International Workshop on Accelerated Radical Innovation
March 10-12, 2005, University of Toledo, Toledo, OH

What is Accelerated Radical Innovation?

The upcoming March 10-12 International Workshop on Accelerated Radical Innovation is intended to build upon the foundation that our community of research and practice has laid down over the past year – at our first conference in Charleston last May and since. One of the major points of discussion among the participants is, what *is* radical innovation, and what do we mean by *accelerated* radical innovation. For the benefit of workshop participants, whether you have been working with us all along or are just joining us, here is a summary our collective conclusions.

Just what do we mean by radical innovation?

(source: Bers and Dismukes 2004)

There was vigorous debate at the Charleston conference regarding the scope and definition of radical innovation, various aspects of which were addressed in almost every paper. One conferee reported that during his doctoral dissertation research, he had uncovered 150 definitions of radical innovation. The conferees agreed that for an activity to qualify as innovation *per se*, it must transform research into utility and encompass not only discovery or invention but also development and profitable commercialization over a reasonable time period. As to what makes an innovation *radical*, the conferees took as a point of departure the working definition formulated by the RPI Radical Innovation Research Project: an entirely new set of performance features; improvements in known performance features of five times or greater; or a significant (30 percent or greater) reduction in cost (Leifer 2000). But they also stressed the disruptive quality of radical innovation ("outside the predicted pattern," "discontinuous," "changes the game," "requires behavioral change") and the high likelihood of significant societal impact ("transforming," "accepted by society," "sustainable"). This discontinuous change can occur along at least one of several dimensions:[1]

a. Values (e.g., DuPont promoting environmental and sustainability values as key, enduring targets)
b. Markets (e.g., Sony Walkman instigating brand new uses and users)
c. Users (e.g., capabilities devised for military or space applications finding commercial buyers)
d. User Behavior (e.g., typists become word processors)
e. Uses or Functions (e.g., weak adhesive enabling Post-Its)
f. Technologies (e.g., nano-layer coatings)
g. Processes (e.g., automating major chunks of a production process)
h. Producing organization behaviors (e.g., DuPont strives to do away with their NIH syndrome)

[1] Courtesy of conferee Alan Porter, Georgia Institute of Technology.

Radical innovation often differs from traditional incremental innovation in another sense – much of radical innovation is *driven by science and scientific technology* (Betz 2003 25-45). Radical innovation in such fields as biotechnology and nanotechnology, for example, cannot proceed without a fundamental understanding of the underlying physical or biological phenomena. Unlike most incremental innovation, which is based either on well-developed science or existing technology, radical innovation makes a more dramatic impact on innovation performance by explicitly linking directly into the concurrently expanding scientific frontiers of pure and user-inspired basic research (e.g. bioscience, nanoscience, etc.). The conferees agreed on one other thing - that a radical innovation is a large enough leap forward that it cannot be accomplished merely by pushing traditional incremental innovation approaches to their limit. Radical innovation *is* a truly distinct phenomenon that requires us to think about it and approach it in different ways. This consensus calling for a different paradigm for radical innovation provided the rationale and point of departure for the conference.

Examples of radical innovation (historical and current)

(source: Bers, 2004)

Historical examples of radical innovation

The results of radical innovation in the past - from biotechnology to communications and information technology - pervade our everyday lives. Some familiar examples include…

Biotechnology

Pasteur's breakthroughs in the microbiology of disease

Solved the mysteries of rabies, anthrax, chicken cholera, and silkworm diseases, and contributed to the development of the first vaccines; set the stage for modern biology and biochemistry. (http://www.accessexcellence.org/AB/BC/Louis_Pasteur.html)

Telecommunications

Cellular mobile telecommunications

Planning begun in mid-1940's, first trials begun 1978, first U.S. deployment 1984. Has revolutionized telecommunications and extended the global voice communications network to hundreds of millions of subscribers around the world. (http://www.privateline.com/Cellbasics/Cellbasics.html, http://www.privateline.com/PCS/history.htm)

Information technology

The stored program computer (von Neumann architecture)

This architectural breakthrough by John von Neumann in the 1930's and 1940's ushered in the computer age. This basic design is at the heart of every computer from mainframes and supercomputers to personal computers, laptops, personal organizers, and digital cell phones. (http://ei.cs.vt.edu/~history/VonNeumann.html)

The Internet/World Wide Web

The World Wide Web of today is the product of a series of breakthroughs in computer-to-computer communications starting in the 1960's (Ethernet, Internet Protocol, local area networks, routers); the creation of the hypertext transfer protocol (http), the hypertext markup formatting language (HTML), and the universal resource locator document addressing system (url) by Timothy Berners-Lee in 1989-90; and the design of Mosaic, the first commercial browser and predecessor of the Netscape Navigator, by Marc Andreesen and other graduate students between 1992 and 1994. (http://www.ibiblio.org/pioneers/lee.html).

Where radical innovation is going – some contemporary examples

Dramatic as these examples are, the pace of radical innovation shows no sign of abating. With the new millennium we are entering a golden age of radical innovation – across a broad range of disciplines.

Information/communications technology

The introduction of broadband wireless communications networks (third generation cellular and other schemes) could eventually offer humanity instantaneous, low-cost access to limitless information and connectivity to others around the world.

