The Innovation Paradox:
How Innovation Products Threaten the Innovation Process

By Scott Francisco

Published in: *Reconstruction: Studies in Contemporary Culture* – Vol. 10, No. 2, 2010
http://reconstruction.eserver.org/102/contents102.shtml

Abstract:
Innovation is both a growing trend and a genuine necessity for the economy, society, environment, human health and national security. Innovation outputs appear prolific, and ongoing research continuously advances new strategies for innovation success. Little if any research, however, connects the *products* and the *process* of innovation, and explores the impact each is having on the other. This paper proposes that the products of innovation today, particularly ICT devices, networks, databases and analytics, are themselves attacking the foundations of innovation process and skills. Research on the core skills, creativity, risk-taking and mental structures necessary for innovation find that they are best cultivated in hands-on, socio-spatial environments.

The conflicting realities of product and process result in the Innovation Paradox: *The more we innovate in our current fashion, the more we undermine the very environments and skills necessary for robust innovation ecosystems.* While several prominent authors predict dire consequences, such as "Dark Ages" where knowledge and culture are all but lost, this paper offers a new perspective. By redefining what we call, and how we practice, innovation we can begin to change the narrative and unbind the innovation paradox.

The Innovation Paradox: ***How Innovation Products Threaten the Innovation Process***

Our role is not to disparage wealth, but to expand its reach…to unleash the creativity and innovation that still make this nation the envy of the world. - President Barack Obama (remarks on Regulatory Reform, June 17, 2009)

Innovation demands not one kind of knowledge but many.[1] - Peter Drucker

The world we live in is very nearly incomprehensible… Technopoly deprives us of the social, political, historical, metaphysical, logical or spiritual bases for knowing what is beyond belief.[2] - Neil Postman

…I know Kung Fu! - Neo (post-download, in *The Matrix*)

Introduction to a Paradox

Today with increasing frequency and urgency we hear that the western-led global economy, the biosphere, if not the human race, depends on innovation for survival. This is yodeled from the mountaintop of the World Economic Forum in Davos, preached at evangelistic TED conferences on America's west coast, and has become required course material at elite business schools around the world. The business sections of every major newspaper report daily on innovation's profit potential, monthly magazines and journals offer scientific validation, and an annual crop of inspirational books by gurus young and old promise measurable results at pace with the weight-loss genre in the adjacent aisle. From the trendy and self-promoting to the time-tested and well researched, these enthusiastic voices all share a common theme: innovation is the answer to our problems, whether they are financial, environmental, political, medical or even social.

Meanwhile, scattered in the lowlands a less visible group of scientists, writers, sociologists, educators and researchers invoke caution, concern and even fear in response to the outputs of innovation. They cite hazardous by-products, social breakdown, the decline of culture, knowledge and skills, or the danger of reliance on increasingly obscure, complex and networked systems.

If there is any disagreement in the innovation cacophony, there is universal agreement that innovation is both a current fetish, and a force in our world with undeniable cultural, environmental and economic impact. For better or for worse, innovation has become the predominant fuel for the global economic engine. Cut off the fuel supply and the engine stalls, with potentially disastrous consequences –a small taste of which we have seen over the last two years. In addition to the direct economic realities, energy and natural food supplies are under intense pressure, multiple environmental crises are in full view, and many experts consider our education systems, work-life balance and family structures to be in crisis as well. Creativity, leadership and invention seem to be needed more than ever to provide new answers, paths and solutions.

While innovation is most commonly thought of as a singular and simple 'good', it clearly has two faces, each with its own set of complexities. As it turns out these two faces may be in conflict with each other. Considering the stakes of economic, environmental or cultural survival that innovation raises, the question posed by this paper is how today's *products* of innovation are impacting the *process* of innovation. It

argues that while the process of innovation is an intensely creative, demanding and important human endeavor, the tendency of innovation outputs today is to undermine or confuse innovation's creative process. This negative feedback loop is the "Innovation Paradox": *The more we innovate in our current fashion, the more we disconnect ourselves from the human experiences, behaviors and values that constitute the roots of innovation as we know it.*

Understanding this potentially debilitating paradox will require a close look at these innovation *products*, specifically innovation's most prolific and prominent area: Information and Communication Technologies (ICT). ICT is an ever-broadening category including the networks, databases, computational algorithms, analysis and automation tools, social media, gaming environments, and the full spectrum of interfaces and devices which have led to the radical accessibility of information, entertainment and the new "I can always find out" reality.[3]

Alongside an investigation of innovation products, this paper will examine the *environments* of innovation: the contexts, organizations, places, subcultures, behaviors, habits and values that support the skills and creativity necessary for rich and complex innovation.

This investigation will be guided by my experience as a design professor and architect, recent research at MIT, and my work as a strategy consultant to a number of the world's most innovative organizations[4] – experience that all directly engages innovation outputs and process as a matter of course. In architectural education and practice this engagement with innovation is found in the primary goal of architecture, which is to produce new creative solutions to the built environment, as well as in the use of increasingly sophisticated ICT products to "assist" in architectural education, research and production. In the strategy-consulting world a similar confrontation with innovation products and process is found in the corporate tendency today to enlist ICT products to solve spatial, informational and cultural challenges in organizations and the workplace, as well as the need to demonstrate innovation from within. In addition to my firsthand experience the investigation will be backed by substantial and diverse research authorities such as Richard Florida, Richard Sennett, Jacque Ellul, Judy Estrin, Neil Postman, Ivan Illich and Ursula Franklin – authors who have researched and written on the topic for decades.

Combining my direct experience with this research, I will show how our "brave new world" of ubiquitous innovation may be drowning human learning, creative skills, even basic productivity, with information and a numerical/technical approach to problem-solving. It will become evident that the deluge of data and devices supplied by ICT innovations crowds out, or even makes irrelevant, the opportunity for people to engage knowledge *as experience*, such as dialoguing directly with other people, confronting and creatively solving problems in a socio-spatial context, and drawing on the immediacy and tangibility that real *place* presents. Since innovation is a socio-spatial process (more than a technical one), and relies primarily on a motivated application of skills, knowledge and imagination to new dynamic contexts, it follows that the direct people-and-place experiences being displaced by current innovation outputs are the very experiences essential for the development of an innovative skill set and an innovative mind.

This is a new and urgent perspective; innovation is both vital and threatened. While there is no shortage of writing, theory and research on either the creative process of innovation today, or on the impacts of technology and digital media on society,[5] these two areas of study have rarely been connected under the rubric of "innovation". My intention is to draw direct connections between innovation outputs and process. I will explore what innovation means today, why innovation processes depend on a socio-spatial and experiential knowledge base, how current innovation outputs undermine this base, what might happen if we do not change the focus of our innovation outputs, as well as several specific ideas about what we need to change to save innovation from itself.

1. What Do We Mean by 'Innovation?'

Given that innovation is such a keyword[6] today it is important to recognize that what we mean when we say "innovation" is in flux. Nevertheless, this definition is critical if we are to promote or support it. In simple terms innovation means to make or introduce something new, a product, a service, a process, even a concept or image, into a particular context. In her extensive research and writing on the "social behavior of creativity," Harvard professor Teresa Amabile defines innovation's foundation of creativity, implementation and context as follows: "All innovation begins with creative ideas. […]We define innovation as the successful implementation of creative ideas within an organization. In this view, creativity by individuals and teams is a starting point for innovation; the first is a necessary but not sufficient condition for the second."[7]

While this definition is robust and often cited, it lacks some important nuance. Today's increasingly measurement-oriented milieu requires several more ingredients added to the mix. Innovation today implies a mix not only of creativity and pragmatism, but also rational theory and specifically *measurability,*[8] which can be applied to local or global economic systems to increase efficiencies and/or consumption (i.e. to create *growth*).[9] New "creative ideas", even when "successfully implemented", are often excluded from the innovation club if they cannot demonstrate an aspect of measurability. Innovation today is predominately defined in terms of measurable efficiencies/streamlining, increased consumption and growth and/or increased digitization.

Digitization: Innovation as ICT Proliferation

For the last few decades in western world the most significant and measurable growth-area of innovation has been in Information and Communication Technologies (ICT). And while this paper will not attempt to evaluate the relative economic contribution of different industries, it is concerned with two aspects of ICT: One, that digitization has become synonymous with innovation, and two, that computation and digital media have transformed the majority of business, management, production and design processes, financial markets, and even macro economic trends. It is now commonplace that ICT innovations have changed the way people communicate, trade, learn and work by making information radically accessible, liquid and integrated. The impacts of ICT proliferation apply equally to individuals and large-scale institutional, corporate and governmental users, even as these boundaries are increasingly blurred and intertwined.

Before looking at the consequences of these environmental changes, it is critical to establish the connotations of innovation in today's context*. When we speak about innovation today, we increasingly mean a form of Information and Communication Technology*. Innovation has become a euphemism for ICT. Influential voices of Silicon Valley, like Robert Atkinson, president of the Information Technology and Innovation Foundation promote "stimovation", a category of stimulus reserved for "innovation or digital stimulation".[10] This is reinforced when the business press report "low innovation rates" correlated to a "failure to adopt new technologies" or a "low number of graduates in innovative *fields* like math, computer science and engineering"[11] or that "countries scoring [high] in innovation spend more on science and technology."[12] Furthering this association, this same media does not usually label "back-to-basics" or "hands-on" educational programs as innovative, even when these represent a successful new approach within a given context, or garner improvements in core subject areas like math or science.[13] By popular definition, innovation overwhelmingly means "digital".

A prominent example of the innovation/ICT inference is the *One-Laptop-Per-Child* [OLPC] program initiated by Nicolas Negroponte of MIT's Media Lab. The goal of the project is to "eliminate global poverty" by providing laptop computers to as many children in third world countries as possible. OLPC assumes that broadened access to digital technology and networks is a reasonable answer to hunger, hygiene, education and cultural development.[14] The program focuses on new hardware design and distribution to make their computers accessible, as well as innovations to make them universally connected and durable. The combination of ICT innovation and a benevolent cause has been a magnet for the global innovation elite, raising millions of dollars from cutting-edge philanthropies and investors. OLPC founders and members have been thrown onto the world stage, speaking at hundreds of technology and development conferences, and published numerous articles and books about the project.

The positive momentum of the innovation label, however, can be at odds with results. Six years into the project, the mission, viability and approach are disputed from both inside and outside sources. Several OLPC leaders have resigned and now publicly criticize the motives and agenda. Recipient governments have spoken out against the project, citing more appropriate (i.e. less innovative) expenditure of public funds such as libraries and schools.[15] After six years of intensive effort and hundreds of millions of donated dollars expended there is no clear evidence of OLPC achieving its intended outcomes.[16] Nevertheless, there remains a constant stream of metrics: number of units distributed, size and weight reductions, number of countries involved, donors, and dollars, even quantities of information processed. The fact of these numbers is enough to keep support coming from numerous corporations, governments, policy makers (such as the UN) and other funding agencies, reaffirming the powerful association with innovation via ICT and measurement, irrespective of evaluated outcomes.[17] Compare this to many development programs with impressive poverty-fighting results such as trade schools and basic skills programs, that do not have access to the innovation label, and often struggle for support despite proven impact.[18] OLPC is an example of the practically unbreakable bond between innovation and ICT. In this widespread model, increased digitization is innovation's assumed positive outcome.

Figure 1-3. "One Laptop Per Child" is considered a paradigm of innovation due to is promotion of ICT products– irrespective of results. Digitization and "connectivity" are increasingly the assumed outcome/product of innovation. Successful programs that do not engage ICT products are rarely referred to as "innovative," even if they are more effective; as many educational and training programs in Africa have shown.

Streamlining: Innovation as Measurable Efficiency and Technique

The modern workplace has always been a place where innovation products are adopted early and in quantity. Beginning with the "Taylorist" approach in the 19th century and fueled by recent digital technologies, measurement and data are now central features of innovation products in the workplace. Managers and engineers today are universally tasked with discovering new efficiencies and exploiting ever-smaller margins. A well-known harbinger of this obsession with measurability came decades ago as the mantra: "You can't manage what you can't measure."[19] This went on to arm legions of technocrats and is now a pillar of today's innovative business strategy. The extrapolation of this thinking are all manner of metric-based systems designed to facilitate increased integration, automation, corporate de-layering and outsourcing which are in turn intended to increased control and efficiency in managing people, products and services. Measuring and managing are also the foundation of innovation products like Google Earth, or Google Book, whose respective goals are to digitize the surface of the whole earth and every book ever written (and then control access to the data).[20] The exponential increase in documentation, measurement and storage required for information integration, and the expected efficiency returns are fundamental characteristics of innovation outputs today. Even the most socially intrusive examples of this are held up by innovation promoters as evidence of an improving world such as: "How IBM Improves Productivity by Tracking Employees' Every Move."[21] This optimism about measurement and efficiency is reinforced in the news media, where anxiety about digital surveillance is denounced as anachronistic or regressive.

A recent article in the NY Times, for example, introduces NYCWIN, a new satellite network designed by New York City agencies to network and precisely track the locations and movements of thousands of city workers and vehicles:

> A $500 million high-speed network, one of the largest of its kind in the world…covering 95% of the city… city agencies [will] use network-connected hand held-devices and tablet computers to increase efficiency and flexibility…[But] the network, which can track movements down to the minute, might be used to benchmark performance in ways that could penalize workers.[22]

Concerns of NYC staff regarding worker autonomy, relationships, trust, craftsmanship, or organizational knowledge[23] are soundly trumped by the promise of streamlined operations. This anticipated environment, free from friction and redundancies, is universally promoted by innovation experts and consultants, private-sector business elite, "futurists," and salespeople for new ICT products and processes, such as Microsoft's "Envisioning Lab" video: http://www.officelabs.com/productivityfuturevision which paints a startling and naïve picture of a future world improved by gadgets. Likewise, the advent of "free" social media/email accounts which gather user-data to be sold to the highest bidder, has quickly become a default social reality and is enthusiastically promoted by innovative media and marketing agencies as a way to stay competitive, current and visible, as well as to "track the numbers" in terms of "hits" and "tweets."

