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The Impact of Convergence on Organizational Innovation

SANG M. LEE DAVID L. OLSON SILVANA TRIMI

INTRODUCTION

Thomas Friedman asserted that globalization and digitization are the two most obvious megatrends that have helped flatten the world. *Globalization* has greatly accelerated because of the advances in information and communication technologies (ICTs). These tools have enabled technologically advanced organizations in countries such as the U.S., U.K., Germany, Japan, South Korea, and Finland to gain competitive advantage in conducting global business. For example, India has become preeminent in computer technology, the United States in bioengineering, and South Korea and Finland are leaders in the manufacture and use of cellular phones.

The most profound impact of globalization and digitization occurs through their interaction, a form of convergence. Convergence of business functions through business process reengineering (BPR), widely practiced in the 1990s, brought about process innovation. Convergence of organizations, technologies, industries, and people create new opportunities for collaboration, open-source participation, development of new technologies, new products and even cybernetic organisms (cyborgs—organisms with both natural and artificial features).

Organizational convergence has become a popular strategy for many firms, such as Nike Inc., Wal-Mart Stores, and Dell Computer Corp., to leverage the advantage of ideas to include open sourcing, outsourcing, or global supply chain alliances. Industry convergence involves strategic innovation for development of sustainable competitive advantage. Thus, *convergence revolution* is at the center of the whirlwind of global change. Technology convergence has led to taking developments in one engineering or scientific field and applying them to other fields, to include cross-fertilization of ideas from physics applied to medical applications. People are involved, in that they develop expertise in one field and learn to apply it in another, bringing fresh ideas to old problems. Furthermore, globalization has brought people together from around the globe, resulting in much greater sharing of ideas than was experienced in prior centuries.

The emergence of a new business environment is a result of megatrends and rapid changes in the global

economy. Thus, organizations must behave differently and innovate strategically by exploring new frontiers to create value. What is new is that the ecosystem of convergence has now developed to a sufficient level that it affords organizations new opportunities for value creation and business models development, a form of perfect storm.

EVOLUTION OF CONVERGENCE

The ability to connect ideas across areas has grown over cultures (globalization), knowledge (different fields of expertise), industries (such as agriculture, manufacturing), economic boundaries (national, regional, global), strategic competitive advantage (economies of scale, scope, expertise), and primary innovation strategy (exploration, exploitation). Thus the driving force of the economy in advanced countries has transitioned from agriculture to manufacturing and to knowledge-intensive service industries. The economic emphasis has also changed from national to regional and now to global economy. The source of competitive advantage has progressed from economies of scale, to economies of scale and scope, to economies of scale-scope-expertise, to new economies of scale-scope-expertise-convergence. The primary innovative strategy has gradually gravitated from exploitation of current competencies to exploration of new competencies.

The success of any organization is largely based on its ability to predict the future direction of convergence that can enrich the entire value chain—operational innovation, new products/services, new customer values, and new customer base. Evolution of convergence can be examined in six broad levels that are relevant to organizational innovation—from components/products/services, functions, organizations, technology, industry, and biological/artificial systems. [Table 1](#) summarizes convergence levels and their basic purposes to create organizational innovation.

LEVEL 1: COMPONENT/PRODUCT/SERVICE CONVERGENCE

Convergence reflects human intelligence in putting things together in new ways. It has always been with us, whenever anyone constructs a better

TABLE 1 EVOLUTION OF CONVERGENCE AND ORGANIZATIONAL INNOVATION.

	CONVERGENCE LEVEL	PURPOSE
Level 1	Component/product/service convergence	Product/service innovation
Level 2	Functional convergence	Process innovation
Level 3	Organizational convergence	Value chain innovation
Level 4	Technology convergence	Technology, product innovation
Level 5	Industry convergence	New industries, customer value innovation
Level 6	Bio-artificial systems	Ubiquitous innovation

mousetrap. This has long been the focus of gaining competitive advantage (through building better products). But there are many more opportunities in today's world.

Examples of Component/Product/Service Convergence

Convergence of components and products has existed throughout time. Clock radios are a result of converging two mature products as components of a new product. Cell phones represent convergence of telecommunications functions such as Internet access, music, and photography. The electro-motion toothbrush is another good example of convergence obtained by combining electronic skills of Braun, Oral-B toothbrush and Duracell battery technology.

