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Article

Competing Visions: the University, Innovation and Engineering after the Space Race

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Abstract: This paper seeks to address critical elements of science, technology and the environment with a focus on the university as the economic driver of technological innovation. This paper relies on several key texts and prominent voices to present an argument based on differences of perception and expectations of outcomes within a goal of addressing engineering and design innovation as an outcome of education, while viewing engineering's bearing on perceived competitiveness within an emergent and ever more ambiguous multinational global marketplace.

Keywords: innovation, engineering, education, design, sustainability

Introduction:

The intent of this paper is to place innovation within a context shaped by a regaining of fundamental knowledge and addressing of historical contexts that is needed in order to place engineering and design on a less speculative and more historically sound path than current forces in engineering and industrial design education are being convinced to take by numerous pressures. This paper's lofty (and admittedly impossible) goal relies on several key texts and voices to present an argument based on differences of perception and expectations of outcomes within a deeper goal of addressing engineering and design innovation as a byproduct rather than objective. Innovation and its bearing on perceived competitiveness within ambiguous multinational global markets sets confusing stakes for all and a truly green economy may be one potential outcome if we can connect the dots, but there are many

obstacles along the way to impede such connections. Where, how and why ideas will be formed and transformed into innovative new technological solutions to solve insurmountable environmental dilemmas is a problem facing all universities today and presents a major shift in the role of the university in the twenty-first century, as well as the role of it faculty, students and teaching in general. The university is in crisis and innovation may not be the panacea to all of its woes.

A classic overused and often paraphrased quote by Albert Einstein credits Einstein as having said that if he had one hour to save the world he would spend "fifty-five minutes defining the problem and only five minutes finding the solution." Daniel Kahneman's *New York Times* best selling text, Thinking Fast and Slow, promised to show all of us how to compartmentalize our brain's processes to receive its maximum potential through an application of his theories and research based in case studies, empirical data and sound conjecture. The resulting book became something like a self-help guide for how to use our brains that relied on accessing deep structural tools to reconceive the world by understanding how we think [1].

Visible signs of progress in science, engineering and technology, like the devices we tether to our bodies to communicate with each other, benefit the individual and society at large, but physical evidence of technological transformation can also be destabilizing and blur our grounding in both historical and temporal reality. Innovative art and design practices that rely on technology shifting frameworks and invisible realizations such as nanotechnology, design futures, strategic foresight and other new technology-infused conceptual paradigms leave manufacturing and become new methodologies in themselves. Active problem seeking and the production of cultural artifacts based in unforeseeable future applications and therefore vague meanings require more depth of inquiry to cope with the greyness of our unknowable and rapidly changing future.

Successfully coping with such changes requires a shift that is not measurable through trending, malleable through branding or even close to being mediated through social networking, as we are being manipulated to believe. Design, is a cultural practice that helps us realize changes at a pace that humans can digest and experience in real time. Objects and interfaces mediate adaptation, disruptive or not. New design methodologies (branded now as design research) and alternative design practices, such as visualizing quantitative data, describe potential outcomes of the repercussions of technological change in bits that can be digested and managed. These new research methods explore the latent relationships between future risks and hopeful potentials (innovation) through non-traditional means of representation, exploration and dissemination.

Fundamental questions about how we even can approach the cultural re-framing of the daunting problems facing society and the environment today are limited to using our limited and outdated palette of tools and archaic means of representation, which Thomas Kuhn would argue is a paradigm that needs to be overcome in itself to help us problematize, as Einstein wished to do in his hypothetical, using the very best parts of our deeply underutilized brains.

Exhibitions like the *Design for the Elastic Mind* show at the MOMA held several years ago, the aestheticized bioremediation installations of Mel Chin and the endless community-based DIY projects designed by non-designers from Gujarat to Brooklyn are helping to reframe numerous unsolvable

wicked problems using interdisciplinary and creative forms of inquiry grounded in humanities-rich practices that are shaped by the social sciences methodologically. In an age when research funding, direct connections to industry and patent seeking is seen as the only way to reshape our universities to make them efficacious, and profitable, these peripheral means of questioning represent an opportunity for deep and profound change, and more profit too potentially as well [2].

