Strategic Innovation and the Autocatalysis of Vision and Technology: A Design Ecology Approach

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Alexander Manu (2007a &b) in developing his ideas on strategic foresight framework and pre-competitive innovation has made a very cogent and important critique of the pursuit of innovation. He has correctly pointed out that innovation for the sake of innovation or to gain a competitive edge in the marketplace does not lead to any breakthroughs and at best merely mitigates existing problems. He also argues convincingly that the problem lies with a lack of imagination and vision and that the focus on innovation has been tactical rather than strategic. Manu (2007b) articulates his criticism by way of saying "that tools now drive vision instead of the other way around." I agree with this assertion but tools still have a role to play in creating a vision – not the dominant role – perhaps a supporting role – but one that cannot be ignored. This is not to suggest that Manu is unaware of the stimulation of extant tools but rather to emphasize the dual role of vision and tools in the emergence of innovation that is both strategic and tactical. Manu (2007b) clearly understands the need for the tactical component when he writes, "Once a company has explored possibility and articulated a vision, the exploration and the articulation of possibility becomes the strategic framework on which tactical innovation is performed."

We agree with Manu that the relationship between tools and innovation must change so that innovation is neither driven by technology nor bound by it. The purpose of this article is to add additional insight to Manu's observations by making use of recent work in formulating the notion of design ecology (Logan and Van Alstyne In preparation & Van Alstyne and Logan 2007). Van Alstyne and I have identified ten elements in Table 1 below that are key to the emergence of a design ecology that leads to innovation. Our work suggests that the relationship between tools and vision is not that one drives the other but rather that true innovation occurs when tools and vision coevolve and autocatalyze each other. New tools emerge because of a vision of a better way to do things. But once new tools are created a new environment emerges and new visions become possible and in this manner tools and vision coevolve. The tools and the vision form an autocatalytic set because the set of tools or technologies that form the technosphere catalyze new visions and visions in turn catalyze the creation of new tools. This mutual relationship of coevolution and autocatalysis has been described by Tomasello (1999, p. 5) as the "ratchet effect".

> The process of cumulative cultural evolution requires not only creative invention but also, just as importantly, faithful social transmission that can work as a ratchet to prevent slippage backwards—so that the newly invented artifact or practice preserves its new and improved form at least somewhat faithfully until a further modification or improvement comes along.

Table 1. The components of the design ecology:

1. the designer as catalyst,
2. the intentionality of the client* and client as catalyst,
3. the needs, desires and expectations of potential users that are either explicit or possibly latent including considerations of popular culture, fashion, aesthetics, novelty and pleasure of use.
4. current and past products, services, systems and processes of the culture, i.e. the technosphere,
5. creativity and psychological factors impacting on the designer such as imagination and vision as pointed out by Alexander Manu (2007b).
6. design research
7. the engineering resources of the client and the constraints of natural law,
8. the client's marketing resources,
9. the dynamics of the marketplace, price and the community as a whole including the role of government,
10. the client's financial resources, management skills and its ability to collaborate with the design team,

* The client is the organization that will commercialize through manufacturing and marketing the designer's innovation. It is sometimes the case that the designer is a member of the organization that will commercialize the designer's product or service or will exploit the designer's process or system. In almost all cases the design team will be a separate unit from the one commercializing the design team's design. Every once in awhile as was the case with Thomas Edison and Cyrus McCormick, the inventor of the reaper, or more recently with the inventors of Google, the designer will start a company to exploit their invention(s).

The autocatalysis of vision and tools that we suggest is required for innovation entails consideration of items the following items of Table 1.: 3 (the users), 4 (the technosphere) and 6 (creativity). In our original formulation of Table 1 we used the term creativity and psychological factors for item 6 but we have since incorporated Manu's language and added the terms imagination and vision as they are more descriptive. We believe that the use of the term technosphere is more appropriate than the term tools when talking about innovation and the autocatalysis of technology and imagination or vision. The reason for this choice is that the technosphere as a whole has historically stimulated innovators' imagination and contributed to the development of their visions of new innovations. One of the objectives of this article is to demonstrate this. We will support this argument with some of the examples that George Basalla (2002) develops in his book *The Evolution of Technology*. His position is that breakthrough innovations are not the product of a single heroic and insightful inventor but rather a product of the slow accretion of ideas in the technosphere by many different contributors.

A central thesis of Kauffman (2000, p. ???) book *Investigations* is the existence of an Adjacent Possible in the biosphere, which is defined in the following manner:

> Autonomous agents forever push their way into novelty—molecular, morphological, behavioral, organizational. I will formalize this push into novelty as the mathematical concept of an 'Adjacent Possible," persistently explored in a universe that can never, in the vastly many lifetimes of the universe, have made all the possible proteins sequences even once, bacterial species even once, or legal systems, even once. Our universe is vastly nonrepeating; or… nonergodic.