Nike and Apple Computer Inc. have recently combined the iPod with gym equipment, allowing health club members to make exercising more entertaining. These two organizations also provided wireless systems embedded in Nike running shoes to communicate with the iPod Nano for monitoring heart beat, running speed, and distance run while listening to music.

LCD technology has allowed development of more realistic video games, better picture quality, and enhanced ability to learn and teach through clearer visual displays of classroom content. E-book devices, such as Kindle, may replace books and newspapers through the use of ambient light from the surrounding area. Once a page is displayed, no further power is needed to keep it visible, as power is only consumed during updating. Newer devices have also been found to be easier on human eyes, yielding sharp images readable even in bright sunlight. This technology has been brought to market by Sony Corp. (Reader), Amazon (Kindle), and Motorola Inc. (Motofone).

Another type of convergence involves service and service convergence, such as medical tourism. Global standard hospitals combine medical care, transportation and immigration details, and provide after-treatment rest at a resort hotel. For example, Bangkok Dusit Medical Services offers a package combining top-flight medical treatment with travel arrangements and resort stays for recovery.

LEVEL 2: FUNCTIONAL CONVERGENCE

A process is a logical set of related activities taking inputs, adding value through doing things, and creating an output. The traditional organizational structure is based on vertical semi-independent functional areas such as manufacturing, sales, finance and human resources. These silos had vertical walls, and thus cross-functional processes were not very efficient.

Business process reengineering (BPR) is an activity in which an organization accomplishes process innovation to make the value chain more efficient by destroying functional walls. Process innovation through BPR represents functional convergence to develop efficient and lean value chains. BPR is closely tied to enterprise information systems (ERP, for enterprise resource planning), because in order for ERP to provide benefit to the organization, at least some of the functions of organizations must change. Today, enterprise systems are an extreme form of functional convergence through unifying of organizational databases and reporting systems.

Examples of Functional Convergence

In the early 1990s, Texas Instruments Inc. faced long cycle times and declining sales. They applied BPR to TI's TI-30X solar calculator. This calculator was developed by cross-disciplinary teams from engineering, marketing and other departments. These teams were to be in control of every aspect of product development, from design through marketing. The first pilot teams failed. Functional departments, unwilling to give up good people, space, or responsibility, sabotaged the projects. Power continued to lie in the old functional departments. Texas Instruments responded by changing the way it was organized. Development teams became the primary organizational units. Functional departments focused on redefined missions supporting the development teams. Budget was allocated by process instead of by department. After the new system became established, launching time for new products was cut by as much as one-half, profitability enhanced, and return on investment multiplied four-fold.

McDonald's Corp. was instrumental in making the fast food industry a major component of the U.S. (and

even the world) economy. Prior to the 1950s, you could get food in one of many independent restaurants, each with its own décor and cooking style. McDonalds came up with a business functional style, bringing mass production to the food industry. Processes were created to make a limited set of products available in short periods of time, by low-cost labor that followed carefully laid out instructions. This idea led to a massive revolution in food distribution in the U.S. It had side effects, in that it made food obtained during travel less risky from botulism. Physicians Mutual shifted from a centralized, mainframe-computing environment to a distributed server-based framework to allow broader access to its information system. As part of the change, business processes were redesigned, and a new service-oriented architecture was installed. The system enabled the information technology group at Physician's Mutual to improve service in a rapidly growing environment that was increasingly distributed.

LEVEL 3: ORGANIZATIONAL CONVERGENCE

Economist Ronald Coase theorized that firms would expand until the costs of organizing a marginal transaction internally equal the costs of conducting the same transaction in the open market. Each organization would keep its core competence to maximize value creation and outsource the rest, shifting from vertical integration (within the organization) to horizontal integration (across organizations).

New technological developments have further changed the way organizations are structured. Communications technology has made it possible to combine the skills of people in different locations. When a firm had to physically send specialists to problem areas, this was a constraint on the physical structure of organizations. Either an organization had to be large enough to hire specialists in each location where they were needed, or it had to rely upon transportation systems to send the specialists to problem areas. Electronic communications release organizations from such constraints.