A less optimistic view of this world awash in measurement and digitization is held by technology theorist Jacques Ellul, who is responsible for the expression "think globally act locally." In *The Technological Society* (1964) and subsequent works, Ellul adopts the term "technique" to describe pervasive, systematically applied and integrated documentation, measurement and computational analysis. He defines "technique" as "the totality of methods rationally arrived at having absolute efficiency…in every area of human development." For Ellul, innovation products often become synonymous with ever-increasing and rationalized efficiency, data and the requisite technologies. This results in an environment where "keyboards enable orders without personal contact" and "networks […]abstract, invisible and

imperceptible […] impose themselves on real life, and condition it."[24] For Ellul and many technology theorists who followed him – like Ivan Illich, Neil Postman and Ursula Franklin – the result of technique is an exponential spread of an "a-cultural" or "inhuman" environment.[25] From these viewpoints, technique is perpetually prescribed and justified by the technician (politician/industrialist/engineers). For every problem that technique creates, like increasing demand for fossil fuel, technicians promise new technical solutions just over the horizon. In the meantime, humans must always adjust to the current technical reality, such as the current 50,000-barrel/per day oil eruption in the Gulf of Mexico. In *Tools for Conviviality* (1973) Illich describes this self-augmenting obsession with managerial/technical solutions: "The cure for bad management is more management. The cure for specialized research is more costly interdisciplinary research, just as the cure for polluted rivers is more costly nonpolluting detergents. The pooling of stores of information [...] the attempt to overwhelm present problems by the introduction of more science is the ultimate attempt to solve a crisis by escalation." [26] Innovation has become deeply implicated in this escalation.

A contemporary handbook of "technique" escalation is the genre-typical *Corporate Agility* (2008). In 250 pages of fodder for the manager intent on streamlining operations, it offers "a whole new business model" that enables companies to "embrace new technology, and rethink the way they structure their work environments."[27] One example of the innovation needed for this new model is the TUS (or Time Utilization Study) developed by world-renowned workplace consultancy DEGW, with whom the author consulted for several years. The TUS system measures hour-by-hour occupancy of over 300 distinct spaces, in addition to the frequency with which certain activities (i.e. conferences, phone calls, heads-down work, etc.) occur. Handheld computers are used to compile information on work patterns, specific job functions and the use of space by distinct business units." [28] Analyses of these measurements are said to "accurately project the square footage needed per employee", which in the author's experience is invariably "less" than what employees previously had.

In a more sinister example, "PeopleCube Inc" offers a complete digital "workplace management system [that] automatically collects data in real time, filters the data to identify space management use, and deposits the relevant information in a usable and actionable format."[29] PeopleCube's unmanned network of cameras and computers observes the entire workplace and automatically "recommends" space changes and reductions for optimal efficiency. In my extensive field experience consulting with Fortune 500 companies in every major business sector, I have spoken to hundreds of leaders who are torn between competing pressures to measure and streamline operations, and their intuition that these new "flexible" environments are working in opposition to the social fabric that supports organizational craftsmanship, knowledge and creative performance. In most business sectors, however, the pressure to demonstrate some form of "measurable results" to board members and shareholders is so powerful and pervasive that almost any product, service, system or device that can offer this has a tendency to be implemented; despite its cost, and even when this works against leadership's decades of cultivated intuition and experience.

Similarly in the profession of architecture, innovations in ICT have led to a new way of designing buildings based on efficiency and integration of information. Building Information Modeling (BIM) has now displaced conventional drawing and models with a software system that links all aspects of the design and construction process. Traditional architectural practice relied on different media used in progressive iterations (hand sketches, drafted drawings, physical models, contract documents and specifications) in addition to the documents and artifacts of the building trades, such as shop drawings and full-scale mock-ups. A BIM model, on the other hand, streamlines all information into one digital file. This information becomes "parametrically" linked, enabling automated quantitative analysis for every aspect of the project, and replacing the need for the layers of knowledgeable interpretation that traditional media demanded.

The scope of this new software is so all-encompassing that some architecture offices have even integrated employee productivity monitoring with BIM software: tracking individual employee computer-time for each task in creating the virtual information model. Extending the capabilities of this digital integration, BIM models and productivity monitoring systems can also be connected to a (now commonplace) Computer Aided Facilities Management (CAFM) system. CAFM systems are databases that track and schedule workspace elements like furniture, maintenance and conference rooms. By connecting CAFM to a BIM model, managers can link the initial design of the space to its ongoing management, and through systems like PeopleCube, also monitor the end user. The entire lifecycle of the workplace can be digitally analyzed and "optimized".

These examples of streamlining innovations that mix digital technology and measurement, are both means and ends for transforming the environment of the workplace—but remain blind to the less measurable factors of social impact or creative output.[30] Confronting this new reality sociologist Richard Sennett describes how "analytic technologies" have enabled firms to engage in Foucault's "'Panoptic Surveillance'" "…in order to deliver quick, flexible results."[31] Extending this theme in *Workplace Surveillance, Inc* (2002) Bilge Yesil considers how information and communication techniques facilitate and normalize corporate surveillance becoming the "central means of social ordering and orchestration." She considers how "Surveillance works to standardize, create categories and classes, measure and calculate, predict and reduce the uncertainty of individual behavior, and induce a desirable and predictable behavior."[32] More surprising and disconcerting, Yesil finds the workers she interviews resigned to, or even defending, the technical and managerial surveillance in service of "improved efficiency." As Sennett describes, Panoptic Surveillance has become a given condition in the "cutting-edge" world of innovative products and systems. What remains unclear is whether these "cutting-edge" environments actually support the innovation skills, behaviors and creativity that produced them.

Obscure Dependencies; Innovation as Increased Complexity and 'Black Boxes'

Another prevalent characteristic or side effect of contemporary innovation products has been defined as "Obscure Dependencies" [33] – critical relationships, connections, parts, or modules in human-centric systems that become invisible and/or inaccessible to their users. Almost no sector or industry today is spared from obscure dependencies. The news media regularly reports a litany of sudden inexplicable failures in financial systems, automobile braking systems, education systems and oil-extraction and containment systems (to name a few examples in one edition of The New York Times newspaper). Innovative techniques for measurement, calculation, regulation and automation have been incorporated into systems like professional sports, children's education, automobile engines, agriculture and investment banking. The goals is clearly to increase efficiency, validate decisions and produce "measurable results"— more games won, higher test scores, better fuel efficiency, higher yield on crops or investments.

While it may be difficult to argue with these specific goals or "the numbers"[34], the innovations have created a new kind of relationship between parts and people in these systems. Pathways and connections that previously relied on direct human interpretation and evaluation have become more abstract and opaque, less visible and less accessible. These systems resist direct engagement, interaction and dialogue. Looking under the hood of a 2009 Toyota Prius, beside a 1970's VW Bug gives a vivid picture of how new innovation products have transformed the relationship with the user. While the older VW is a visible and accessible system that expects and elicits user participation, the Prius presents a "black box" that even its designers have a hard time understanding. Likewise the financial system that now relies on complex instruments and computational modeling is no longer reactive to its users –the

market. While often efficient according to short-term measurements, these are systems that are prone to "crash" unexpectedly, and where user (re)action and recourse is increasingly irrelevant. A prominent example in workplace consulting is the trend towards "work from home" or "Mobility" programs. Most often these are thinly-veiled strategies for real estate cost savings, even when billed as promoting flexibility. The disconcerting outcome of these technology/central management-dependent programs, however, can lead to stunted social and cultural fabric and a lack of shared responsibility and ownership that often attend dispersed teams[35]. The inability for workers to see or understand their role or "place" holistically within the larger organization can be debilitating at a team and individual level. One is left to consider the social and economic impacts of new work environments that are increasingly defined by opaque or invisible processes and products, and from which users are fundamentally excluded.

Figure 1. 1975 VW Bug engine - a transparent interactive system that encourages user participation.

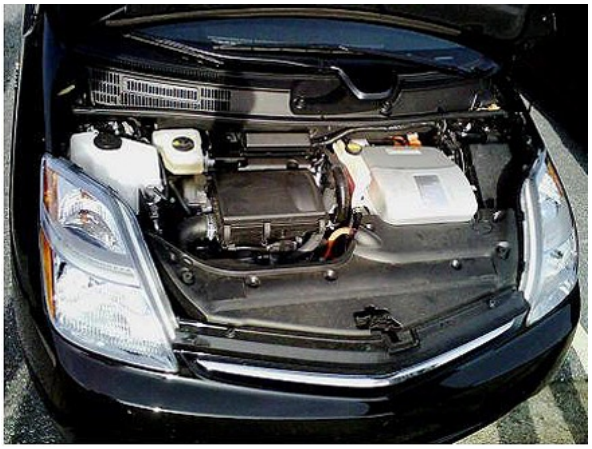


Figure 2. 2009 Prius engine: an opaque system that excludes user participation and knowledge.

Growth; Innovation as Increased Consumption

"If you build it, they will come!" was the mantra that propelled *Field of Dreams* main character Ray Kinsella. Innovation's *modus operandi* today is similar in its singularity: "If it's innovative, they will buy." Innovation today is propelled and proven by bottom line results. This expectation for increased consumption is founded in innovation's connection to "implementation" and "growth". [36] Furthermore, innovation is applied to consumption both directly, as "product development," and indirectly, as "marketing strategies". It is critical to understand that innovations are not *passively* "pervasive" as Bill Mitchell of MIT's Media Lab would suggest[37] but rather *actively pervasive*. Advances in sports equipment offer an example where technical innovation, measurable performance, advertising and obsolescence are intertwined. Innovation by definition is self-perpetuating. Its products are not simply consumed and used, but are themselves tools designed to increase consumption.

This is important because while many innovation products are perceived to be highly "efficient" in a particular (and measurable) way, it is the proliferation of the product that allows any efficiency to be realized. *You have to spend if you want to save*. Net results of efficiency and proliferation will vary according to the product and are notoriously hard to measure. The much loved Prius automobile, for example, may have the potential to save fuel, but to do this it must first be widely consumed. It must be marketed, produced and proliferated. The true success of the Prius is measured by its sales, not in un-consumed fuel. This confusion is seen in several (much contested) "studies" showing the Prius to be less energy-efficient in the long term than the mammoth Hummer.[38] Other studies question the environmental

impact of toxic elements in its battery. Mysterious brake failures and the inability of engineers to diagnose the problems are other impacts that are difficult to measure.[39] Needless to say, innovation products will always carry both the desired and problematic characteristics of growth: They will always provide something new to consume, the "need" to consume, along with the unforeseen consequences accompanying each new thing. Thus when we speak of innovation today we must consider not only the new product, but also its distribution and impact. This concept becomes critical when examining whether innovation products impact the environments where innovative process is cultivated or required.

Today's definition of innovation assumes digitization, streamlining, measurability and growth. This is well summarized by the title of another typical business book: *Making Innovation Work: How to Manage It, Measure It, and Profit from It* (2009). The essence of the title is reinforced by a short quote from within: "Innovation is the key element in providing aggressive top-line growth, and for increasing bottom-line results." [40] This widely-held concept of innovation assumes human creativity (immeasurable by definition) can be applied to creating new "techniques," measurable efficiency and increased consumption. But this definition does not recognize or "own" the potential impacts. If the impacts of these innovation products undermine the conditions, behaviors, skills, or patterns that are necessary for a healthy innovation *process*, we can expect to see the negative feedback of the Innovation Paradox. It may be that a solution to this paradox lies in redefining innovation via holistic longer-term thinking. Before jumping to conclusions, though, we should take a close look at the environments where innovation flourishes.

2. Innovation Environments

If innovation is as vital to individuals and society as I believe, and to the environment and economy as so many experts claim,[41] then special care must clearly be taken in its protection and cultivation. This demands a close study of the environments and systems where innovation flourishes. Thousands of individual researchers, corporations, universities and governments continue to study this in great detail within different disciplines. The following sample of representative research and writings show that successful innovation environments are living social systems with integral characteristics like "place, geography and community," purposefulness, and motivated actors. From these independent but nested points of view, the nature of systems that best support innovation will be understood as "multi-minded," delicate, balanced, and highly vulnerable to the impacts of innovation outputs.

Cities and the "Creative Class"

In 2002, Carnegie Melon economics professor Richard Florida rocked the sometimes-sleepy world of second-tier urban government and planning with a radical thesis. In *The Rise of the Creative Class* he defined the 'new economy' as driven by an emerging "Creative Class" of innovative knowledge workers with new and complex motivations. Furthermore, to attract this Creative Class, and claim a piece of the new economy you had better be: a) a city, and b) one that is considered a cool place to live*;* a place packed with diverse counter-intuitive offerings like arts scenes, great cafés, integrated university neighborhoods and even gay culture. Florida coined this constellation of values the "bohemian index" and almost overnight became the most sought-after consultant on North American urban development. The race to bohemianism was on for dozens of middle-American cities: Who could be more 'gay', Louisville or St. Louis? Who had the better underground club scene, Omaha or Wichita? It could be argued (in another study) that the success of Florida's thesis was based on a number of unacknowledged drivers; but the premise was strong, deeply researched and mostly born out in the subsequent 8 years: *Creative Class*

innovators are drawn to places that provide a sense of belonging, purpose, challenge and diverse opportunities to explore.[42] His research showed that innovators often chose a sense of place over purely financial drivers in establishing where to live and work[43], *based on their desire to protect and cultivate their own creativity.*[44] Florida describes this new emphasis on "place" as the essential magnet for the Creative Class: "In contrast to the many techno-futurists that say the wired and wireless information age has made location and community irrelevant, the creative workers I talk with say they are vitally important. These people insist they need to live in places that offer stimulating, creative environments. Many will not even consider taking jobs in certain cities or regions."[45]

Throughout Florida's research, interviews and exhaustive data, the same message repeats: What motivates, inspires and sustains these innovators are real socio-spatial *experiences*; that only vibrant physical places and human communities can offer.