> *Now that the space race is over*
> *It's been and it's gone and I'll never get to the moon*
> *Because the space race is over*
> *And I can't help but feel we've all grown up too soon*
>
> Billy Bragg, from *William Bloke*, "The Space Race Is Over"
> sound recording released in 1996, Elektra

In Billy Bragg's lyrics from his 1996 recording, William Bloke, the British folk rocker and social activist stirs up his own postmodern sentiments about the reality of technological innovation and its ambiguities after the space race. Bragg began his career as a socially minded folk busker in the London tube, ironically situating himself within a historical and technological framework that created the perfect forum for his music and its historical displacement. Technological determinism has allowed technology to lose its luster along with the promise of a new and better life through technological innovation. In today's technologically saturated world technological determinism, postmodern nihilism and a general sense of loss is reduced to a series of words originally sung in the subways of London by a street performer was formed below the ground as the masses scuttled off to their corporate jobs in a technologically mediated workplace. It is this mass scuttling off to the office that is the image that Mathew Wisnioski too conjures up in his work, which he laments in his critique of the engineering profession's transformation in the 1960's to a service profession in the United States in his text, *Engineers for Change: Competing Visions of Change in 1960's America* [3].

The Idea of Postwar Technology

Attitudes towards technology in the postwar boom of the 1950's and 1960's gave rise to "a spectrum of deterministic accounts of technology ranging from the deeply pessimistic, akin to Orwell's view, to the deeply optimistic. Optimistic determinists, exemplified by the founder of cybernetics Norbert Weiner, the engineer-poet R. Buckminster Fuller, and the science fiction writer Arthur C. Clarke, argues that technological evolution is as inevitable, natural and inherently good as ecological evolution. On the other more pessimistic side, many cultural critics – Jacques Ellul, Siegfried Giedion, Freidrich Juenger, Ivan Illich, Herbert Marcuse, and Lewis Mumford foremost among them – argue that technology was becoming as autonomous and totalitarian force." Davison points out that we are now much wiser and have amassed a body of literature that amounts to a sea change in how we perceive technological innovation and now understand many of the ways in which technologies are cultural products embodying particular, especially historical, social interests and perspectives" that move beyond the previous definitions of the meaning and use of artifacts ascribed to technological innovation" [4].

The view of the engineer as "the personification of technological progress" is the main subject of Wisnioski's text, Engineers for Change: Competing Visions of Change in 1960's America. As Wisnioski tells his story, engineering and technological research had become, and remains an elite service discrete from the worlds of manufacturing, assembly and production. The images conjured by Wisnioski of the bespectacled engineers working behind desks in teams continue as we move research and innovation into the university and across all disciplines to further distance innovation from the manufacturing process and making. A number of design incubators and other entrepreneurial institutional constructs keep sprouting up in every university department from art to the humanities as a result of this cross pollination in the spirit of innovation as an abstract goal.

The catchall discipline of "digital humanities" is also losing its luster as a very clear example a technocentric attitude wearing thin in academia, despite the promises the digital humanities once held to revive so many dying fields and disciplines. However, a recent collection of essays titled, *Hacking the Academy: New Approaches to Scholarship and Teaching from Digital Humanities,* provides a number of thought provoking propositions and models that argue or transforming research methods, teaching, publishing and even reading through digitization through a convincing argument [5].

Innovation, Engineering and Artscience

I found Wisnioski's book very useful to help construct my own understanding of innovation within the contemporary university because of its contextual depth and historical reflection on what could have been. It is a sad book. Wisnioski's deconstruction of the engineering profession is pieced together like the recreation of an industrial accident scene. Matthew Wisnioski's *Engineers for Change, Competing Visions of Technology in 1960's America*, launches the MIT Press series, Engineering Studies, by looking at engineering and the competing views of the profession and attitudes towards technology with a focus on the 1960's as a key historical period in which contemporary engineering practice is formed along side its relationship to technology, intellectualism, innovation and social contexts.

