Socio-technical Evolution Needed in Economic Crisis

By Fumio KODAMA

"Technology Fusion" Seen Bringing More Sustainable Solutions

What would be necessary to improve R&D in Japan to deal with the economic crisis? We are facing two changes now. First, investors with short-termism are losing their influence over corporate management and management should find it much easier to be engaged in long-term issues. Second, under the current circumstances where the market growth of existing products either stops or declines, a linear, step-by-step strategy of substituting them with improved products will not create a sustainable solution. However, an idea of "technology fusion," combining existing technologies into hybrid ones, would bring us more sustainable solutions.

Technology fusion blends incremental technical improvements from several preciously separate fields of technology to create products that revolutionize markets. Therefore, this is a nonlinear, complementary and cooperative process.

In terms of the category-oriented argument of technologies today, technology fusion – which Harvard University Professor Clayton Christensen calls "disruptive" technologies – will be dominant over the "sustaining" ones.

The next question is how technology fusion or disruptive technology could happen more easily. The latest academic argument introduces us to "open innovation" against "closed innovation." Whereas the latter happens within an organization, the former considers the network effect of technology and its potential to create a new business model as very important.

An intelligent transport system (ITS) and electric cars are good examples of technology fusion or disruptive technology which could have a broader impact upon business management and even create a new social system since automobiles can be managed not by drivers but by an information system. In achieving social system revolution, we need to follow the principles of "open innovation" where a wide range of social stakeholders are allowed to participate in the management of technology.

Open Innovation: A Key to New Socio-technical System

How can we achieve a new social system with the application of new technology? What should be the relevant process to realize "open innovation?"

In his 1977 essay, which used a metaphor of *"The Moon and the Ghetto"* for uneven performance of American technologies, Richard Nelson put a basic question formulated as "if we can land a man on the moon, why can't we solve the problems of the ghetto?" He wondered: "In an economy with such vast resources and powerful technologies, why can't we provide medical care at reasonable cost to all who need it, keep the streets, air and water clean, keep down crime, educate ghetto kids, provide decent and low-cost mass transport, halt the rise in housing and services costs, and have reliable television and automobile repair service?"

During the 1960s, according to Nelson, the search for "the Great Society" entailed highly publicized efforts. Broad new mandates were articulated – the war on poverty – and specific policies were designed to deal with various aspects of the problem. The techno-science orientation came later. Nonetheless the intellectual rhetoric has been strong, and has generated at least token efforts to launch aerospace companies on problems of garbage collection, education and crime control, and programs with evocative titles like "Research Applied to National Needs."

The following years saw a sharp decline in faith, within the scientific community as well as outside, regarding our ability to solve our problems through scientific and rational means. It is apparent that many of the more optimistic believers in the power of scientific and rational means overestimated that power.

In order to enhance productivity as a nation to cope with the economic crisis, we need to disrupt these failed experiences.

First of all, we need to continue our incremental and step-by-step technological development process as a complementary process to the disruptive technological development. We can identify what a disruptive technology is by continuing incremental technology development and learning its limits. We should be also able to judge when the disruptive technology performance exceeds the one by the incremental one and the latter should be finished by pursuing both in parallel. Thereafter, we need to expand and enhance the idea of disruptive technology or technology fusion for describing the evolutionary process in which technological development could shift smoothly from industrial to societal ones.

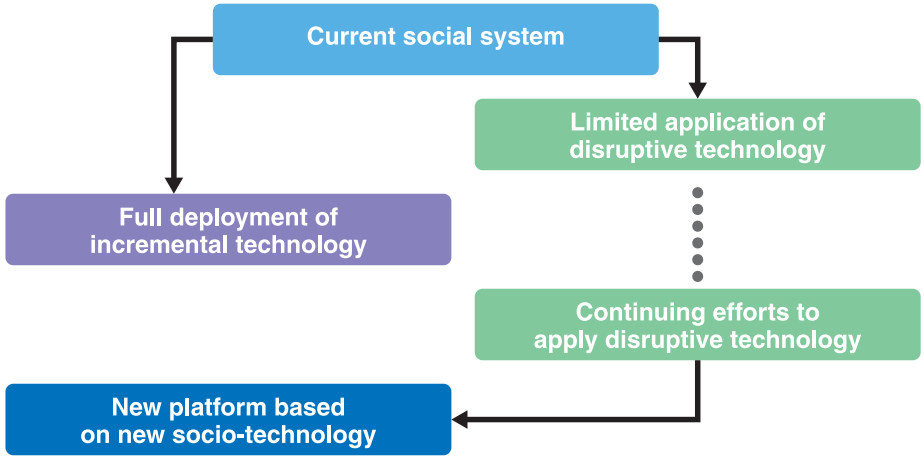
The sequence of evolution is: (1) technology fusion; (2) service fusion; (3) company fusion; (4) industry fusion, and the final stage will be (5) "societal fusion." *(Chart)* As examples, I thought of social system technologies such as the ITS, industrial recycling systems, and socio-technological systems preventing global warming. This final stage differs from the preceding stages in the sense that building social infrastructure has to be conducted in parallel with industrial development.