The Social Context

The image of Creative Class workers "voting with their feet" towards vibrant cities (followed by hopeful corporations with money to spend) shows that innovation is a part of a social system with exceedingly complex feedback loops. Creative Class innovators see their work less as a product belonging to a company (who may be paying for the innovative work) than as a product of "the social and cultural milieu […a] mechanism for attracting new and different kinds of people, and facilitating the rapid transmission of knowledge and ideas."[46] This social core of innovation on which Florida bases his thesis is critical, because to the degree that innovation is interdependent with a social system it cannot simply be purchased, automated, or made more technically efficient. As a social phenomenon, innovation is created only in the minds and activities of people in a social context. It relies on *language*, *knowledge*, *values*, *internalized experience,* an *understanding of context* and *vision of the future*—all distinctly human, and distinctly cultivated, characteristics of a social system. Innovation process is not fundamentally a technical activity as is often misunderstood, even while its products today tend to be technical or technocratic in character. Innovation comes only from minds and groups in a search of meaning and purpose.

In *Reassembling the Social* (2005) famed sociologist Bruno Latour addresses this unique condition as he takes his esoteric social theory to the Oxford business school in a series of lectures. He begins to redefine and deepen the meaning of "social", with a critique of the longstanding establishment view. He uses Actor Network Theory (ANT) to challenge the notion of a social "science," where quantitative data is analyzed, theorized and applied to new contexts. In place of this scientific model, Latour postulates that "the social" is constituted of motivated associations between "actors"—people *and objects*—engaged in a constant process of adaptation and assembly into groups. Without going too deeply into Latour's fascinating labyrinth, it becomes clear that ANT reinforces the Innovation Paradox by acknowledging that both the products *and* processes of innovation are at play in the same social field. In moment of levity Latour offers a vignette of the inseparable social relations between human and non-human actors:

> There is no doubt that you have become a couch potato in front of your TV set thanks largely to the remote control that allows you to surf from channel to channel – and yet there is no *resemblance* between the causes of your immobility and the portion of your action that is carried out by the infrared signal, even though there is no question that your behavior has been permitted by the TV command.[47]

This Fundamental Attribution Error[48] that Latour refers to is equally characteristic of the wireless internet surfer who sees "no resemblance" between ubiquitous "helpful" information networks, and the fact that

the surfer no longer needs to *know* anything. Similarly, the lost automobile driver no longer has access or ability to read a map (relying on digitally-voiced satellite navigation commands); the digital photographer no longer understands "exposure" or "depth of field" (due to the availability of automated digital image enhancements); and the architect who can no longer communicate by hand sketch when required on a building site (because their work now resides in a digital model). According to Latour, we will find no escape from the impacts of these tools by simply returning to the social realm, because these tools have become social actors too; they follow us. The fact that these non-human actors today are mostly *products* of innovation is something we must face. These products, from texts to tweets to touch-screens, have entered the social realm as actors with real agency. (How this agency impacts the social process of innovation will be the subject of the following chapter.)

The 'Purposeful Multi-minded System'

Taking La Tour's academic view of the "social system" into the practical field of organizational development, Jamshid Gharajedaghi writes *Systems Thinking* (2006) to explore the characteristics of organizations that exemplify innovation process. He begins with a chronology of paradigms describe how people work creatively together, and then discusses the adaptations that have occurred to maintain competitiveness in dynamic contexts. Each of his three models are paired with a corresponding "system": The "Machine Model" (mindless system), the "Biological Model" (uni-minded system), and finally the "Social Model"(multi-minded system). After exploring each of these organizational paradigms, his conclusion is that the (recently understood) multi-minded system has become essential to effective competition in today's knowledge economy with its growing need to reconcile "complexity and chaos". He describes the Social Model/multi-minded system as follows:

> Multi-minded systems are exemplified by social organizations…'a voluntary association of purposeful members who manifest a choice of both ends and means'. This is a whole new ball game. …a system whose parts display a *choice* that cannot be explained by mechanical or biological models. A social system has to be understood on its own terms….the critical variable here is *purpose*.[49]

Gharajedaghi goes on to describe how the members of a socio-cultural organization are "held together by common objectives and collectively accepted ways of pursuing them", and that "culture is the cement that integrates the parts into a cohesive whole."[50] While his perspective is analytical, Gharajedaghi concludes, perhaps paradoxically, that the best organization environment for innovation is an intensely human one—in many ways the opposite of technical—defined by concepts like choice, purpose, culture, values, adaptability and ultimately design:

> A *purposeful system* is one that can produce not only the same outcomes in different ways in the same environment, but [also] different outcomes in both the same and different environments. This ability to change ends under constant conditions is what exemplifies free will. Such systems not only learn and adapt; they also create. Human beings are examples of such systems.[51]

The *purposeful system* directly links the "social" with the innovation cornerstones of invention and adaptability. In *Systems Thinking*, the chronological progress from "mindless" to "uni-minded" to "multi-minded" highlights the competitive advantage of a rich social environment over technical or managerial efficiency. Just like the cities that court the Creative Class, organizations and leaders who seek long-term competitive advantage through innovation must also defend and promote the uniquely human elements of the social environment.

The Innovation Ecosystem

Judy Estrin, former chief technology officer at Cisco Systems uses a different model to describe environments for innovation. Amidst the recent financial crisis she wrote *Closing the Innovation Gap* (2009), a call to reverse declining innovation in America.[52] Taking a different tack than Gharajedaghi, Estrin describes the essential environment for innovation as an "ecosystem".[53] The "Innovation Ecosystem" model was inspired by Estrin's biology studies and observation of a tidal pool:

> As you look deeper into these ecosystems you learn that different types of organisms each with its own distinctive lifecycle—are cooperating and collaborating to ensure the vitality of the whole system. Well-understood orderly phenomena exist side by side with seemingly more random ones. Many of these phenomena also apply to innovation.[54]

What is most important about Estrin's ecosystem analogy is the concept of a place in delicate balance; when one thing changes in an ecosystem, the results are interconnected, often pervasive, and unpredictable. In an ecosystem, invasive species like the infamous Cane Toad (intentionally introduced in Australia to control insects) can decimate local flora and fauna with sterilizing effects.[55] To the extent that we see the environment for innovation as an ecosystem, we can likewise foresee the potential impact of introducing new "actors" by way of innovation outputs (such as ICT products). Gharajedaghi might respond that the inherent adaptability of the social model (having "choice" and "agency" that biological systems do not possess) may allow it to counteract the systemic collapse that "mindless" or "un-minded" models are subject to. Nevertheless, cause and effect is an unavoidable and easily observable reality in systems, particularly those as complex as an ecosystem or a social system.

The ecosystem analogy has tremendous utility to illustrate the concept of a balanced complex system, even if Gharajedaghi has shown the limitations of the biological model. On closer reading of Estrin, however, we see that she is actually using "ecosystem" to describe a human community. The characters, values and motivated behaviors look more like Gharajedaghi's, Florida's or Latour's social model, than it does a tidal pool. A hybrid of the tidal pool, the city and the social, viewed through a "purposeful multi-minded" lens, may begin to reveal the complexity and potential fragility of the systems essential to innovation process. What happens when new innovation products are introduced, Cane Toad fashion, into these systems? Will innovation survive?

Each of these authors show that innovation process thrives in environments that are *physical* [Florida] *social and cultural* [Florida, Latour, Gharajedaghi] and *balanced* [Estrin]. Innovation is a social activity, despite the fact that innovation's outputs are often digital, and oriented towards measurement and consumption. As these new non-human actors are inserted into our social systems in the form of innovative efficiencies, methods and devices there will be an unavoidable change to these environments. Innovation products touch and transform our language, our patterns of behavior, our values, our cultural context and perhaps our vision of the future. What impact these environmental transformations will have on the innovation process must now be explored in more detail.

3. Innovation: Skilling and Deskilling

Having outlined the character of today's innovation outputs and the essential characteristics of innovation environments, this section will look at some specific skills necessary for innovation, and then investigate whether these skills are threatened by recent changes to our environments. To start this investigation one might "look for a job" as an innovator: What are the skills that the business world is looking for today when it seeks an innovator for hire? In a highly competitive job posting, IDEO, one of America's most prolific innovation producers and outspoken advocates, describes their desired skill-set for an "Interaction Designer", an individual who will be producing cutting-edge ICT innovations. The posting asks for the following:

1. User Centered Perspective
Candidates must truly believe in a Human-centered approach to design and be comfortable going out into the world for inspiration. They understand basic Human Centered Design methodology, are comfortable with ambiguity and want to push design methodologies.

2. Communication skills
Candidates must have strong presenting, verbal skills, written skills, and storyboarding. Additionally, successful applicants understand the value of design and brand within a design and business context.

3. Team skills
Successful applicants believe that better work is done through collaboration and have the ability to inspire teams through collaboration as well as direction, vision and planning. The ability to relate to individuals and nurture talent also a requirement.

4. Visual design sensitivity
Candidates for this position know the difference and spot the difference between good and great work and are able to nurture teams to deliver great work.

5. Prototyping skill
Successful applicants will understand that you succeed sooner by trial and experiments… that prototyping can be done at many fidelities, and have experience doing and leading that work. They understand that grounding ideas in concrete designs is the best way to gain learning's and move forward.[56]

Given that the source of this description (IDEO) is so prominent in innovation thinking today, and that these requirements are so well detailed, the job posting could serve as a contemporary manifesto for innovation skills. Allowing this, it then begs the question: what would an ideal "training-camp" look like for this prospective innovator if it were designed it from scratch? What would most assist our innovative job seeker to acquire a human/user-centered approach, along with diverse communication skills, the ability to collaborate, inspire teams, and nurture talent? How can we help our prospect learn to conduct concrete experiments "at many fidelities" and to "understand the difference between good and great work?"

Immersive Hands-On Education

While directing the first-year design program at the University of Kentucky, College of Architecture this was the question posed at the beginning of each semester when a class of new recruits arrived to begin their creative journey: how can we best prepare these students for a career of intense applied and disciplined creativity? Many things were kept on the table to answer the question: How should the studio space be arranged? What should be the content and sequence of lessons, projects, conversations and activities in drawing, construction, history and theory? What tools and materials (individual and shared) will be engaged? Where will we travel to see the great works of architecture, cultures and cities? If this all sounds exciting, it is—amidst long days and nights of hard work. The greatest challenge is often finding the time to experience everything on architecture's generous table.

With all of these unique educational elements however, what most differentiates the traditional architecture education is its commitment to hands-on making, a process that requires direct engagement with cultural, material, theoretical, environmental and historical contexts and artifacts. Students regularly build real, inhabitable structures, produce physical drawings and models, make useable furniture, and experiment directly with new materials and the natural landscape. The fact that all of these artifacts exist in physical space (as "focal things") frames the social reality of architectural practice knowledge, production and innovation ("focal practice").[57] Physical space ensures that the people, process and products of architecture are mutually present, dialogical and interdependent. Not surprisingly, in addition to becoming practicing architects, a high number of architecture graduates go on to excel as innovators in other fields like music, art, graphics, software design, marketing and other design industries.[58]

As strong and proven this hands-on education is, it is also under constant threat. Because it requires time and immersion, tools and materials; it is expensive and sometimes risky. Architecture programs today are increasingly pressured to incorporate the efficiency and integration that ICT environments offer and demand. While the traditional architecture studio is a place saturated with shared material experimentation, graphic communication and social connections, many studios today have become computer labs, where models and drawings exist primarily in the digital world of computer screens at individual workstations, or emerge un-conflicted from robotic 'plotters' in a form that discourages a spontaneous or dialogical engagement with the media. Rather than groups of students talking over drafting tables, cardboard models, collages of collected images or hand drawn renderings, students today are most often seen with headphones, staring into solitary computer monitors. Having closely evaluated hundreds of architecture students over the last ten years, my observations at several recent architecture reviews reveal not only increased reliance on new digital presentation tools, but a marked decline in fluency in basic visual language, materiality, structure, and social and geographic context—the foundations of architectural innovation.[59]

Figure 3. *University of Kentucky Architecture Studio*: Socio-spatial learning and interaction is the default practice due to the physicality of the materials of experimentation and communication. Innovation skills are acculturated naturally through hands-on engagement and collaboration.

Figure 4. *Columbia University Digital Design Lab.* Digital media is now often used as the default mode of design exploration and communication. This can lead to a less discursive, more linear and individualistic practice by virtue of spatial configuration and lack of shared tools and artifacts.