In an entirely contrasting point of view, Harvard biomedical engineering professor, David Edwards, in his text, *Artscience, Creativity in the Post-Google Generation*, positions science "in the service" of art to facilitate the innovative "crossover learning," that can "spark the passion, curiosity and freedom to pursue – and to realize – challenging ideas in culture, industry, society and research" in his contemporary spin on innovation, particularly with academia. Edwards hypothesizes a mythic new hybrid being, an "art scientist" who might help form "the lasting breakthroughs for the betterment of humanity" that innovation today requires. By comparing the historical and critical deconstruction of engineering n using Wisnioski's work and comparing this to the rhetorically speculative and highly aspirational work of Edwards, Wisnisoki's methods and conclusions appear as a cautionary tale for the overly speculative and optimistic marketing and rebranding of innovation within the academy [6].

Edwards' alternative point of view is based on his definition of a new hybridized creature, destined fifty years after Wisniosli's engineers shaped our world, to forge a future based in science and technology, but tempered by the world of art. Edwards' calls his new being, the "artscientist" and gives

us numerous case studies and examples of these unique people ranging from Peter Rose, the Canadian architect, to numerous others who have found the art of biology or the science of art.

As Edwards defines his term, "Artscientists: (1) synthesize and idea to realize some artscience passion within an industrial career; (2) find a mentor in their apprentice years as they from their careers; (3) achieve some innovation that confuses them; and (4) following a period of searching discover freedom by recognizing that artscience creativity is tied up more in process than in the product that they must nevertheless, continue to sell." (129-30). Edwards goes on toe redefine his interpretation of industry as "essentially the artscience experience of entrepreneurs as we might find them in what economists call secondary manufacturing) tertiary (service), and quaternary (research) industries" [7].

David Edwards paraphrases the Dean of Harvard's Engineering and Applied Science Faculty, who spoke of a "changing" university and of the "global" university. The Dean described how "ideas can come from anywhere and we must be open to hearing them." Edwards describes a new world of cross disciplinary collaboration between artists and scientists in which both are equally valuable in deciphering new applications and needs for technologies with the hypothesis that the new researcher will be an "artscientist," a cyborg possessed by a vision for the future that is not shackled by professions, disciplines or even deep expertise in one area. Terms like "vision", "catalyst" and "experimentation" become the verbal royal jelly in this new world that is populated with artists and scientists who are "probing more deeply into the complexity of nature" and other areas where art alone or science alone would be at a disadvantage [8].

The relationship between David Edwards' emergence of artscientists and Wisnioskli's retelling of the de-evolution of the post-war engineering profession chart very clear pathways for the future of innovation on the university campus, that has arrived with ambiguity and hyperbole. This hyperbolic language is very copasetic with the current generation of millenials who will be authoring this sea change and paradigm shift. "If engineers were to respond as the moral professionals to socio-technical crises that were only vaguely understood, they needed to define the relevant problems, generate conceptual tools, and justify their authority to multiple constituencies" [9].

Precedents

Key precedents for understanding deliberate pairings of art and science, particularly within the context of innovation as engineered acts of creation can be seen in Harvard University's Program on Technology and Society (begun in 1968); MIT's Center for Advanced Visual Studies (of the same era); and Experiments in Art and Technology (also of the same era). Wisnioski's research utilizes these examples to provide a closer look at curricular and ideological reform for the engineering profession within the context of engineering as a profession and its resultant service to the "military industrial complex" while showing us how innovation as a creative activity might liberate the engineer to be released into the rhetorical space of liberal experimentation that his profession's allegiances would seem to prevent [10].