It is no longer necessary to move an Indian computer engineer from Hyderabad to New York City to gain his services. The engineer can stay in Hyderabad, remaining in his traditional culture, cost much less to the organization but be paid well above the local wage, and be able to live well. Outsourcing and off shoring have become much easier and very important.

Examples of Organizational Convergence

In the era of e-global and digital economy, organizations have the opportunity to collaborate with other firms to enrich their value chain. Strategic alliances

and joint ventures with suppliers, component assemblers, distributors, and even competitors are good examples of organizational convergence. Vendor participants in supply chains, such as Wal-Mart, Nike and Dell, are required to have strong collaborative functions. Inter-organizational relationships or business-webs, where each partner organization brings its core competence to the value chain, are new business models that agile organizations are using to become and remain competitive. Supply chains are being created that link previously independent organizations, at least temporarily, into cooperative assemblies and draw upon the specialties of participants from around the globe. For example, Nike is simply a brand management firm, while all of its products are produced by partner organizations all over the world.

LEVEL 4: TECHNOLOGY CONVERGENCE

The 1990s saw a great deal of convergence in the technology area. Information technology boomed, with the power of computers growing by leaps and bounds (Moore's Law). Communications technology also saw rapid development, and this led to a convergence of information and communications technology, enabling devices such as personal digital assistants (PDAs), evolving into the ubiquitous Blackberry, iPhone, MP3 musical technology. The 1990s also saw the development of biotechnology and nanotechnology (such as bio pills). Other developments in medicine are the application of robotics technology in medical treatments (Da Vinci surgical robots). Another example of technology convergence is digital convergence. Digital convergence is a consequence of ubiquitous computing, also referred to as invisible or ambient computing, coined by Mark Weiser of Xerox in 1991. Digital convergence involves analog-digital integration, wired-wireless integration, voice-data integration, and service-device integration, which result in convergence of networks and telecom-broadcasting convergence.

Examples of Technology Convergence

Since the 1980s, there have been numerous revolutionary convergences of seemingly heterogeneous technologies to create new products, services, new processes, or even new technologies. The most prevalent convergences have involved information and communication technology (ICT), biotechnology, engineering, nanotechnology, and artificial intelligence. Liquid-crystal displays (LCDs) have replaced clock dials and most of the display meters we see in automobiles. Science has miniaturized LCDs, enabling convergence with computer devices, leading to texts and graphical displays with minimal negative effects on the reader's eyes. The electroluminescence of organic

compounds can be utilized to build organic light-emitting diodes (OLEDs), thinner and brighter than LCDs, with wider viewing angles. These devices have thus far appeared as secondary displays on the exterior of mobile phones or in music displays.

In the pharmaceutical industry, many new drugs have been introduced through convergence of biotechnology, agriculture (genetically engineered plants), and chemical engineering. There is the potential to treat patients at the genetic structure level through analysis of their DNA. Neural technology is the convergence of biology with computer science. Neuroscientists are interested in the neocortex, as it promises better understanding of how learning and memory work and how to treat psychiatric disorders and brain diseases.

Technology convergence also includes application of modeling approaches taken from engineering and applied to biology. These efforts can lead to biological computers. Convergence of engineering and biotechnology has also yielded remarkable products and services such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scanning. Further development may lead to atomic force microscopy, enabling scanning at the cellular and sub-cellular level.

LEVEL 5: INDUSTRY CONVERGENCE

Convergence has occurred in many business and technological sectors, including the telecom industry and financial industry. The business applications of developing technology led to the replacement of analog telephone systems with fully digitized networks. This has evolved into a continuum of products that could be classified as either telecommunications or computer products, with subsequent merging of industries. The telecommunications, computer industries, and content providers are converging into a single information and entertainment industry. Thus, telecommunications companies, such as Verizon, provide telecom services, Internet services, and movie downloads, as do cable companies such as Time-Warner. There is also convergence within the financial services industry, with banks and insurance companies cross-selling products. Industry convergence can create new industries and customer value innovation.