General and Specific Innovation Skills

In *The Case for Working With Your Hands*, political philosopher-turned-motorcycle-mechanic Matthew Crawford, PhD, claims that the recent loss of manual trades and activities to automation and outsourcing is both a disservice to young people (particularly boys) looking for meaningful ways to contribute to society, as well as a loss of irreplaceable knowledge and skills on which human society still very much depends. He vaunts the intellectual complexity of mechanical challenges, the direct gratification of a job well done, and the delicate social and cultural community that highly skilled trades depend on, promote and cultivate.[60]

But the loss of these activities may also have a significant impact on innovation. In terms of skill sets and their development, innovation process may have more in connection to Crawford's "manual activities" than is broadly understood. There is often a tendency to think of innovation emerging from innate talent, intelligence and creativity rather than broad experience and skills. For this reason, everyday hands-on activities like motor mechanics, sewing, guitar playing, drawing, fishing, cooking or truck-driving would seem irrelevant as preparation for the knowledge economy. This common dismissal of manual activities overlooks the complex inferential problem solving they require. Done well, let alone mastered, each of these activities involves tremendous contextual sensitivity and creativity brought to bear on dynamic layers of intention and constraint. It is well understood that these manual activities require practice and direct experimentation. Moreover, each requires acquisition of a new language and "learning the rules" which in some sequence must be identified, followed, understood, bent, and finally transcended or rewritten as mastery is attained. While there may be differences in scale, this is just as true for parking a truck on a busy Manhattan street, preparing a delicious healthy meal from scratch, or drafting the floor plans of a new house using pencil and paper.

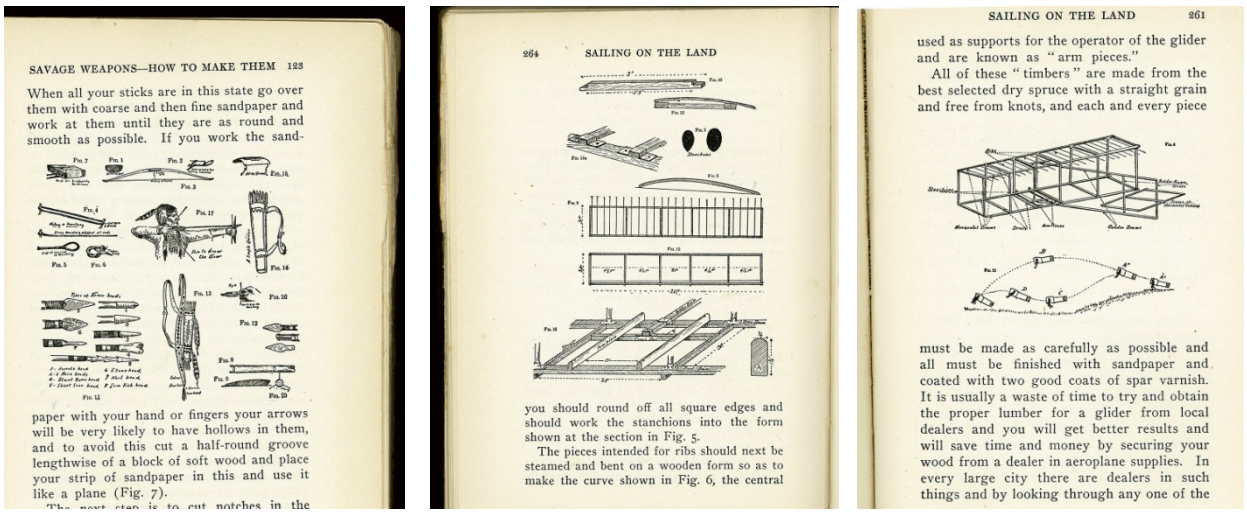
To the degree that innovation process relies on learned skills, it too requires practice before success. It requires a mastery of language wherein relevant relationships can be understood, and through which experimentation, speculation, re-combinations and transformation can occur. With innovation, however, the languages to be mastered can be divided into two categories: *specific* and *general*. Specific languages are the obvious domains of specialized or disciplinary knowledge, such as metallurgy, finance or nanotechnology. These disciplinary languages are the prerequisite for basic operation and innovation in their respective fields, and are the focus of most education, research, investment and policy-making in today's knowledge economy and society.[61]

I would like to posit that a general or "generative" language of innovation is perhaps more important and also more threatened, than the specific skills and languages that are highly emphasized today.[62] In tis new definition, the generative language of innovation is a skill-set based on problem solving in socio-spatial environments, which provides the matrix for cross-referencing skills and knowledge acquired in diverse activities (from cooking, say, to truck driving, fishing to finance, farming to aerospace engineering). This generative language is both highly pragmatic and highly metaphorical, and thus spatial on both counts. It underpins and fertilizes imagination, interpolation and extrapolation – the cornerstones of innovation. One prominent historical example of this generative language can be found in the makeup of NASA's Apollo program. An unusually high proportion of engineers, computer scientists and astronauts, including Neil Armstrong, were 'farm boys' who ended up at MIT –representing a near perfect fusion of the general (farming) and specific (MIT's famous Instrumentation Lab) skills of innovation.[63] Interestingly, MIT also embodies this interdependence in its founding mantra: *Mens et Manus* – "hand and mind."

Play Skills

Children's physical play is another example of cultivating the generative language skills needed for innovation. Play is widely studied and well understood as a building block of cognitive development. According to Howard Chudacoff, author of *Children at Play* (2007) the context and rigor of children's play has changed significantly in the last few decades. Until recently play was characterized by sustained autonomous activity in socio-spatial environments like sandboxes, "street corners or back yards." This type of play demanded complex scenario building, role paying and the use of symbolic props.[64] But according to Chudacoff, today's play occurs in more structured contexts, often relying on digital games and media or other prescriptive toys. In parallel to Chudacoff's work, other researchers have found a measured decline in children's emotional and cognitive development including executive function, self-regulation and language development—all of which are correlated to imagination, IQ, school success…"predicting development in virtually every domain." To preserve the essential benefits of play, Chudacoff et al recommend forgoing the "prescriptive play" that digital and commercialized toys demand. Chudacoff argues parents and teachers should embrace "unsupervised places" where children can manipulate their environment, tools and equipment with their own ingenuity, and encourage "make believe" activities and "complex imaginative play that build self-regulation and creativity."[65]

One of many examples of how expectations for children's play has changed can be found in *The Boy's Outdoor Vacation Book* (1925) that offers an array of activities for boys. Chapters include: "Savage Weapons—How to Make Them," "Sailing on Land or Water", with a section on building a glider. What is most striking is that in each case these activities requires the boy to first construct, from scratch, the object or vehicle, from bow-and-arrows to a full-size wood frame glider à la Wright brothers, with only basic written instructions and materials. The tacit assumption in the book is that an unsupervised boy of ten or twelve years old would have a level of skill, motivation, concentration and executive function to complete these complex tasks requiring tools, teamwork, risk-taking and many layers of social, spatial and technical problem-solving. The fact that this book was widely distributed assumes that parents and caregivers have a level of trust in the capabilities of the children to whom it was given. Comparing these activities to the norm of today's early-adolescent play paints a rather stark contrast, with significant ramifications for innovation.



SAVAGE WEAPONS—HOW TO MAKE THEM 123

When all your sticks are in this state go over them with coarse and then fine sandpaper and work at them until they are as round and smooth as possible. If you work the sand-

paper with your hand or fingers your arrows will be very likely to have hollows in them, and to avoid this cut a half-round groove lengthwise of a block of soft wood and place your strip of sandpaper in this and use it like a plane (Fig. 7).

264 SAILING ON THE LAND

you should round off all square edges and should work the stanchions into the form shown at the section in Fig. 5.

The pieces intended for ribs should next be steamed and bent on a wooden form so as to make the curve shown in Fig. 6, the central

SAILING ON THE LAND 261

used as supports for the operator of the glider and are known as "arm pieces."

All of these "timbers" are made from the best selected dry spruce with a straight grain and free from knots, and each and every piece

must be made as carefully as possible and all must be finished with sandpaper and coated with two good coats of spar varnish. It is usually a waste of time to try and obtain the proper lumber for a glider from local dealers and you will get better results and will save time and money by securing your wood from a dealer in aeroplane supplies. In every large city there are dealers in such things and by looking through any one of the

Figure 5. *The Boy's Outdoor Vacation Book* (1925) outlines a litany of activities that require complex socio-spatial skills, motivations and collaborations with people and materials

Figure 6. The *iPad* and other digital devices offer an unlimited number of "activities" that are pre-programmed in black boxes and do not require complex socio-spatial problem-solving or direct collaboration. Where does this kind of vital learning now occur?

Basic Training

Of the many models of skill-development grounded in social and physical space the most infamous may be "basic training", used to bring military recruits up to a standard of fitness, skill, and discipline. Drills, exercises, tools and equipment, are practiced in 24-hour immersion that also serves to socialize shared values and behavior. Recently, however, the military has had to fortify its training program. It has found that today's recruits come with significantly less physical and spatial skills and awareness, and therefore require longer training. In an NPR interview, General Mark Hertling describes the changes that he attributes to increased ICT in youth culture:

> We are seeing a decline across the board…This isn't a decline [only] in our recruits; this is a decline in our American society in terms of their physical capacity. It's just a softer generation….more advanced in terms of their use of technology, and not as advanced in their physical capabilities or ability to go into a fight… It's not just a fitness issue, either. We certainly have a generation that is not as disciplined when they enter the military….Whereas they might have what they believe is a form of courage or discipline, it's not what we expect of a soldier in tense and difficult situations.[66]

While military leaders may attribute this "deskilling" to the advent of electronic media, gaming and entertainment, the military paradoxically promotes these same technologies in recruiting and training to increase efficiency and reduce costs; and in advanced operations to gain strategic or tactical advantage. Under the heading of "unforeseen consequences," the military now confronts a series of dysfunctions that accompany these highly mediated activities: The US Air Force reports "sensory isolation" of pilots flying drones remotely, and "significantly increased fatigue, emotional exhaustion and burnout" compared with crews of manned aircraft. The report blames the disconnection from "sensory cues like the sense of touch and place," and a high percentage of mishaps are attributed to "situation awareness errors associated with [poor] perception of the environment."[67]

Similarly within the architectural profession, there is increasing debate about the preparedness, skill sets and mentoring of beginning architects. On one hand, the skills with new ICT products such as BIM, 3DMax, Maya and Rhino[68] are demanded and desired in new recruits, partially to compensate for senior architects who rarely have time or interest to learn them. On the other hand we hear from leaders in the

profession that new recruits no longer come equipped with certain critical thinking and spatial skills that architecture requires.[69] The situation is exacerbated by the fact that the ICT skills are in such high demand. This leads to the "CAD monkey" phenomenon, where young designers are kept busy with digital production, while the more senior architects perform the integrative problem solving and negotiation at the core of the creative work. This is a widening gap between increasingly complex "production/media" skills and the higher-level communication and "integrative thinking" skills.[70] The more "innovative" new software becomes, the more specialized its operation, the less likely it is to be fully integrated into high-level knowledge work (transfer and production). Most importantly, this gap undermines the mentoring process in architecture that has traditionally relied on the direct sharing of visible and tangible tools, documents, language and artifacts—between all levels in the architecture studio.[71] While innovation products have resulted in spellbinding ICT tools for the profession of architecture, these tools have also disrupted the socio-spatial ecosystem of communication, skill development, knowledge transfer and innovation; Whether the loss is greater than the gain remains to be seen.

The Craftsman

Perhaps the most basic and historic of all the models of skill development through socio-spatial immersion can be called "craftsmanship": the pursuit, and ability to do good work for its own sake.[72] Craft is a socio-spatial and cultural activity even more than it is a technical one.[73] A craftsman begins their journey as an apprentice where skills and knowledge are progressively developed through experience: repetition, successes and failures[74] in the context of the human and non-human actors in the workshop. Sociologist Richard Sennett and economics professor Patricia Pitcher each use the concept of "The Craftsman" as a touchstone to describe these essential skills, values and behaviors. The craftsman also used as a counterpoint to the threat that "technocratic management", "flexible institutions" and new technologies bring to the building blocks of innovation. Each author from their different research perspective argues in favor of the stability, slowness, discipline and motivation towards mastery that characterizes craftsmanship, working with physical materials and the hand.[75] Pitcher's *Artists, Craftsmen and Technocrats* (1997) emphasizes the value of "craftsmen" in building sustainable, innovative organizations, while Sennett focuses on the positive potentials of craftsmanship in society, and the corresponding danger of the "flexible" workplace. In *The Corrosion of Character* Sennett studies a company of bakers in transition from a craft organization based on skills, knowledge and culture, to one characterized by the efficiency of innovative computer-controlled machines:

> It is, I came to realize, the very user-friendliness [of the machines] that may account for the confusion the people feel about themselves as bakers. In all forms of work, from sculpting to serving meals, people identify with tasks which challenge them, tasks which are difficult. But in this flexible workplace, with its polyglot workers coming and going… the machine is the only real standard of order….Difficulty is counterproductive in a flexible regime. By a terrible paradox when we diminish difficulty and resistance, we create the very conditions for uncritical and indifferent activity on the part of the users.[76]

Throughout his research and writing Sennett continually reminds his readers of the problematic connection between the "progressive" or "efficient" products of innovation (such as computer-controlled baking equipment, flexible management practices and outsourcing) and the social impacts these unintentionally cause. Automation and outsourcing are particularly dangerous outputs of innovation. Production environments, like workshops, minimally automated factories and manufacturing plants, have traditionally cultivated the foundational skills of innovation through daily hands-on problem solving and teamwork required for competitive operation. Owing to today's paradigm of innovation products, these

environments are either disappearing or being transformed, and with them the opportunities for hands-on problem solving, skill building and craftsmanship. It is critical to note that this deskilling and loss of craftsmanship that Sennett and many others see is not simply a loss of local consumable "craft products" (like handmade bread, wooden boats or hand-drafted drawings on vellum) but more importantly the loss of an essential social, cultural and mental apparatus for being and acting in the world. Looking back at the IDEO manifesto, this mental apparatus, and the socio-spatial skills that go with it, are not only pillars of the innovation process but prerequisites for the job.