My own historical examples for Wisnioski's argument would be a series of projects titled, Soft Architecture Machines, that Nicholas Negroponte in his text of the same name. Negroponte used this project to report on a series of experiments by the Architecture Machine Group at the Massachusetts Institute of Technology in 1968 to 1972 in a set of experiments meant to dive into robotics, artificial intelligence and the mystique of the design process. My favorite pieces of the larger experiments in AI are when Negroponte and team analyze the design process in architectural practice by observing human architects, which depended upon replacing random acts of intuition within a computing environment shaped by coding designed to mimic each seemingly random step of the subjective design process of making architecture with an emphasis on doodling, sketching and looking for ideas within random drawing gestures. Was there a deep system? Could this intuitive process be turned into an algorithm and repeated by a machine? Each step of the larger project was accompanied by theorizing about artificial intelligence, systems analysis and lastly a rigorous scientific methodology that was applied in an artistic way. This may have been the beginning of the artscientist as a hybrid being, and was undoubtedly a key moment in the birth of MIT's Media Lab [11].

I think about these new creative approaches to engineering innovation and call to question the notion of scientific method from a very primal point of view. I have assigned readings in my own teaching to students from Henry Petroski because he questions intentions as well as methods in engineering practices and methodologies. Petroski is among the most accessible engineering theorists and can help address design problem solving critically. In To Engineer is Human, the Role of Failure in Successful Design, Petroski states, "Innovation in engineering, as in everything, involves risk and is an invitation for something to go wrong. But it does not follow that innovation must lead to failure. And because there have always been dramatic engineering projects that have proved the nay-sayers wrong about this or that daring new design, today's engineers are not acting irresponsibly when they want to use an untried material or structural design to build a bridge longer of a skyscraper taller than one extant. They are merely following in the tradition of the great nineteenth-century builders of daring structures that outlived their opponents" [12].

Purpose, Goals and Aspirations

Innovation as an abstract goal tied to the evolution of both appropriate and inappropriate technologies, presents numerous dilemmas, as does the commercialization, industrialization or militarization of technological research. It is accepted that the major research labs at MIT, Stanford, Cal Tech and other instrumental key loci for innovative engineering are funded and even formed as a result of potential military applications for unforeseeable new technologies. Innovations such as microwave ovens originate in military applications that have trickled down or gone awry, and the marketplace is glad the military is footing the bill for the research and development for these new technologies. The first microwave oven was originally intended by its inventor, Percy L. Spencer, while working with a maegetron for a radar set, when he noticed a chocolate bar in his pocket was melting [13]. Innovation is the stuff of legend, and fortunate failures as Petroski reminds us form the glory stories of accidental triumphs that shape industrial design legends.

What happens when this patronage of purpose is eliminated and free form, non-objective experimentation occurs funded through arts agencies and humanities-based sources? Does the non-specific purpose eliminate the "ought to" of engineering's rationalism that Wisnioski speaks of and the historical precedents mentioned previously fade away and true innovation such as those executed at MIT's Media Lab. Will we have more fantastic accidents when art and science are left to collide on their own, or has the fundamental structure of research been replaced and narrowed? The public rarely has appetite for research gone astray, but is very forgiving when a new app or piece of software or hardware results.

Unfortunately, as Wisnioski points out, attitudes of engineers assembled in teams of interdisciplinary innovators see their work, all too often, as merely giving technical advice to those who are carelessly playing with their profession and generating ideas without technical expertise. Engineering, as the lead profession charged with innovation through technological progress, is at risk. Using the Media Lab at MIT as an example, a mass of work produced in these experimental lab settings may result in gallery shows, publications, performances and other non-traditional outcomes. Given this, it is a universal definition of innovation and a universal attitude of those who claim to be innovators that is what is being questioned. Wisnioski's unraveling of the engineering profession in the 1960's in America is a snapshot of a profession in crisis viewed largely through the byproducts of this crisis. It is in the symposia, recruitment campaigns and arguments between curricular reformers in engineering schools that we see the seeds planted for the engineering profession that would be liberated from the stigma of designing weapons for wars to designing tools for global markets as the new goal.

