to shower after a quick run. The space does not have to be modern or upscale. Power and connectivity are essential; carpet and acoustic ceiling tile are not.

Whatever the space, it needs to convey a sense of ownership. Faculty, staff and students of the Inworks should be comfortable putting holes in the walls or hanging things from the ceiling. Furniture should be movable, light should be adjustable, and whimsy with respect to creative use of space should be encouraged.

Operational Issues

The Inworks is intended to provide an environment in which individuals develop the intellectual capacities required to solve important problems. Such problems have societal impact, are complex (in the systems sense), are interdisciplinary, are ambiguous in both specification and solution, are really hard, and often interrelate with other really hard problems. The process of addressing such problems is informed by theory and practice in (among other things) the nature of creativity, how people learn, how people frame and solve problems, how people work together, how people find common vocabulary across disciplinary boundaries, cognitive science and neuroscience, psychology, pedagogy and andragogy (Knowles), and constructionism (Papert).

The development of the Inworks should itself be guided by the ideas and principles that led to its creation. We have to be willing to try ideas that might fail because failure is an essential element of innovation[18], we need to evaluate everything that we do, to learn from mistakes, and try again; in short, to "fail fast." While we should be intentional about every aspect of what we do, we must also engage in significant experimentation.

Thus, for both practical and programmatic reasons, the Inworks should operate in many ways as a "start-up," and should be guided by entrepreneurial principles that lead to successful ventures: mission focus, leadership integrity, agility in response to changing circumstances, close attention to

[18] *To Engineer is Human: The Role of Failure in Successful Design*, Henry Petroski, Vintage Books (Random House), 1992.

the needs of customers and excellent relationships with investors and partners. In this case, the customers are represented by students, faculty, and alumni, and the investors are the university, external donors, and the same students, faculty, and alumni.

Financial Model

In steady state, the Inworks' general budget will be governed by tuition revenue, external research and development funding and external philanthropy. Initially, however, the Inworks will need start-up funds sufficient to sustain operations as the new Inworks takes shape. Funding needs will decline over several years, by which time the Inworks will be capable of sustained operation and growth without additional supplemental funding. The Inworks should also receive an initial allocation of a small number of new faculty lines to enable the Inworks to build its core faculty.

The Inworks can be created with a modest start-up investment, and after a few years of operation will generate substantial revenue for the campus. Thus, under a reasonable set of assumptions, the Inworks has a strong business case. In addition, the Inworks will have a significant "net new student" impact on the campus, i.e., students will choose to enroll primarily because they want to engage with the Inworks.

Resource Impact on Other Units

The new Inworks must come into being in a way that does not have significant negative impact on other campus academic units. General funds designated for existing units should not be diverted to the Inworks. The new Inworks should not employ a retention-based (bidding) model to compete for faculty (or students) of other units; programmatic choices should guide participation. In addition, there should be clearly articulated principles and policies for faculty engagement from units outside the Inworks so that the chairs, directors and deans of those units can plan appropriately.

One promising idea is the potential for the Inworks to serve as the home for interdisciplinary graduate degrees that need to draw from several departments. Examples of such degrees might include electronic entertainment (computer science, graphic design, music, narrative), global development (public health, economics, social science, business, engineering) and technology entrepreneurship (engineering, business, medicine).

## Conclusion

This document has outlined and argued for the creation of an “Inworks” that would foster design thinking, computational thinking, disruptive innovation and radical interdisciplinarity as a means to draw together faculty and students from disciplines across campus. The Inworks would serve as a campus-wide catalyst for collaborative innovation that targets significant social problems, in the process imbuing students with critical intellectual capacities needed to succeed in the 21st century. While the business case for the Inworks is strong, the programmatic case is stronger. Universities will either adapt to the profound social and economic changes brought about by the global networked age, or they will find themselves overpriced relics in competition with forces that they do not fully understand.