Kauffman (2000, p. 54) extends this claim for the technosphere. "Science, technology, and art tumble into the Adjacent Possible in roughly equal and yoked pace." Thus the generation of new tools and technologies is not by way of imagination and vision alone but also through the stimulation of a knowledge of the technosphere through the agency of the innovators.

Our thesis is that innovation arises from the autocatalysis and coevolution of technology and vision fueled by imagination and driven by a vision. Given that technology or the "how" drives the tactical and vision and imagination or the "what" drives the strategic then perhaps it is not a question of strategic versus tactical innovation but rather a mix of the two. In terms of military campaigns where the terms of strategy and tactics were first used the day could only be carried by the formulation of a winning strategy coupled with the appropriate tactics to realize the objectives of the strategy. The etymology of strategy is from the Greek word for a military general "strategos". The etymology of tactics is also from the Greek: "taktikos" for order and "taktos" for arranged. Merriam Webster defines strategy as "the science and art of using all the forces of a nation to execute approved plans as effectively as possible during peace or war." Whereas they define tactics as "a method of employing forces in combat." In addition to these definitions related to military activity there are also definitions of strategy and tactics used for the business or political arena. Strategy is defined as "a careful plan or method" and tactics is defined as "a device for accomplishing an end". The strategy is the vision and the tactics are the tools.

Successful innovation is not a question of strategy versus tactics but rather the integration of the two. One by itself will not carry the day and so for successful innovation one must have both a strategy that encompasses imagination and a vision as Manu points out and associated tactics in the form of appropriate technology. The strategy guides what one wants to do or create and tactics provide the how – how one will realize the successful completion of the strategy. The most important part of the vision is the ability to read ahead of time the needs and desires of the potential users of the planned innovation.

The strategy or the vision for innovation entails risks and the ability to think outside the box. It is not a safe road, which is why many disdain to travel it and are content to pursue the safety of a tactical innovation in the hope to gain a competitive advantage in the marketplace. This is the reason that most innovations are sterile and lead nowhere as has been pointed out by Manu (2007b). Tactical innovations are more straightforward, less risky and based on prior experiences. This is why when exploring a new and dangerous territory and formulating a strategic innovation it is important to fall back on proven tactics by making use of trusted and proven tools. Tactics are the actual way on the

ground in which strategies are executed. To summarize: strategy determines what to do and tactics how to do it. Both are needed to achieve one's objectives and they must be mutually self-supporting. A vision without the means to achieve it for lack of the right tools leads to fantasy. And good tactics without a vision is sterile and do not lead to an innovation worthy of the name.

Let us now turn to practical illustrations of these ideas with some concrete examples of successful innovations that were products of both a vision and imagination as well as the successful deployment of elements from the technosphere.

Concrete Examples of Visionary Innovations

We agree with Manu (2007b) when he writes, "It was the destination that has created our tools and not the tools themselves." The key word here is "themselves" because tools by themselves without a vision do not lead to new innovative tools. But one must also bear in mind that it is the array of tools in the technosphere that can stimulate the imagination of the innovator and lead to the creation of a new tool. We will first illustrate this idea with some of the examples Manu cites, namely, the passage around Africa, manned space travel to the moon, Google's capacity to search the Web and the introduction of electricity. We will show in each case that there was a solid prior technological base to each of these breakthroughs that when coupled with imagination and a vision led to the emergence of the next significant innovation in the technosphere. In each case what stimulated the imagination and created the vision that led to a new innovation was not just the tools in the technosphere but some form of human social or psychological motivation, i.e. the desire for a new destination.

Astronomical observations and an improved understanding of the heavens suggested by the Copernican revolution led to advances in navigation and made the finding of a passage around Africa to the riches of the Orient possible. But without the motivation of the riches that arrived in Europe on the overland trade route known as the Silk Road there would have been no motivation to find an easier route to the Orient via a passage around Africa.

The vision of manned space travel to the moon would never have crossed anyone's mind if it were not for the advances in rocketry that the Germans developed during World War II in terms of the V2 rockets that terrorized London. Actually it did cross the mind of Jules Verne but given the lack of any possible technology to achieve such a feat his suggestions fell into the realm of fantasy rather that a vision to achieve a practical objective. Another motivation for a manned mission to the moon was the American's desire to prevail in the Cold War especially after the successful launch of Sputnik by the Soviets with the help of their German rocket experts. Kennedy's vision was a strategy in the original sense of a military stratagem.