It is this transition of purpose and meaning that Wisnioski unpacks engineering using popular culture, insider squibbling and educational reform as his tools. The result is the current strive for a radical reinvention of the university as an entrepreneurial enterprise. Classical language studies, the humanities, literature and other fields are all under threat to find immediate marketable applications for their products and these are producing radical new solutions, obtuse majors and programs of study tethered to communication technologies as a lifeline. What market-driven purpose do visioning experiences produce, other than billable hours for those organizing such events? How does the business model of companies like IDEO work in the long run?

Forensic design research, as IDEO practices it, would have been needed less in the past when projects were more concrete and professions were less narrowly construed to utilize more deep expertise and less ambiguous outcomes. We do need more consultants now because we have fewer experts and we value expertise less and less. Indeed, Wisnisoki's book seems to serve as a parable to be careful what you wish for. The university as change catalyst became the norm and is now a buzzword of honor on the postmodern campus. As Wisnioski points out, "Reformers, however, faced an uphill battle in their desires to integrate social inquiry about technology in the making of new engineers. Universities are both notoriously resistant to change and almost continuously involved in 'crisis' and 'reform" [14}.

What does any of this have to do with today and the fluid interplay between art and science, engineering and sociology and a myriad of other interdisciplinary degrees, programs and institutional paradigms? What does it mean when we create teams of expertise to incubate and nurture products

shaped by emergent technologies in interdisciplinary labs that may promote anything from wearable technologies to biomimicry to produce marketable designs? "We try to create organizational environments that amplify the number of ideas we and those around us translate. These environments also help the odes move farther and faster from the center-point of the idea-impact space….Leaders of academic institutions may try to raise resources and build excellent labs and recruit motivated students to do the same thing." It is Edwards' belief that the university is the idealized environment to achieve hybrid of thoughts and innovative uses of technology that grow from rich environments built upon idea sharing and trans-disciplinarity [15].

If innovation in engineering wrestled with the end of the patronage of the industrial military complex in the 1960's, we are now faced in the post-communication age with an abundance of tools, an ease of dematerialization, unfamiliar business models and abstract means of monetizing experiences that we can barely recognize or be able to contextualize. John McDermott's outlook as he made so clearly evident in "The Opiate of the Intellectuals" was that…"He thought that the negative effects of technology were simultaneously inevitable and overwhelming: inevitably negative because of the nature of capitalism, overwhelmingly negative because all attempts to regulate technology were bound to fail unless capitalism was overthrown – and this was unlikely to happen, given what he thought were the inadequacies of his fellow revolutionaries" [16]. McDermott's view that technological transformation and the very tools of this transformation were seeded with "authoritarianism built into the technologies themselves" [17]. The irony of this dilemma is whether to blame the technologies themselves or the institutions that foster and fund their creations.

Conclusion

David Edwards calls for artscience to rely more on the pragmatic applications of academic research that can react to global realities, like taking advantage of keeping makers and thinkers together. Universities are being potentially displaced by the colleges as places for applied research, in contrast to the speculative research described by Edwards. Numerous articles are also appearing across the globe questioning the value of a postsecondary education. Like Wisnioski's deep and historically rigorous unpacking of the engineering profession, we could likewise use a similar project to foresee where all of this innovation on the campus may be headed. Wisnioski allows us to see where, when and how things went awry, perhaps now is the time to pay attention to the historical contexts that facilitate true innovation, rather than forcing the issue.

I will offer another point of view. Paul M. Krebs, Dean of the College of Humanities and the Social Sciences at Bridgewater State University, pines over his humanities students inabilities to embrace failure or even go beyond first drafts of incomplete ideas, while his computer science teaching colleagues instruct their students to embrace failure as a means to analyze data and encourage progress towards a more perfect end with draft upon draft being seen as a part of "the scientific process" in an editorial written by Krebs in *the Chronicle of Higher Education*. Without belaboring Professor Krebs' thesis, it is fitting to recall that each discipline, on its own, does not have the tools to problematize its current condition and this may be a good thing to keep the university, engineering and design education and the professions alive and malleable [18].

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