Convergence can lead to gains in other areas as well. The convergence of computational technology with opportunities in the communications and music industry has led to the iPod. Convergence of technological capability, educational opportunities, and the dispersed location of people has led to development of distance learning, utilizing media in the form of recording technology, communication technology for two-way (and multi-way) communication, file sharing technology for learning materials, and Web-based education.

Examples of Industry Convergence

Industry convergence occurs when two or more previously distinct industries become direct competitors or cooperators or create a new one. Apple's iTunes, which competes with music distributors, is the convergence of IT and music industries. When The Walt Disney Co. went into the travel convention business, that decision was a convergence of entertainment, hotel, and golf industries.

There are three types of industry convergence. *Functional* convergence occurs when products from different industries perform the same function(s). Personal computers and television industries both provide some of the same functions, and are becoming more and more substitutes for each other. *Complementary* convergence occurs when multiple objects of value from different industries are obtained in one location, such as getting travel and lodging services in the same location (as when travel agents sell both airline tickets and hotel rooms). *Institutional* convergence happens when firms behave as though products of two industries are linked.

While complementary convergence focuses on the product being developed, institutional convergence focuses on the organizational structure. The banking industry has converged with the mortgage industry, to provide both checking deposit services and mortgage loans. The convergence between education and entertainment has led to firms providing educational service combined with entertainment, to include driver safety schools catering to those receiving traffic citations. Some oil industry firms (BP, Exxon Mobil Corp., Shell Oil Co.) claim that they are in the energy business, allowing them to expand beyond developing petroleum products to hybrid fuels, wind, and other energy forms. Digital convergence of IT and broadcasting is another example of institutional convergence. Bloomberg News Service shifted its focus from output at given intervals (such as the evening news) to pools of content distributed in multiple ways.

LEVEL 6: BIOLOGICAL AND ARTIFICIAL SYSTEMS CONVERGENCE

Norman Borlaug was recognized for developing wheat resistant to stem rust. This advance promised better yield for crops in areas of scarcity, which was labeled the "green revolution." The expectation was that overpopulated and under-producing areas would be able to sustain themselves. In the United States, genetic engineering has enabled much more cost-efficient food production. In the 1990s, one of the most popular areas of technological growth was in genetic engineering of food. However, by 1998 Japanese and Europeans rejected what they referred to as "Frankenfood."

There is similar technological advance in the medical field. Francis Fukuyama proposed three possible futuristic scenarios in this crucial branch of science:

1. Drugs such as Ritalin and Prozac aid self-esteem and concentration, but have side effects for specific types of individuals. Genomics in the future may enable drugs to be tailored to genetic profiles (medical anthropology), minimizing side effects. Functional foods, such as meals-ready-to-eat used by the military, combine focus on nutrition and health and could change the entire life science sector, converging the food and pharmaceutical industry.

2. Stem cell research can regenerate almost any body tissue, providing physicians with tools capable of extending life well beyond 100 years for those who can afford it. However, humans are complex systems, and other aspects of aging may make such gains moot. Further, extended life may clog social systems (e.g., Social Security and Medicare in the U.S.).

3. Human reproduction may be supported by technological advances allowing prospective parents to design the intelligence and/or appearance of their offspring. This may sound attractive, but deeper reflection scares many people. Germans in the 1930s were pioneers in this area of biological study, and the Chinese are making advances in this area today.

The idea that computers can evolve into life forms is interesting to some. Ray Kurzweil discussed the potential of computers to gain intelligence in his books. The former focus was on building organizations to predict and control, to sense change and to respond. Kurzweil has even predicted that about 2040 we will

reach a singularity, where computers attain the power to function as well and even better than humans.

The evolution proposed by Kurzweil, leading to ever-smarter computers capable of functioning at or beyond the human level, can lead to greater understanding of molecular technology environments. Molecular technologies enable biotechnology and nanotechnology, with the potential for connectivity at more places and more flexible times, utilizing autonomous software to converge information, biology, and business to achieve ubiquitous innovation.

Examples of Biological and Artificial Systems Convergence

The convergence of biological and artificial systems represents the highest level of convergence. As such, it represents the cutting edge of development, where ideas from the prior levels of convergence can be utilized to lead radically new methods and products. Ubiquitous life (u-life) involves a state where our lives are managed and controlled by a combination of technologies and systems. These advances are changing the life style of people through miniaturization, visualization, manipulation, and evaluation.