The technological ground for the Google breakthrough was certainly the Internet and the World Wide Web coupled with their incredibly rapid and universal adoption. But the final bit of technology that made the Google vision possible was the technical capability

of creating a unique search algorithm by two brilliant computer scientists Brin and Page. The motivation was to create a tool that allowed users to access the information they needed from the vast storehouse of information on the Internet. This motivation that addressed the needs of millions of users coupled with the brilliant business acumen of Google to monetize their service through targeted advertising created their immensely successful innovation. Here is another example of the technical innovation preceding the vision.

Finally we turn to electricity, which as Manu (2006) points out "was developed, structured and integrated to speed things up and make them more powerful." But there was another revolutionary innovation that flowed from electric technology, namely ubiquitous electricity distributed from central generating stations to every home and business in the land. At first each factory that exploited electric power had their own local electric generators. It was Edison who created the vision of electric distribution inspired by an earlier technology namely gas lamps and the gas distribution system. Gas lighting for the home was achieved by creating a distribution system that allowed every home and business to enjoy the lighting of gas lamps. Edison who invented the light bulb realized the way to create a market for his new invention was to copy the distribution system of gas for gas lamps but apply it to electricity. He carefully calculated how he could compete with the gas lamp price-wise knowing that the increased safety from fire and the absence of the unpleasant smell of gas would give him an automatic market advantage. The real impact of his innovation was not just lighting with electric light bulbs but also the electric distribution system, which made electricity ubiquitous and paved the way for household appliances and entertainment and communication systems in the form of radio, the phonograph, the telephone and eventually television and personal computers. Edison's development of the electric distribution system is a perfect example of how an idea plucked from the technosphere coupled with an imaginative idea to provide a service that users were ready to accept led to one major innovation, home electric lighting and consequently led to a number of other innovations represented by electric powered household appliances and communications systems.

The phonograph provides another interesting example of the need to couple technology with the right vision. Edison invented the phonograph, which he envisioned would be used in offices much as dictaphones were later used. It turned out that this was not a very popular idea with the business community at the time. The killer app for the phonograph turned out to be recorded music. Here is a clear example where the technology preceded the vision but the technology eventually generated the successful vision. I believe it is an excellent example that illustrates our thesis that the tool and the vision can co-evolve and that one can drive the other but true innovation requires both.

Edison was also one of the inventors of movies and at first created a monopoly of the film industry on the East Coast of the USA, which excluded the participation of Jews. The Jews interested in making movies moved out to Hollywood and created a new vision for this technology as a dream machine. Like their ancestor Joseph who was sold into slavery in Egypt and interpreted Pharaoh's dream they interpreted the American dream, a new myth that came to dominate American life and became one of America's most

important exports. Their innovation took hold only after the technology had been developed by Edison and others like the Lumiere brothers in France.

Another interesting example is the story of the MP3 player and the iPod. Here is another example of the technology preceding the vision. The iPod did not really represent a technological breakthrough. The technological innovation was the MP3 player but Steve Jobs added a vision to the MP3 player and created the iPod revolution. He exploited design ecology either by calculated design or by intuition. In either case he understood the needs of his potential users and he waged a masterful marketing campaign making sure the mechanics and engineering of creating and distributing the product were flawlessly executed. Adding to the success of iPod was the fact that a short time before its introduction Apple created iTunes. iTunes was another revolution, which transformed music distribution into a service rather than a product and made the iPod even more attractive.

The last example that we will consider is the Gutenberg movable type printing press and its role as one of the forerunners of the Industrial Revolution. The technologies from which the Gutenberg movable type printing press descended were the silk textile press, the grape press for winemaking and Chinese block printing press for text. The Gutenberg press met the needs of a new reading public spawned by the emergence of the medieval university and the Renaissance of classical learning both of which trends the printing press reinforced creating an even bigger market for it and the books that it produced. The printing press also found other applications as the producer of the family Bible and the propagation of the Protestant Reformation. The press also met the needs of scientists to capture and store their data in a reliable format that could be reproduced without errors.

The innovation was not just the product of Gutenberg's mechanical skills and inventiveness but also of his business partner's commercial acumen, who wrested control of one of the presses from Gutenberg in a civil suit. Fust used that press to print a 1000 Bibles which he sold in Paris for a huge profit and started the new industry of book publishing. Gutenberg continued to improve his invention and died a poor man.

Perhaps Gutenberg's greatest impact of all was the fact that the Gutenberg press was the first tool of mass production creating absolutely identical manufactured products, namely multiple copies of the same book. It also achieved this feat by mass-producing the type fonts used in the press by pouring hot lead into molds. The printing press served as a model for mass production (McLuhan 1962 and Logan 2004).

Conclusion: Innovation is a product of design ecology and the autocatalysis of visions and tools and of strategies and tactics. Tools give rise to new needs and new visions which in turn give rise to new tools which in turn lead to still more new visions and so on and so forth. In this way tools and visions co-evolve.

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