The final stage of evolution, "societal fusion," can be produced only by several subsystems fusing with each other.

Obviously it is difficult to achieve "societal fusion," which is not the same as the fusion we have experienced before. We have to look for hard evidence of the fusion between two systems which evolved quite independently. Numerically controlled (NC) machine tools have a long history. However, NC machine tools controlled by personal computers (PCs) are only recently realized because NC tools and PCs have evolved independently through their own evolutionary paths.

The two systems reached their modular architectural structures through their own evolutions. However, the PC reached an "open" architecture, while the NC reached a "closed" architecture. Therefore, it is difficult for those two systems to be fused, although both of them are modular structure. The PC-controlled NC is realized only after the NC system gets to an open architecture in which three functions – display, calculation and driving – are modularized and work independently, without any interference. Only after the NC system is designed by open modular structure, the PC comes to be "ported" into the NC's display module. Thus, the NC and the PC are integrated and fused.

CHART
Evolution process of socio-technology



Source: Compiled by author

Managing Technologies to Achieve Evolution

In managing this process, we should observe carefully how human beings react to disruptive technology. We need to plan what part of the social system to adopt disruptive technology based on these observations. In this process, the knowledge of social science should be seen to play an important role in addition to the knowledge of technology and natural science since social technologies concern the interaction between groups of human beings rather than the interaction between artificial products and human beings.

Why does the porting make smooth evolution of societal systems? In order to realize progressive evolution of societal systems, we need "disruptive technology," such as integrated circuits (ICs) and the global positioning system (GPS). Indeed, disruptive technology used to be equivalent to "competence-destroying discontinuity." However, if the introduction of these disruptive technologies *destroys* subsystems in the sense of the drastic changes to be made in these interconnected subsystems, the evolution of societal systems becomes very hard to be initiated. In other words, we cannot change all subsystems at the same time. We should do it one after another in order to follow the evolutionary path.

This evolutional nature of societal system technologies becomes even more vivid when it comes to widespread diffusion of the electronic boarding pass used for the mass transportation of passengers in larger cities. This is equipped with disruptive technology, i.e., radio frequency identification (RFID). The initial diffusion of this electronic boarding card system resulted easily in the even wider diffusion as an electronic money system by the use of cash deposit made on the boarding pass. In terms of "porting," this case can be interpreted as a two-stage process. The first one is that the RFID card is "ported" into toll systems of mass transit. The second one is that this RFID card is "ported" into cashing systems of convenience stores. Thus, the initial introduction of RFID in mass-transit evolved into cashing in major retailing systems.

In summary, we need some disruptive technology, i.e., nonlinearity in technological discontinuity, to have a societal evolution. In order to bring nonlinear technologies into societal systems and their evolutionary path, the introduction process of disruptive technology should be incremental, gradual, and continuous. In other words, the process of societal change has to be comprehended by human minds, i.e., it has to be linear. Thus, we find an interesting contrast in linearity between technology and society.

The most plausible scenario to create a new societal platform such as environment-friendly transportation and city systems should be "coordination" among the different technology trajectories, then a "ported system" where porting is visible partially without holistic coordination, and finally on a new platform. We need multiple porting to reach a new world. The "porting" operation is critical to the evolution of societal system development. "Engineering" integration or fusion is the heart of the question.

In the social systems of tomorrow, in which evolution will proceed through multiple porting, management of technology becomes critical; how to manage the process of multiple porting becomes upmost important. JS

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