The deskilling caused by innovation products is summed up by architecture professor and theorist Malcolm McCullough who describes the trend towards cultural and spatial "illiteracy" in two books, *Abstracting Craft* (1996) and *Digital Ground* (2004). He cites the importance of "everyday space" and "landscape" for ordering thought. Referring to cultural changes engendered by technology he warns that "the cycle of embodied environmental literacy can turn downward. Technological convenience allows many helpful new constructs to form, but it also allows events that would normally serve environmental learning, to dwindle." Reading *The Boy's Outdoor Vacation Book* alongside contemporary expectations for children's play highlights this literacy "downturn," and runs directly opposite to IDEO's call for highly developed environmental skills as a prerequisite for innovation employment.

Environments that Support Innovation Skills

Returning to the qualities of our "training camp" for the future/hopeful innovator, these studies can be taken as a summary of both necessary ingredients, and warnings. Where automated, distracted, multitasking and digitally-flexible environments are understood as detrimental to innovation skills, the best environments for cultivating productive creativity are rich with interconnected and layered values: *complexity and clarity, risk-taking and support, challenge and tangible results, universality and locale*, *internal motivation and external reward*—all characteristics of problem solving in physical and social space.[77]

At a recent NASA conference on knowledge management, collaboration and innovation, David Pender frames the ideal innovation environment for innovation using the Japanese concept of "ba," or "shared learning space." In "ba," shared language, common metaphors and well-understood routines for communication provide individuals with the "freedom and security" to facilitate the delicate process of innovation. Pender recommends a substantial investment in these "communications infrastructures" that will "nurture a culture of sharing ideas in an atmosphere of trust and care."[78] This atmosphere of trust and care and investment in "communications infrastructure" that Pender refers to is the extreme opposite of the streamlining trends implemented by many managers in the contemporary American workplace. In my experience working with hundreds of these managers I have found that there is often an absence of narrative compelling enough to counter the growing (symbolic) force of innovation products like CAFM, TUS, PeopleCube and BIM. Without powerful narratives[79], even seasoned leaders are left with only experience and intuition against a seemingly inexorable tide of data, measurability and "technocization" of their organizations. Faced with these odds, most of the leaders I have worked with have adopted an "*if you can't beat 'em, join 'em*" strategy, choosing to align themselves with "state-of-the-art" rather than risk the indignity of obsolescence represented by the dreaded "dinosaur" label.

This does not have to be the case. One example of an exception to this corporate tendency was a recent project at the Canadian Broadcasting Corporation (CBC) in Toronto. In the face of streamlining demands CBC adopted a more user-centric approach to workplace strategy. Rather than a prescriptive numerical model which had been advanced by some management factions, we worked with DEGW and the CBC to

develop an approach and toolkit called “The Sandbox” which allowed teams to co-develop solutions for unique “workplace neighborhoods,” as well as a process outlining roles and rules.[80] The Sandbox is a physical board game environment that requires the presence and participation of representative stakeholders. This participatory approach allows design decisions to be integrated and informed by deep organizational knowledge. It also provided an opportunity to educate new recruits and more distant organizational members (such as senior management and real estate reps) on the tacit but critical aspects of team performance and space use. While budgets (spatial and financial) are typically dictated by senior management, the transparency and openness of the Sandbox process allowed different levels of leadership to share a common language, knowledge and goals. This process can be more time-consuming than quantitatively driven or “top down” decision-making as it requires the acquisition of language and skills that are not typically part of management repertoire—such as reading floor plans and diagrams. The results, however, have been transformative with respect to both team buy-in, and enabling efficient and effective spatial solutions. In The Sandbox, workplace innovation is cultivated by shared ownership and shared visibility of both purpose and constraints.

Figure 7. 8. “The Sandbox” involves participants in face-to-face dialogue and problem-solving in physical space. On the right, CBC executives use a 3D Sandbox approach to solve a complex restacking of 1.5 M square feet of corporate space.

The skills needed for innovation today are real. They are social, spatial, cultural and linguistic and they are fostered in real places shared directly with people via tangible symbols, materials and tools that demand practice, patience and craftsmanship over convenience, obscure analysis and calculation. The environments that best cultivate these skills will draw people into present relationships, mentally, physically, symbolically, in time, space and body. Magnetic places that support these values and generative skills for innovation can certainly be designed by today’s innovators for the innovators of the future. To do this, innovation leaders must first believe this stewardship is important, and that innovation should not be limited to its current one-track mindset of streamlining efficiency, measurement and consumption. Innovation can be applied to creating challenging, multi-dimensional experiences “shared learning spaces” and “common metaphors.” And given that metaphors are themselves based on a socio-spatial context,[81] it follows that innovation-learning environments should reinforce, refresh and ‘skill up’ our use of metaphors by favoring time, space, material and the body. Of course, the importance and urgency of this design challenge assumes there is a real problem… [Insert: *Newsweek* “The Creativity Crisis: For the first time, research shows that American creativity is declining…” July 10, 2010 http://www.newsweek.com/2010/07/10/the-creativity-crisis.html

4. The Sustaining Illusion and the Downward Spiral

If today's digitally networked environment is so detrimental to innovation, why do we see such an abundance of high-profile innovations today? Economists, entrepreneurs and technophiles can point to innovation products like Cloud Computing, 'iPads', 3D TV, BIM, nano-technology, the Da Vinci surgical robot, among thousands of new technical wonders to demonstrate the leadership of American innovation. Surrounded by this evidence—is the Innovation Paradox a real threat? It is beyond the scope of this paper to analyze a rate of innovation, and many researchers have already attempted this with differing results.[82] Instead, I want to answer the question in different way by pointing out another attribution error that obscures the relationship between current innovation environments and outputs—between the contexts that I believe displace socio-spatial experience with digitization, and the seeming success of innovation process today.

The illusion that *innovation products must be beneficial to innovation process* is sustained by what I will call the "innovation lag": a delay between the recent environmental changes previously cited, and their corresponding impacts. The Cane Toad introduced in Australia took decades to destroy the local ecosystem, thus seeming harmless (or even helpful) for many years.[83] The changes to innovation's socio-spatial ecosystem due to the introduction of innovation products may likewise take decades to reach full effect—with similarly powerful and irreversible consequences. This lag is due to the relative speed of the environmental changes, compared to longer cycle of latent knowledge and skill embedded in the contribution of today's innovation leaders. Simply put, most people leading innovation today did not grow up immersed in the very innovations they are currently producing. Even today's most famous digital innovators grew up without internet-enabled information overload or the ubiquitous multitasking now demanded by mobile devices such as Blackberries and iPhones. We will never know if Steve Jobs, Bill Gates, Sergey Brin, Larry Page, James Cameron (or thousands of other innovation leaders currently in their late 30s, 40s or 50s) can rightly attribute their innovation success to hands-on learning, or immersion in diverse socio-spatial contexts, although this theme appears in most of their biographies. Steve Jobs, for example, credits his study of physics, literature, poetry and calligraphy, as well as his travels to India as a young adult, as key to his innovation background. After graduating in physics, James Cameron became a truck driver before entering into the exceedingly hands-on role of "miniature set builder" in the film industry. Larry Page, while surrounded by computers as a child, describes wanting to be 'an inventor', and his obsession with taking apart "everything in the house".[84] And both Larry and Sergey were students of Montessori schools—educational environments with an unmatched focus on socio-spatial and cultural contexts. What is critical to understand in these examples is that *creating* Google, and *living with* Google should never be confused or conflated. While the creation of these incredible 'products' is certainly innovative, *the use and proliferation of these same products may just as easily have devastating consequences in preparing others for innovation.*

Nevertheless, this conflation is very common. Parents, public schools, even universities, in an attempt to "boost" innovation or creativity, increasingly prescribe learning environments that are saturated with innovation products. This conflation or misattribution is analogous to the CEO of Nestle, Kraft or Cadbury believing they should feed their children a diet of highly processed convenience foods in order that they grow up to be successful food industry executives. Instead, we intuit that these CEO-parents do the opposite, and hire health-focused chiefs who prepare fresh organic meals on demand—restricting the intake of company foods to protect their children (even as they promote these products to the mass consumer). Michael Eisner, the former CEO of the Walt Disney Corporation grew up in Manhattan, but credits his success in innovation and leadership to his time at Keewaydin Canoe Camp in Vermont; so much so that he wrote *Camp* (2005) a book about the experience and its impacts. Likewise, we can be sure the children of Bill Gates, Steve Jobs and James Cameron are *not* spending their days behind

closed bedroom doors playing video games or "surfing the net." Rather, we are sure they are traveling the world and experiencing lessons in real kung fu, guitar playing, pencil drawing, organic farming, or real surfing in real oceans—activities that have no resemblance to their digital counterparts in terms of risk taking, problem solving and learning experience. Perhaps intuitively, we know that these children are engaging the socio-spatial world in a way that will allow them to follow in the footsteps of their successful parents.[85]

Figure 9. *Little Tikes "Young Explorer™ $2,599.99*". Starting children early with "innovation products" is increasingly promoted in schools and family settings, but may have unforeseen consequences in social and mental development.

Figures 10 + 11. *Summer Camp and Kung Fu class*. (images: Camp Mini-Yo-We and Daniel Guy). Immersive hands-on learning experiences for children are filled with multi-layered skills, risks and motivations, but are increasingly displaced by mainstream digital "alternatives" and become the prerogative of an elite class.

The Downward Spiral

The children of America's most successful innovators may be insulated from the proliferation of innovation products but the mainstream environment is increasingly saturated. In *Elsewhere USA,* Dalton Conley, Dean of Social Sciences at NYU, describes *How We Got from the Company Man, Family Dinners and the Affluent Society to the Home Office, BlackBerry Moms and Economic Anxiety* (2009). He presents widespread changes to family relationships characterized by ubiquitous connectivity, mediated by devices and continuous multitasking:

> Mr. 2009 asks his kids about their day. They chat as each of them keeps one eye on a computer or communication device. Dad wishes to be totally engaged and interested, but he simply can't. It's not just that he is constantly multitasking…or that his attention span has shrunk…it's his kids

> too: even if he were totally available they are not….A new breed of American has arrived on the scene.[86]

In New York Times article "Breakfast Can Wait," Brad Stone paints a similar picture through the eyes of the Gude family of Lansing Michigan:

> Karl and Dorsey can remember simpler times not long ago. They sat together and chatted as they ate breakfast. They read the newspaper and competed only with the television for the attention of their two sons…Today Mr. Gude wakes up at 6am to check his work email and his Facebook and his Twitter accounts. The two boys start each morning with text messages, video games and Facebook…'Things I thought were unacceptable a few years ago are now commonplace' [Dorsey] says, 'like all four of us starting the day on four separate computers'.[87]

The full impacts of these changes to the family environment are not yet known, but there is strong evidence that they could be severe and widespread. The recent obesity epidemic in American children offers visible evidence of a transition from normative physical play to substantially increased "screen time".[88] Perhaps more dire, however, are the changes to children's mental structures at an early age engendered by digitally mediated environments. "The Early Catastrophe; The 30 Million Word Gap by Age 3" (2003) by University of Kansas researchers Betty Hart and Todd Risley, is an exhaustive study on the relationship between learning outcomes and family environment. It shows how everyday communication essentially "determines" the educational future of children by age 3. The study recorded and analyzed "everything" that went on in the home of 42 families over 2 ½ years, and found an unprecedented correlation between the type of verbal communication (complexity, vocabulary, duration etc.) in the family context, and the long-term education success of the children.[89] It found that "by the time the children were three years old, trends in amount of talk, vocabulary growth, and style of interaction were well established and clearly suggested widening gaps to come. Even patterns of parenting were already observable among the children…" After six years of painstaking analysis, data showed that "the problem of skill difference among children entering school is bigger, more intractable and more important than we had thought. So much is happening to children during their first three years at home…that an intervention must address not just a lack of knowledge or skill but *an entire general approach to experience*."[90]

Countless other studies cite radical and rapid changes to the socio-spatial "ecosystem" of the American family as new "non-human actors" are invited in, or enter uninvited.[91] A recent report on reading ability in New York State showed that less than 40% of eighth grade students read at a proficient level. The number drops to 12% for minority students.[92] Meanwhile, the connections between family context, culture, communication, and foundational learning outcomes remain undisputed.[93] The recent introduction of innovative ICT products has caused changes to these social systems that are faster and potentially more consequential to childhood development than any in human history.

The impact of our transformed communication context is not confined to early childhood development. Many other reports show particular changes to social environments impacting adult populations.[94] In "Driven to Distraction",[95] John Lorinc examines how "quantum leaps in wireless digital technology…high powered portable devices…vast storehouses of digitized entertainment…ubiquitous connectivity" come with "a psychological cost that is ultimately rooted in how the brain functions." The author cites several studies attesting that our "technological miasma inundates us with an inexhaustible supply of electronic distractions"…creating a hyper-connected world that has "made it difficult to think".[96] This reduction in quality and quantity of thinking time has been echoed by numerous colleagues and clients of the author, who complain that despite their responsibility to deliver strategic and sometimes life-altering decisions,

they rarely have time to contemplate or reflect on these decisions due to the expectation for, and distractions of, constant connectivity. University of California neuroscientist Adam Gazzaley comments that "nonstop interactivity is one of the most significant shifts ever in the human environment. We are exposing our brains to an environment and asking them to do things we weren't necessarily evolved to do. We know already there are consequences."[97]

Walter Kirn's "Autumn of the Multitasker"[98] offers a poetic compilation of the consequences of multitasking that innovation outputs enable and demand. Kirn weaves numerous studies with his first-hand experience and claims that "neuroscience is confirming what we all suspect: multitasking is dumbing us down and driving us crazy." Kirn warns that "efficiency, convenience and mobility", three hallmarks of today's innovation products, are to blame for creating an environment that leaves us little choice about whether or not we multitask. He cites an extensive Kaiser Family Foundation Study where over 50% of high school students report regularly multitasking with at least two types of electronic media at once, and where "still-maturing brains" are being "shaped to process information rather than understand or even remember it." [99] It is the ubiquity of devices and networks, Kirn argues, that make these changes to our environment and behavior inescapable. This despite the fact that "scientists using mental imaging" can observe multitasking "messing with the brain in several ways…boosting stress hormones such as cortisol and adrenaline" and "wearing down our systems through biochemical friction."