Miniaturization allows convergence in a number of areas. Miniaturization has impacts in health care, through gene splicing and molecular biology. *Visualization* advances also come from molecular technology. X-ray crystallography enables resolution to about the size of a water molecule. Atomic force microscopes allow scanning surfaces to detect variances in atoms, which are then translated to an image. Applications can be useful in development of drugs or materials.

TABLE 2 EXAMPLES OF CONVERGENCE PRODUCTS AND SERVICES.

LEVEL	MANUFACTURING	SERVICE
Product/service convergence	Cell phones (telephone, information access, camera, games); Coffee (soy milk, decaffeinated, diet, frappacinos)	Jazzercise Medical tourism (Bangkok Dusit Medical Services and Bumrungrad Hospitals in Thailand)
Functional convergence	Toyota's lean manufacturing Enterprise resource planning systems	McDonalds' hamburgers (fast service, consistent quality, entertainment for kids)
Organizational convergence	Steel (movement from mass production to minimills)	Bank of America and other banks (from checking accounts to include savings, mortgages, bill paying, many other services)
Technological convergence	Hybrid cars	Cell phones by Nokia, Samsung (communication, music, e-mail, photos, etc.)
Industrial convergence	Starbucks Political ads (from stump speeches and posters to a transformation of the television industry)	e-Bay (transformed want-ads and flea markets to get rid of white elephants to an e-commerce revolution)
Bio/artificial systems convergence	Medical testing (X-rays to MRIs and beyond)	Chinese medicine (emphasizing herbal remedies and acupuncture)

Manipulation extends the knowledge gained through visualization. The NanoManipulator combines virtual reality and tactile feedback; it is used in medical training to allow students to experience the feel of inserting needles into spinal columns. *Evaluation* is gaining value from technology. The ability for remote sensing is usable in detecting when impurities are present, or when mechanical parts are wearing out, or when other specification limits are exceeded. In the medical field, translation of measures into simulations of human organs allows experimentation in virtual space rather than real bodies.

Table 2 recapitulates some of these convergence examples.

TYPES OF INNOVATION

Innovation can be viewed in a number of forms (see Table 3). One type focuses on creative ideas to improve products or services. This form of innovation is to build a better mousetrap. While it leads to better things for consumers, it does not alter business models. A second type is to improve processes in the value chain. This form of innovation leads to better efficiency through increased productivity. While it also provides value to consumers, such as lower price and better product quality, it also does not lead to altered business models. A third type is redefining the customer base, bypassing middle-men organizations by exploring e-customers, global customers, customer communities and even noncustomers.

The last form of innovation is strategic, involving new business models. Innovation of this type has been fostered by companies in different industries. Thus Southwest Airlines Co., which abandoned the hub-and-spoke business model dominant in major airlines, competes on direct connections and provides commuters in major routes—alternatives to all forms of transportation, including driving or train-commuting. IKEA revolutionized the furniture industry by offering a clear new style of furniture delivered in an up-scale distribution setting. Breakthrough strategies can be simple innovations. JC Decaux entered business by providing municipalities with street furniture for benches, bus shelters, and other facilities at competitive prices. Then they strategically innovated themselves by developing complementary income streams through advertising posted on the street furniture.

STRATEGIC INNOVATION

The convergence revolution is opening new opportunities to create value in different ways than the traditional business thinking. The traditional management strategies emphasize reinforcing or optimizing the existing core competence of the firm as a stand-alone organization. Examples of these strategies include benchmarking, continuous improvement, differentiation, focus, cost leadership, global strategy, and customer-centric management. The traditional management strategy involves improving efficiency in the value chain by emphasizing economies of scale, economies of scope, and market expansion. While these practices are good when executed properly to increase the firm's share in a zero-sum game, they would not allow the firm to reinvent itself to explore blue oceans. We have coined the term convergenomics to reflect convergent strategies. Convergenomics requires thinking outside the box, abandoning preconceived notions to consider new ideas.