Renewable energy sources

Work currently under way could lead to clean, renewable energy sources, reducing dependence on depleting sources of fossil fuels and their adverse impact on the global environment. (http://www.emagazine.com/january-february_2003/0103feat1.html)

Genomics

Public and private efforts at mapping the genome of various species are leading to applications in the fields of disease prediction, diagnosis and intervention; agriculture; livestock breeding; food bioprocessing; waste control and environmental cleanup; and new energy sources. (http://www.ornl.gov/sci/techresources/Human_Genome/medicine/medicine.shtml)

Nanotechnology

"The science and technology of precisely controlling the structure of matter at the molecular level" offers promising applications in health, electronics, transportation, the environment, and national security. (http://www.nanotechnology.northwestern.edu/)

Challenges facing Radical Innovation

The lag between the creation and exploitation of new science.

As the historical examples of radical innovation show, decades can separate scientific development from its exploitation for commercial application – a gap to which the innovation community ruefully refers as the "Valley of Death." The two processes often occur in different worlds (universities and industry, for example). Exploitation of new scientific developments is often held up until requisite complementary technologies are developed. The notable exception is Pasteur's innovation, perhaps the first conscious science-based radical innovation, which pointed the way to a new integration of these disparate disciplines into a new form of radical innovation that we term accelerated radical innovation (Stokes 1997, 57-58).

Learning to manage radical innovation as a disciplined process in the current results-oriented business/financial environment.

Traditional "command and control" and do-it-all-yourself models lack the flexibility to adapt to the risk, the pace, and the chaotic nature of radical innovation.

Developing and validating the tools and processes required to manage radical innovation.

Taken together, these tools and processes will make radical innovation a *manageable, repeatable, transferable*, and *teachable* process on a par with other knowledge-based disciplines.

Moving beyond the traditional (closed) business model.

Radical innovation exceeds the specific capabilities of even the largest, best-endowed firms. And so, even as we learn to manage radical innovation within the existing business environment, we must find ways to open that environment to collaborative, networked models of innovation (across business partners, cultures, academia, etc.) (Chesbrough 2003).

Creating a receptive public environment for the deployment of RI.

Considering how disruptive radical innovation can be to existing practices, it requires a mindset of receptiveness, understanding, and openness to change at *all* levels of society. An early implementation of genomics, genetically modified organisms, got off to an inauspicious start when it encountered massive public opposition in many countries despite this innovation's potential for eradicating hunger and creating healthier, more affordable food.

Accelerated radical innovation - a new way of doing business!

In the past few decades a variety of new approaches to management practice (such as total quality management, lean manufacturing, and enterprise resource planning) have yielded order-of-magnitude impacts – five-to-tenfold improvements in such metrics as cycle time, cost, performance, and/or technical/market risk.[2] If radical innovation could be put on a similarly sound foundation of principles, tools, and processes, it would not be unreasonable to expect similar leaps in critical business metrics. We refer to this new approach as **Accelerated Radical Innovation *(ARI)***. Once radical innovation is put on a sound conceptual basis, we expect it to become far more common, and far more successful at addressing some of the critical challenges now facing the international community.

How will ARI be accomplished?

This question cannot be answered with any precision at this time. But enough evidence and field experience was brought forward by the conferees to suggest some key attributes of this new discipline .

Mission-oriented

Just as most corporate innovation today is oriented toward specific market needs and most government-sponsored defense and aerospace research is mission-oriented, accelerated radical

[2] For example, an improvement in the quality of a product or process from three sigma (traditional target) to six sigma (current target for many companies) is over three orders of magnitude (http://www.isixsigma.com/library/content/c010101a.asp).

innovation will be focused on well-defined, socially important objectives. Tools such as technology roadmapping will be used to identify the areas required for development to achieve the objectives.

Science-based

Underlying basic scientific research will be far more tightly coupled to use-inspired research, to applied research, and finally to successful commercialization. We will find viable pathways through the Valley of Death.

Information-driven

Emerging computer science and telecommunication tools for technology and market assessment, opportunity recognition, program and process management, and new knowledge generation will be developed and widely exploited to dramatically improve the effectiveness of the existing innovation phases of discovery, commercialization and diffusion. (Dismukes, 2004)

Collaborative

Radical innovation requires more disparate technologies, sciences, and management disciplines than can be found under one roof. To assure the ready availability of all the requisite disciplines and capabilities, accelerated radical innovation will be inherently collaborative. ARI will be accomplished by communities of research and practice comprised of companies large and small, technologists, scientists, the academic community, the policy community (politicians, agency executives, regulators, think tanks, etc.), and the financial community, all from multiple world regions. Cultural and communication gaps dividing these communities will be bridged.

Adaptive and Self-renewing

Given the rate of growth of new knowledge, the unexpected twists and turns along every path, and the crush of unanticipated events (e.g., the stock market crash, the 9/11 attack), accelerated radical innovation – which is necessarily a long-term, mission-driven process - must be adaptive and self-renewing. ARI must be able to continuously sense, interpret, and assimilate events as they unfold. ARI must strike an appropriate balance between the discipline needed to achieve its mission and the adaptability needed to respond to the unanticipated.

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