In an interview with *Wired Magazine*, Maggie Jackson, author of *Distracted: The Erosion of Attention and the Coming Dark Age* speaks of "interruption correlated with stress, frustration and lowered creativity…When you're scattered and diffuse, you're less creative. When times of reflection are punctured, it's hard to go deeply into problem-solving, into relating, into thinking…we've created a culture, and are making choices, that undermine our powers of attention."[100] Given that innovation is at its core a creative, problem-solving activity that specifically requires "relating" and "powers of attention" these trends ought to signal DEFCON 1 for anyone concerned about innovation process. *[See Newsweek "The Creativity Crisis"]*

Since today's iconic innovators did not grow up in digitally immersive environments, however, we will not fully see the impacts of our current state of digital immersion (e-mmersion) until these current leaders retire and the "digital natives" assume leadership roles in innovation. The sustaining illusion of innovation today is that digital natives are "doing fine," based on current innovation outputs that are mostly instigated and lead by the pre-digital-immersion generation. Instead of using current innovation outputs as a guide we must look into the past (knowledge and history) and the future (theory, intuition, wisdom) to understand the potential consequences of the "virtual" environments we are creating. Looking at present outputs alone will be of very little help in assessing their long-term consequences.

What if We Don't Break the Innovation Paradox?

By this point it should be clear that innovation, the lifeblood of the economy and an apex of human creativity, thrives only in the soil of "multi-minded" socio-spatial and cultural systems, yet produces technologies that can be counter-productive to these environments. Developing innovation skills require environments that support complex, direct transparent and motivated relationships between people, language, values, tools, materials, places and events. Meanwhile, says Neil Postman, "new technologies alter the structure of our interests: the things we think *about.* They alter the character of our symbols: the things we think *with*. And they alter the nature of community: the arena in which thoughts develop."[101] These threats to the innovation ecosystem ought to be alarming at a grand scale. A further analogy is an agrarian society planting a (financially lucrative) crop in limited arable land despite the crop's known by-

product being ruinous to future use of the soil. Given that this is precisely what we have seen in disastrous "cash-crop" or "monoculture" farming in both African and America contexts—we should be on high alert for similar self-destructive behaviors. As Estrin points out in *Closing the Innovation Gap,* America is "focusing on the short-term […] and not planting the seeds for the future" with respect to innovation.[102] Even an abbreviated list of imminent crises, such as chemical pollution in the food chain, water scarcity, depleted fish stocks, global warming, limited fossil fuel supplies, drug-resistant diseases, and population demographics should give us reason to aggressively protect innovation environments.

The fact that an alertness to innovation's short-term focus is not commonplace in our techno-centric economy is clearly evident in the titles (and content) of today's government reports, professional conferences, news headlines and business books—all forums where innovation is presented and discussed one-dimensionally as a social or economic "good," [103] while oblivious, if not obfuscating, any potential downsides to innovation process. Ironically, North Americans spend billions of dollars consuming fictional narratives that describe a future desolated by the products of our own making.[104] At the same time, highly respected sociologists and cultural theorists have been writing on the topic for decades with negligible impact on the institutions of economic or political power. Respected academics and writers such as Jane Jacobs, Ursula Franklin, Richard Sennett, Ivan Illich, Albert Borgmann and Neil Postman predict devastating consequences in society and even "dark ages" if this is not addressed. In *The Twilight of American Culture* Morris Berman predicts a situation so dire and irreversible that he calls his only recommendation "the monastic option": a heads-down preservation of existing knowledge and culture while the dark ages pass by unstoppable. The fact that the voices of these authors are not heard by economic decision-makers could be attributed to a dangerous combination of the "sustaining illusion" and an intellectual chasm between contemporary socio-cultural theory and economic theory and practice. Can this chasm be bridged soon enough to avert disaster? This will require connecting the two realities of innovation within the neo-liberal economy: *how innovation works* (socio-spatial) and *what innovation produces* (technical). It is my hope that this connection will be useful to all forms of innovation discourse, but let's start with: "…economist, meet sociologist…!" Having made this (re)introduction, I appeal to progressive economists to attempt to calculate the financial impact of a "skills-and-knowledge-loss tsunami" in America. Perhaps only through these calculations will the issue be taken seriously as a matter of public policy, cultural value and personal commitment in our society.

5. Conclusion: Saving Innovation from Itself

The Matrix (1999) begins with the main character Neo facing a decision: maintain a life of tranquil illusion in a virtual reality or enter the unknown "desert of the real." Packed with prophetic irony and insights, the film moves through dueling realities of physical and digital space, where the currency of information, knowledge, skills and the motivations of humans and machines are in constant flux. Soon after taking his leap of faith, a newly (re)birthed flesh-and-blood Neo "downloads" a lifetime of martial arts training. Neo wakes from his electronic coma and exclaims, "I know Kung Fu!" But does he? In the (digital) dojo Neo must embody and socialize his skill. He must confront an opponent/master. He must learn to innovate. The paradox in *The Matrix* is that the deluxe hyper-reality of virtual space, filled with the aesthetic delights of food, wine, beautiful women and soaring architecture, is seen alongside the bleak, impoverished and technologically dependent "real" world. Nevertheless, it is the metaphorical socio-spatial quality of the dojo environment—a human-centric space manifest as a traditional hand-made Japanese "post and beam" wooden structure, flooded with natural light—that allows for Neo's development of skill, knowledge and finally transcendence. In the end, the voracious and dehumanizing (man-made) machine can finally be vanquished only when humans learn to strategically (re)inhabit it and dismantle it from within.[105]

Figure 12. Dinner at the Cottage. (image: Scott Francisco) Food is just one socio-spatial activity that links "generative" innovation skills with place and culture.

Figure 13. "Neo is Fighting Morpheus in the Dojo!!" Information was not enough. In the dojo, Neo had to socialize his skill, and learn to innovate.

Innovation today is in crisis, having developed a paradoxical relationship between the proliferation of its products and the socio-spatial context necessary for its process. Our recent dependence on the "knowledge economy" coincides with our creation of environments that do not value or cultivate the knowledge we need to sustain it. As we produce exponential amounts of information (and systems to access and manipulate information) we are neglecting the cultivation of situated knowledge and human creativity, the foundation for robust problem-solving and innovation.

Meanwhile, our future innovators have been led to believe that they too "know kung fu" along with military tactics, architecture, guitar heroism, surgery, dating, social relationships, business negotiations even sex—based mostly on multi-tasking with flat screens and buttons.[106] The extreme naivety that this represents is evidenced in the "design solutions" seen in many online forums that solicit (unpaid) digital design services from millenials in exchange for the opportunity to be noticed by a potential client, or rated by a "virtual community".[107] Ironically these streamlined disembodied non-experiences that are becoming the predominate context for young innovators, are made possible by the innovation products created by a generation who had all the benefit of diverse, physical, chronological, concentrative, often-messy, life experience that real place and real culture demand. Who would have thought that *Avatar* and *Terminator,* movies that embody innovation in both form and content, are the products of a truck-driver from Kapuskasing—a tiny rural outpost in northern Canada? If our innovation outputs are robbing today's generation of the very experiences that have allowed us to be skillful innovators, it is equally our job to give these back: The ubiquitously networked "I can always find out" environment is no place to train the future innovator. We need look no further than the backgrounds of today's most successful innovators, or the way they are raising their own children, to confirm this.

Breaking the innovation paradox is possible, but it will require an about face and a re-definition of innovation. Thankfully innovation's mission is to reinvent, and it can reinvent itself. It can turn against the

single-minded pursuit of digitization, streamlining, efficiency and increasing consumption. It can attack the barriers it has constructed against real life socio-spatial and cultural experience. It can decide to favor socio-spatial learning environments like summer camps and studio workshops over disembodied digital environments like Facebook and corporate "work from home" programs. In the place of "obscure dependencies" innovation can cultivate "transparent" problems to be solved in the daily work and life of people of all ages and in all trades: from three-year-olds, to apprentice mechanics, from professional architects to master craftsmen. To address runaway consumption, information overflow, and energy entitlement, innovation can create products and environments that are *slower, more difficult* and *more expensive*, instead of faster and cheaper. Innovation can even help choreograph selective inefficiencies and redundancies; multi-layered "difficulties" that engender socio-spatial relationships and cultural activity, and nurture deep creative invention and complex problem-solving skills. To be truly sustainable, innovation must change its criteria for evaluation from increased consumption and efficiency, to its cultural impact. Furthermore, innovation must always return to the question: "What might be the consequences of this new thing?"[108]

Richard Sennett concludes *The Corrosion of Character* and *The Culture of the New Capitalism* with a prescription for a society burdened with "innovative", "efficient", "flexible" technocracies. He offers three values: "Craftsmanship, Narrative and Usefulness" that can be used to resist the onslaught of innovation products and stave off the "dark ages" prophesied by Jacobs, Berman and Jackson. For his solution, Neil Postman proposes a "loving resistance fighter" who, in spite of the "confusion, errors and stupidities [around him] always keeps close to his heart the narratives and symbols that once made the United States the hope of the world, and that may yet have enough vitality to do so again." For my part I offer the sandbox, the woodshop, the farm and the architecture studio as environments that have been models of socio-spatial learning and innovation. And to my peers, architects of this current generation, I pose this challenge: What should our buildings look like if they are designed to support innovation process? Instead of the formal whimsy, technology showrooms or robotic 'plots' so commonly seen in architecture today, can we create an architecture that teaches even as it expresses and accommodates our needs? If we apply ourselves to this immediately, perhaps our own children can find out.

I hope it is clear that this paper does not intend to reduce the value of human experience to a purely material realm, or to instrumentalize culture or social-spatial context for the sake of "productivity." It is increasingly clear, though, that many of the immediate and long-term challenges facing humanity in the biosphere can be overcome only in proportion to our ability to successfully innovate—but innovation in ways that are both productive and *reproductive*. To be reproductive innovation must become deferential to cultural development. If America's role is to be a knowledge and innovation leader, not to mention a model global citizen, we have no choice but to study the environments that best support the training of a holistic innovative mind and then apply this learning immediately. From either a naturalistic or metaphysical perspective, innovation is the defining work of the human species. But innovation requires a socio-spatial and cultural context to survive and thrive; the very same qualities that are currently threatened by the proliferation of today's innovation products. Innovation must be freed from the deadly grasp of increasing efficiency and consumption; values that relentlessly obscure, distance, measure and predetermine our interactions and behaviors. Turned against these tendencies, innovation can create products and environments that promote community, family, visible complexity, narrative, stability, iterative progress, local economy, and a mature understanding of limited resources—values that support both the future of innovation, and a life worth living.

What will this future look like? How will our growth-addicted economy function? For the "new" new economy, I offer the paradigm of "the glider" in place of ever-accelerating jet propulsion. When Captain Sullenburger's passenger jet was hit with a "double bird strike" over New York City he credits his teenage

training in manual aircraft, his hours flying engineless gliders and his relationship with people: mentors colleagues and family. In short, it was his robust socio-spatial understanding of flight that allowed him to safely land the plane in the Hudson River.

But a skillful glider can do much more than land safely. At its best this finely tuned meld of man, nature and machine can harness “free” energy and make tangible the invisible. The glider recalibrates our expectations of power and progress. It engages all of the senses. It is difficult, mentally and physically. It involves risk. It demands practice and repetition on the journey towards mastery. But masterful gliding represents innovation at its most sustainable. It is this kind of transparent and tangible environment, this kind of journey, and these kinds of skills that will allow coming generations to escape the innovation paradox; to involve people, place and communities directly; to build on the knowledge of the past through tangible artifacts; to apply personal experience and creativity to current challenges and save innovation from itself.