Strategic innovation is a requirement for firms to survive and prosper in convergenomics. There are many successful examples of such strategic innovation. In the air travel industry, low-cost airlines (Jet-Blue, AirTrans) have reshaped value chains by reinterpreting criteria to measure customer value. Fleet standardization is a means to reduce maintenance costs. Use of cabin crews to clean planes between flights also lowers operating costs. Use of small, low-tax airports enables price advantages. Southwest Airlines and Jet Blue offer a limited menu of services, focusing on providing value in point-to-point business models. Airline innovations also have taken advantage of technology development. In Singapore, joint efforts of Singapore Airlines and the Civil Aviation Authority of Singapore have led to the use of biometrics to improve customers' flight experience through fully automated seamless travel. Biometrics is used for airline check-in, preimmigration security checks, and immigration clearance. The clear objective is not simply security, but integrating processes to drive service excellence. The same identification information used for security purposes can be used to customize service, the principle behind customer relationship management. This strategic innovation leads to simplified procedures, reduced error, efficient use of self-service technology, greater

TABLE 3 INNOVATION TYPES.

LEVEL	TYPE	IMPACT
1	Reinventing customer value	Better products and services, speed, customization, emotional gratification (aesthetics, memory, inner satisfaction)
2	Process innovation	Reduced value chain cost and improve quality simultaneously
3	Redefine the customer base	E-customers, global customers, customer communities, noncustomers
4	Strategic innovation	New ways of doing old tasks, in a much improved manner; New business models

security, and greater customer service and convenience.

Strategic innovations are also found in banking. Banks serve a mature market in a highly competitive industry with commodity products and services and intense competition from many sources, including automobile companies (for automobile loans) and advisory firms and insurance companies (for financial advice). Product/service innovation options include evolutionary improvement of established business (such as use of Web technology for Internet banking), process innovations to increase productivity and reduced staffing (such as use of ATMs), value engineering through operational excellence through enterprise system technology, and value innovation. Value innovation creates differentiation from competition through providing superior customer value, leading to new demand. Customer relationship management is a means to seek improved customer value.

Healthcare is a growing sector of the global economy, with many opportunities for strategic innovation. Some hospitals are strategically innovating themselves through the help of IT. Examples include Web-enabling patient televisions, which can be accessed for medical care by allowing doctors to access patient records over the Web rather than needing to bring in a computer. Patients can also utilize Web television to complete surveys, order meals, and make purchases. Medical tourism has been successfully launched by Bangkok Dusit Medical Services and Bumrungrad Hospitals in Thailand.

Innovation can be any combination of exploitation of what is known and exploration of what is unknown. Thus, we can also classify innovation strategy based on the type of approach used. The first type can be classified as *evolutionary* or optimizing innovation, where continuous improvement of the existing core competencies is obtained (Kaizen is the main thrust—an evolutionary development). On the other extreme (of classification) is *revolutionary* innovation, where new frontiers are explored to create new core competencies. Two other types of innovation come as a combination between the two approaches. The ultimate innovation type is where both exploitation and exploration are high. We call this ubiquitous

innovation based on convergenomics. In this type, the optimum balance between exploitation and exploration for any given organization depends on several factors—such as the industry type, size, age, management vision, product lines, and DNA of the organization.

CONCLUSION

The combined effects of developments, to include megatrends, have led to a much richer environment—where strategic innovation can lead to improved products, processes, and services. Progress is not expected to be without difficulty. We live in a world with broadband Internet enabling multinational supply chains to deliver goods and services throughout the world, but we also live in a world with millions of people coping with starvation. New business models will enable progress, harnessing the technological advances we have described, along with globalization, changing demographics, and other sources of change. We expect convergence of developments from different sources to lead to revolutionary successes for those organizations able to find the right combination of features.

What we refer to as the era of convergence is expected to open new opportunities for better products and services, with leaner value chains, enabling creation of new customer values and leading to expanded customer bases. Understanding the opportunities available in combining developments from different fields will enable innovators to stay ahead of their competitors. The first-mover advantage in the deep blue sphere of convergenomics will yield wealth-creating opportunities to those able to grasp them. Wal-Mart is an example of such a proactive organization, through use of radio frequency identification (RFID) technology to track inventory and also to provide fresh products to customers, while minimizing cost. Opportunities for strategic innovation are constrained only by limits on human imagination and creativity.



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