Bibliography:

- Abma, Derek. "Canada Gets a D in Innovation." *Financial Post.* February 1, 2010.
- Amabile, Teresa. *Creativity in Context.* Colorado, Oxford: Westview Press, 1996.
- Baker, Stephen. "Managing by the Numbers: How IBM Improves Productivity by Tracking Employees' Every Move." *Business Week.* September 8, 2008.
- Baute, Nicole. "Conference Board Gives Canada a D in Innovation." *Toronto Star.* Feb 2, 2010.
- Beer, Stan. "War of words between aid organization and OLPC erupts." *iTWire.* January 24, 2007.
- Bellow, L. and J. Roach, "Childhood Overweight." *Colorado State University Extension.* 2009. <http://www.ext.colostate.edu/pubs/foodnut/09317.html>
- Belson, Ken. "With Wireless Network, City Agencies Have More Eyes in More Places." *The New York Times.* June 28, 2008.
- Berman, Morris. *Twilight of American Culture.* New York: W.W. Norton & Company, 2001.
- Brown, John Seely et al. *Storytelling in Organizations: Why Storytelling is Transforming 21st Century Organizations and Management.* Oxford: Butterworth-Heinemann, 2004.
- Butler, Tina. "Overstaying Their Welcome: Cane Toads in Australia." *www.mongabay.com* April 17, 2005.
- Chudacoff, Howard P. *Children at Play*: *An American History.* New York: New York University Press, 2007.
- Conley, Dalton. *Elsewhere, U.S.A.: How We Got from the Company Man, Family Dinners, and the Affluent Society to the Home Office, BlackBerry Moms, and Economic Anxiety.* New York: Pantheon, 2009.
- Crawford, Matthew B. "The Case for Working With Your Hands." *The New York Times Magazine.* May 21, 2009.
- Cross et al. "Knowing What We Know: Supporting Knowledge Creation and Sharing in Social Networks." *The Darden Foundation.* 2002.
- CNW Research. "CNW's 'Dust to Dust' Automotive Energy Report." <http://www.cnwmr.com/nss-folder/automotiveenergy/>.
- Davila, Tony et al. *Making Innovation Work: How to Manage It, Measure It, and Profit From It.* Upper Saddle River: Wharton School Publishing, 2005.
- Drucker, Peter. "The Discipline of Innovation." *Harvard Business Review.* August 2002.
- Drucker, Peter. *Managing in the Next Society.* New York: St. Martin's Press, 2002.
- Ellul, Jacques. *The Technological Bluff.* Grand Rapids: W. B. Eerdmans, 1990.
- Estrin, Judy. *Closing the Innovation Gap: Reigniting the Spark of Creativity in a Global Economy.* New York: McGraw Hill, 2009.
- Felsenstein, Lee. "Problems with the $100 Laptop." *The Fonly Institute.* November 10, 2005.
- Richard Florida, Richard. *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life.* New York: Basic Books, 2002.
- Francisco, Scott. "Place in the Face of Obscure Dependencies." *DEGW Insights, vol 4.* 2008.
- Francisco, Scott. "The Way We Do Things Around Here: Craft Culture Versus Specification in the History of Building." *American Behavioral Scientist.* 2007.
- Francisco, Scott. *Useable Space: Culture Versus Technique in Pursuit of Design.* SMArchS thesis. MIT, Cambridge, 2005.
- Franklin, Ursula M. *The Real World of Technology.* Toronto: House of Anansi, 1999.
- Fulford, Robert. *The Triumph of Narrative, Story Telling in the Age of Mass Culture.* Toronto: House of Anansi, 1999.
- Gharajedaghi, Jamshid. *Systems Thinking.* Oxford: Elsevier, 2006.
- Gladwell, Malcolm. *The Tipping Point.* New York: Back Bay Books, 2002.

- Gloeman, Daniel and Gregory Norris. “How Green is my iPad.” *The New York Times.* April 4, 2010.
- Grantham et al. *Corporate Agility.* New York: Amacom, 2008.
- Hart, Betty and Todd R. Risley. *The Early Catastrophe: 30 Million Word Gap.* American Educator, Spring 2003. <http://archive.aft.org/pubs-reports/american_educator/spring2003/catastrophe.html>
- Hertling, Mark. Interview with Scott Simon. “New Basic Training Hardens ‘Softer Generation’.” *Weekend Edition Saturday*. NPR. March 20, 2010. <http://www.npr.org/templates/story/story.php?storyId=124923602&ft=1&f=1049>
- Illich, Ivan. *Tools for Conviviality.* New York: Harper & Row, 1973.
- Jackson, Maggie. *Distracted: The Erosion of Attention and the Coming Dark Age.* (New York: Prometheus Books, 2009).
- Jackson, Maggie interviewed by Brandon Keim. “Digital overload is Frying our Brains.” *Wired Magazine.* February 6, 2009.
- Jacobs, Jane. *Dark Age Ahead.* New York, Random House, 2004.
- Kakutani, Michiko. “Texts Without Context.” *The New York Times.* March 21, 2010.
- Kelley, Tom. *The Art of Innovation: Lessons in Creativity from IDEO, America’s Leading Design Firm.* New York: Random House, 2001.
- Klinkenborg, Verlyn. “The Vanishing Point.” *The New York Times Style Magazine.* March 26, 2010.
- Lakoff, George and Mark Johnson. *Metaphors We Live By.* Chicago: University of Chicago Press, 1980.
- Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network-Theory.* New York: Oxford University Press, 2005.
- Lenhart, Amanda. “Teens, Cell Phones and Texting.” *Pew Research Center.* April 20, 2010. <http://pewresearch.org/pubs/1572/teens-cell-phones-text-messages>
- Lorin, John. “Driven To Distraction.” *Walrus Magazine.* April 2007.
- Macdonald, Cynthia. “Fear of Numbers: Why do so many kids struggle with math?” *U of T Magazine.* Autumn 2008.
- Martin, Roger. *The Opposable Mind: Winning Through Integrative Thinking.* Cambridge: Harvard Business Press, 2009.
- Mitchell, William. *City of Bits: Space, Place, and the Infobahn.* Cambridge: MIT Press, 1996.
- Mitchell, William. *e-topia*. Cambridge: MIT Press, 2000.
- Mitchell, William. *Me++: The Cyborg Self and the Networked City.* Cambridge: MIT Press, 2003.
- Murray, Charles. “Why Charter Schools Fail the Test.” *The New York Times.* May 4, 2010.
- Otterman, Sharon. “On Reading Test, Mixed Results Under Bloomberg.” *The New York Times.* May 20, 2010.
- Paulos, John Allen. “Metric Mania.” *The New York Times Magazine.* May 16, 2010.
- Pender, David. “Emerging Themes in Inter-firm Collaboration.” University of Adelaide, Australia.
- “PeopleCube: The Need for Workplace Business Intelligence.” White paper. <http://www.peoplecube.com/solutions-facility-management.htm>.
- Postman, Neil. *Technopoly: The Surrender of Culture to Technology.* New York: Vintage Books, 1993.
- Powell, Brad. “Scott Francisco’s Sandbox: He’s Not Just Playing Around.” *Office Insight*. October 12, 2009. <http://current.officeinsight.com/pdf/archives/OI101209.pdf>
- Rae-Dupree, Janet. “Unboxed: Innovation Should Mean More Jobs, Not Less.” *The New York Times.* January 3, 2009.
- Rae-Dupree, Janet. “It’s No Time to Forget About Innovation.” *The New York Times.* November 1, 2008.
- Retica, Aaron. “Drone-pilot Burnout.” *The New York Times Magazine.* December 12, 2008.
- Rideout, et al. “GENERATION M2: Media in the Lives of 8- to 18-Year-Olds.” *Kaiser Family Foundation Study*. January 2010. <http://www.kff.org/entmedia/upload/8010.pdf>

- Rogoff, Barbara. *The Cultural Nature of Human Development.* New York: Oxford University Press, 2003.
- Sagoff, Mark. "Do We Consume Too Much?" *The Atlantic Monthly.* June 1997.
- Sennett, Richard. *The Corrosion of Character: The Personal Consequences of Work in the New Capitalism.* New York: W.W. Norton & Company, 1999.
- Sennett, Richard. *The Craftsman.* New Haven: Yale University Press, 2008.
- Sennett, Richard. *The Culture of the New Capitalism.* New Haven: Yale University Press, 2006.
- Stone, Brad. "Breakfast Can Wait. The Day's First Stop Is Online." *The New York Times.* August 9, 2009.
- Vanderberg, Willem H. *The Labyrinth of Technology*. Toronto: University of Toronto Press, 2000.
- Williams, Raymond. *Keywords: A Vocabulary of Culture and Society.* London: Croom Helm, 1968.
- Yesil, Bilge. "Workplace Surveillance, Inc.: Implications on Autonomy and How 'the Watched' Experience Surveillance Technologies." *Reconstruction.* 2002.

Endnotes:

[1] Peter Drucker, "The Discipline of Innovation," in *Harvard Business Review* (August 2002).
[2] Neil Postman, *Technopoly: The Surrender of Culture to Technology* (New York: Vintage Books, 1993), 58.
[3] The theme of this issue of *Reconstruction "I can always find out"* is based on the potential or perceived conflict between information accessibility and its greater consequence in education and society.
[4] These organizations include: Google, Jet Blue, GSK, Princeton University, University of Oregon College of Education, SUNY Buffalo, The GSA, Lilly, Pfizer, The Gap, Deloitte, The Canadian Broadcasting Corporation, The Government of Alberta, AllSteel, AIG, Fordham University, Disney/ABC Television Network, Sesame Workshop, Lojas Americanas, etc..
[5] Nicolas Carr, "Is Google Making Us Stupid?" The Atlantic Magazine, (July/August 2008)
[6] In his famous book *Keywords: A Vocabulary of Culture and Society* (London: Croom Helm, 1968), Raymond Williams described the emergence of a new vocabulary defining the new post war age and provided a lexicon of these new and definitive word/concepts. Innovation is certainly a keyword of our time.
[7] Teresa Amabile, *Creativity in Context* (Colorado, Oxford: Westview Press, 1996)
[8] An interesting tangent is the comparative study of American Pragmatism vs. Continental Theory and philosophy, specifically in the development of the polytechnic colleges and institutes in 19th century America, such as the Massachusetts Institute of Technology, where this author studied.
[9] As an example of innovation engendering and validating increased consumption, see: Mark Sagoff, "Do We Consume Too Much?" in *The Atlantic Monthly* (June 1997). Sagoff makes the outrageous claim that innovation will facilitate a continual increase in consumption, and that consequently we ought *not* to concentrate on curtailing consumption, but instead put our faith in innovation to save humanity and the planet.
[10] Janet Rae-Dupree, "Unboxed: Innovation Should Mean More Jobs, Not Less," in *The New York Times* (January 3, 2009). See also "Q+A: Is America Losing its Competitive Edge?" *Technology Review* (May/June 2010) where Intel CEO Paul Otellini makes similar claims.
[11] Nicole Baute, "Conference Board Gives Canada a D in Innovation," in *The Toronto Star* (Feb 2, 2010). See also: Derek Abma, "Canada Gets a D in Innovation," in *Financial Post* (February 1, 2010).
[12] *Ibid*. See also: Mutoko Rich, "Jobs Go Begging as Gap is Exposed in Worker Skills," in *The New York Times* (July 2, 2010)
[13] Cynthia Macdonald, "Fear of Numbers: Why do so many kids struggle with math?" in *U of T Magazine* (Autumn 2008). See also: Charles Murray, "Why Charter Schools Fail the Test," in *The New York Times* (May 4, 2010).
[14] Wikipedia, "One Laptop per Child," <http://en.wikipedia.org/wiki/Olpc> and OLPC, "Mission," <http://www.laptop.org/en/vision/mission/index.shtml>.
[15] Stan Beer, "War of words between aid organization and OLPC erupts," in *iTWire* (January 24, 2007).
[16] Lee Felsenstein, "Problems with the $100 Laptop," *The Fonly Institute* (November 10, 2005).
[17] See also: Larry Cuban, *Oversold and Underuse; Computers in the Classroom,* Harvard University Press*,* 2001
[18] There are thousands of these projects initiated from inside and outside developing countries. One example that the author is familiar with is The Mully Children's Family in Kenya. Started by a local business man several decades ago, the program places strong emphasis on hands-on training and skills to rehabilitate and reintegrate 1000's of orphaned children into society. Masonry, sewing and sustainable agriculture are two of the many training areas. Another example is the Yana Puma organization in Ecuador which emphasizes an integrated approach basedon hands on participation and collaboration: http://www.yanapuma.org/en/PhilMethods.php
[19] This quote is both attributed to, and denied by, Peter Drucker.
[20] Google, "History of Google Books," <http://books.google.com/intl/en/googlebooks/history.html>. See also: Simon L. Garfinkel, "A Less Personal Computer" MIT Technology Review (May/June 2010). Garfinkel discusses the ominous development of Google's monopoly and privacy invasion via the new Chrome operating system.
[21] Stephen Baker, "Managing by the Numbers: How IBM Improves Productivity by Tracking Employees' Every Move," in *Business Week* (September 8, 2008). Article is an excerpt from book by the same author, *The Numerati* (New York: Houghton Mifflin, 2008).
[22] Ken Belson, "With Wireless Network, City Agencies Have More Eyes in More Places," *The New York Times* (June 28, 2008).

[23] For a detailed account of knowledge as a social network, see: Cross, Parker, Prusak, Borgatti, "Knowing What We Know: Supporting Knowledge Creation and Sharing in Social Networks," *The Darden Foundation* (2002). Originally published in *Transforming Culture: An Executive Briefing on the Power of Learning* (June 2002).
[24] Jacques Ellul, *The Technological Bluff* (Grand Rapids: W. B. Eerdmans, 1990), 146
[25] Theorists tend to split radically on the concept of the "inhuman." The dominant postmodern view, originating in Foucault, embraces the inhuman or "transhuman" as an elevation above, or deconstruction of, repressive structures and power relations of traditional culture. The work of Judith Butler or Donna Haraway's *A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century* (1985) are prime examples. The other view laments and warns against the decline of human value-centric modes of communication and culture. Ivan Illich's *Tools for Conviviality* (1973) offers one such manifesto on the relation between people, culture and a technology, as does Ursula Franklin's *The Real World of Technology* (1990) and Neil Postman's *Technopoly* (1993).
[26] Ivan Illich, *Tools for Conviviality* (New York: Harper & Row, 1973), last paragraph of Section 2: "Two Watersheds".
[27] Grantham et al, *Corporate Agility* (New York: Amacom, 2008), front cover leaf.
[28] *Ibid.* 36.
[29] "PeopleCube: The Need for Workplace Business Intelligence," white paper, <http://www.peoplecube.com/solutions-facility-management.htm>.
[30] See also: John Allen Paulos, "Metric Mania," *The New York Times Magazine* (May 16, 2010).
[31] Richard Sennett, *The Culture of the New Capitalism* (New Haven: Yale University Press, 2006), 51.
[32] Bilge Yesil, "Workplace Surveillance, Inc.: Implications on Autonomy and How 'the Watched' Experience Surveillance Technologies," in *Reconstruction* (2002).
[33] Scott Francisco, "Place in the Face of Obscure Dependencies," in *DEGW Insights vol. 4* (2008).
[34] Gary Wolf, "The Data Driven Life," *New York Times Magazine* (April 26, 2010)
[35] Dr. Marie Puybaraud, *Flexible Working 2010*, Jonson Controls Global WorkPlace Innovation, 2011
[36] Tony Davila, Marc J. Epstein and Robert Shelton, *Making Innovation Work: How to Manage It, Measure It, and Profit From It* (Upper Saddle River: Wharton School Publishing, 2005).
[37] "Pervasive computation" has been an encompassing theme for Bill Mitchell (and his students at MIT). This can be tracked in at least his three latest books: *Me++: The Cyborg Self and the Networked City* (2003), *e-topia* (2000), and *City of Bits: Space, Place, and the Infobahn* (1995), as well as in his various MIT Media Lab projects and curriculum.
[38] Numerous reports challenge the lifetime energy efficiency of the Prius. See: CNW Research's "CNW's 'Dust to Dust' Automotive Energy Report," <http://www.cnwmr.com/nss-folder/automotiveenergy/>. In my view the first report, by Oregon based research group CNW, showing the Hummer to be more efficient than the Prius, simply highlights the complexity that attends the introduction of supposedly efficient new consumables. While I am not supporting the conclusion, the point is that the context and boundaries of consumption are plastic, allowing wide variation in interpretation. For this reason there has been much concern over the attempt of systems like LEED to measure and designate energy consumption. (For a similar analysis of the iPad see: Daniel Gloeman and Gregory Norris, "How Green is my iPad," *The New York Times* (April 4, 2010)).
[39] See also Scott Francisco, "Place in the Face of Obscure Dependencies," in *DEGW Insights vol. 4* (2008), <http://www.degw.com/press_insights_article.aspx?id=8801>. (Written one year before the Prius' fall from grace).
[40] Tony Davila, Marc J. Epstein and Robert Shelton, *Making Innovation Work: How to Manage It, Measure It, and Profit From It* (Upper Saddle River: Wharton School Publishing, 2005).
[41] Judy Estrin, "Innovation is not Optional," in *Closing the Innovation Gap: Reigniting the Spark of Creativity in a Global Economy* (New York: McGraw Hill, 2009), 1-6.
[42] Richard Florida, *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life* (New York: Basic Books, 2002), 22. "The social and cultural milieu provides a mechanism for attracting new and different kinds of people and facilitating the rapid transmission of knowledge and ideas." (*Ibid*. 55)
[43] *Ibid*. 91.
[44] *Ibid*. 32-43.

[45] *Ibid*. 95.
[46] *Ibid*. 55.
[47] Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (New York: Oxford University Press, 2005), 77.
[48] Malcolm Gladwell, *The Tipping Point* (New York: Back Bay Books, 2002) 160.
[49] Jamshid Gharajedaghi, *Systems Thinking* (Oxford: Elsevier, 2006), 12 [italics added].
[50] Jamshid Gharajedaghi, *Systems Thinking* (Oxford: Elsevier, 2006), 85.
[51] Jamshid Gharajedaghi, *Systems Thinking* (Oxford: Elsevier, 2006), 37 [italics added].
[52] The concept of declining innovation is presented by Janet Rae-Dupree, "It's No Time to Forget About Innovation," in *The New York Times* (November 1, 2008).
[53] I first presented Gharajedaghi's "purposeful/social model" surpassing the "biological model" not to discredit the "Innovation Ecosystem" but rather to focus on the specific utility of the 'ecosystem' metaphor: Accepting quantum physics does not require us to reject the Newtonian model - which is often a more practical tool.
[54] Judy Estrin, *Closing the Innovation Gap: Reigniting the Spark of Creativity in a Global Economy* (New York: McGraw Hill, 2009), 3.
[55] Verlyn Klinkenborg, "The Vanishing Point," *The New York Times Style Magazine* (March 26, 2010). The Cane Toad is said to be responsible for depletion of numerous species including birds and reptiles. Kinkenborg describes "native wildlife population on the verge of collapse."
[56] Ideo, "Interaction Designer," <http://www.ideo.com/culture/careers/>.
[57] Albert Brogmann describes "focal things and practices" throughout his work, notably in: *Holding On to Reality: The Nature of Information at the Turn of the Millennium* (University of Chicago Press, 1999), 20.
[58] Philosopher: Ludwig van Wittgenstein; Musicians: *Talking Heads'* David Byrne et al, "Weird Al" Yankovic; Fashion design: Pierre Cardin, Gianni Versace; Artists: Dan Graham, Gordon Matta-Clark, Marcel Odenbach: Furniture designer: Charles Eames; Playwright: Robert Wilson, Max Frisch
[59] Scott Francisco, *Useable Space: Culture Versus Technique in Pursuit of Design,* SMArchS Thesis, (MIT, 2005)
[60] Laurence Prusak and John Seely Brown, *Storytelling in Organizations: Why Storytelling is Transforming 21st Century Organizations and Management* (Oxford: Butterworth-Heinemann, 2004), 69.
[61] The growing emphasis on specific, specialized and technical skills/knowledge is a commonplace critique in academia and pedagogical discourse.
[62] The concept of a "generative language" of innovation follows Noam Chomsky's linguistic model of a "generative grammar" as the basis of human language. Chomsky argues that despite tremendous variation in spoken languages there lies a core grammar in common to all that provides a foundation to language in general. I am arguing that complex problem solving has a similar foundation and that this foundation is primarily cultivated in socio-spatial environments.
[63] A detailed account of this can be found in: Eldon C. Hall, "From the Farm to Pioneering with the Digital Control Computers: An Autobiography," *IEEE Annals of the History of Computing* (Volume 22, Issue 2, April 2000).
[64] Howard P. Chudacoff, *Children at Play*: *An American History* (New York: NY University Press, 2007)
[65] Ibbid; pg 187. See also: Rebeca Mead "State of Play" *The New Yorker,* (July 5, 2010)
[66] Mark Hertling interviewed by Scott Simon, "New Basic Training Hardens 'Softer Generation'," *Weekend Edition Saturday*, *NPR* (March 20, 2010).
<http://www.npr.org/templates/story/story.php?storyId=124923602&ft=1&f=1049>
[67] Aaron Retica, "Drone-pilot Burnout," *The New York Times Magazine* (December 12, 2008).
[68] BIM (Building Information Modeling): a parametric tool for designing buildings and producing construction documents; 3DStudioMax, Maya and Rhino are 3D modeling and rendering softwares.
[69] Discussion by 10 leading architects speaking on the future of the profession at the "Designer Pages" Conference in NYC, April, 2010.
[70] See also: Roger Martin, *The Opposable Mind: Winning Through Integrative Thinking* (Cambridge: Harvard Business Press, 2009).
[71] Laurence Prusak and John Seely Brown, *Storytelling in Organizations: Why Storytelling is Transforming 21st Century Organizations and Management* (Oxford: Butterworth-Heinemann, 2004), 66. This is a wonderful summary of these relationships within an architecture studio from a non-architect's perspective.

[72] Richard Sennett, *The Craftsman* (New Haven: Yale University Press, 2008), 241-267.
[73] Scott Francisco, "The Way We Do Things Around Here: Craft Culture Versus Specification in the History of Building," *American Behavioral Scientist.* (2007).
[74] It is these basic tasks that are both most subject to automation, and most useful for the early training of apprentices. The elimination of these simple 'redundant' or 'inefficient' tasks poses a serious risk to incremental 'learning by doing'. In architecture this was often repetitive drawing tasks or model building, which have been all but eliminated from most architecture offices and replaced by integrated computing.
[75] Richard Sennett, *The Craftsman* (New Haven: Yale University Press, 2008), 289. See also: Matthew B. Crawford, "The Case for Working With Your Hands," *The New York Times Magazine* (May 21, 2009).
[76] Richard Sennett, *The Corrosion of Character: The Personal Consequences of Work in the New Capitalism* (New York: W.W. Norton & Company, 1999), 72.
[77] This topic is covered in great depth by the work of Theresa Amabile in *Creativity in Context* (1996) where she explores both 'stimulants and barriers' to creativity. Also see Tom Kelley, *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm* (New York: Random House, 2001).
[78] David Pender, "Emerging Themes in Inter-firm Collaboration" (University of Adelaide, Australia).
[79] This critical topic of narrative in this context is addressed by several authors, particularly Robert Fulford in *The Triumph of Narrative, Storytelling in the Age Of Mass Culture* (1999), Prusak and Brown in *Storytelling in Organizations* (2004) and Richard Sennett's more academic *The Corrosion of Character* (1999) and *Culture of the New Capitalism* (2006).
[80] Brad Powell, "Scott Francisco's Sandbox: He's Not Just Playing Around," in *Office Insight* (October 12, 2009). <http://current.officeinsight.com/pdf/archives/OI101209.pdf>
[81] See: George Lakoff and Mark Johnson, *Metaphors We Live By* (Chicago: University of Chicago Press, 1980).
[82] Estrin's and others' research points out that America is *not* leading in innovation. I do not want to pin my argument on this contestable fact, but instead focus on the complexity and illusions of the relationship between perceived success and the environment that sustains it.
[83] Tina Butler, "Overstaying Their Welcome: Cane Toads in Australia," *www.mongabay.com* (April 17, 2005).
[84] Wikipedia, "Larry Page," <http://en.wikipedia.org/wiki/Larry_Page>.
[85] This speculation is *not* researched, but instead is posed as a dare to one who would like either pose a counter-argument to the Innovation Paradox, or reinforce the thesis. I will be waiting to hear from you...
[86] Dalton Conley, *Elsewhere, U.S.A.: How We Got from the Company Man, Family Dinners, and the Affluent Society to the Home Office, BlackBerry Moms, and Economic Anxiety* (New York: Pantheon, 2009).
[87] Brad Stone, "Breakfast Can Wait. The Day's First Stop Is Online," *The New York Times* (August 9, 2009).
[88] L. Bellow and J. Roach, "Childhood Overweight," Colorado State University Extension (2009). <http://www.ext.colostate.edu/pubs/foodnut/09317.html>
[89] Betty Hart and Todd R. Risley, *The Early Catastrophe: 30 Million Word Gap* (American Educator, Spring 2003). <http://archive.aft.org/pubs-reports/american_educator/spring2003/catastrophe.html>
[90] *Ibid*. Italics added by author.
[91] Amanda Lenhart, "Teens, Cell Phones and Texting," *Pew Research Center* (April 20, 2010). <http://pewresearch.org/pubs/1572/teens-cell-phones-text-messages>
[92] Sharon Otterman, "On Reading Test, Mixed Results Under Bloomberg," *The New York Times* (May 20, 2010).
[93] For a complete study on the role of culture on learning and creativity see Barbara Rogoff, *The Cultural Nature of Human Development* (New York: Oxford University Press, 2003).
[94] For an overview of latest thinking with numerous supporting books and studies, see: Michiko Kakutani, "Texts Without Context," *The New York Times* (March 21, 2010).
[95] John Lorin, "Driven To Distraction," *Walrus Magazine* (April 2007).
[96] *Ibid*.
[97] Matt Richtel, "Hooked on Gadgets, and Paying a Mental Price" *The New York Times* (June 6, 2010)
[98] Walter Kirn, "Autumn of the Multitasker," in *The Atlantic* (November 2007).
[99] Rideout, Ulla, Foehr, and Roberts, "GENERATION M2: Media in the Lives of 8- to 18-Year-Olds," *Kaiser Family Foundation Study* (January 2010). <http://www.kff.org/entmedia/upload/8010.pdf>

[100] Maggie Jackson interviewed by Brandon Keim, "Digital overload is Frying our Brains," *Wired Magazine* (February 6, 2009).
[101] Neil Postman, *Technopoly: The Surrender of Culture to Technology* (New York: Vintage Books, 1993),
[102] Judy Estrin, *Closing the Innovation Gap: Reigniting the Spark of Creativity in a Global Economy* (New York: McGraw Hill, 2009).
[103] Barely scratching the surface of 'Tech' conferences in 2010: *PopTech; TED; EduCause (Technology in Education); FutureTech; WorkTech; Brainshare; Interact; TechEd; MacWorld; LotusSphere; VM World; IT Expo; Cisco Live…*Likewise, a search of "Innovation" books on www.Amazon.com (initial search shows 39,000 results)
[104] *The Terminator* Series (1984-); *The Matrix* (1999); *Waterworld* (1995); *The Road* (2009); *Idiocracy* (2006); *28 Days Later* (2002); *Avatar* (2009); *Children of Men* (2006); *La Dernier Combat* (1983); *I am Legend* (2007); *Book of Eli* (2010), etc.
[105] Jacques Derrida on Deconstruction: "The movements of deconstruction do not destroy structures from the outside…they are not possible or effective, nor can they take effective aim except by inhabiting these structures…Inhabiting in a certain way…borrowing all of the economic and strategic resources…borrowing them structurally " -Jacques Derrida, *Of Grammatology*. trans. Gayatri Spivak (John Hopkins University Press, 1976) p. 24.
[106] *Guitar Hero; Kung Fu Master, Grand Theft Auto*; *SIM City; Second Life;*
[107] See Mutopo < http://www.mutopo.com/>.
[108] Neil Postman, *Technopoly: The Surrender of Culture to Technology* (New York: Vintage Books, 1993).