Over the past decade, the pervasive and critical nature of embedded software has grown rapidly, leading to serious problems for software development management. Process innovation has thus far overcome many of these problems, but new economic and environmental challenges require major changes in the embedded software field.

**FROM MATERIAL AFFluENCE TO “SPIRITUAL RICHNESS”**

In 2008, a series of financial crises caused the worst global recession since the 1930s. Although there are signs of recovery, a seismic shift in consumer attitudes is fundamentally changing the economic and industrial landscape.

With widespread double-digit unemployment and manufacturing in a deep slump, many people in advanced countries believe that capitalism has undergone a meltdown. In contrast, developing economies have weathered the storm and in some cases even prospered—for example, in 2009 China’s GDP grew at a whopping rate of 8.7 percent. At the same time, climate change and overreliance on fossil fuels have emerged as important concerns.

The economic boom that followed World War II and the rapid growth of globalization after the end of the Cold War fueled a demand for material affluence. However, recent market surveys by a Japanese cabinet office indicate that consumers increasingly seek “spiritual richness”—they value high-quality but reasonably priced goods that are also environmentally friendly.

In 1972, 40 percent of Japanese preferred material affluence and 37 percent spiritual richness, whereas in 2003 the ratio reversed to 27 percent versus 61 percent. A similar shift has occurred in other advanced countries in the wake of the global recession. In response to this trend, Japan and other forward-thinking governments are encouraging “glocalization”—the adaptation of global thinking to local needs—and establishing a vision for a green technological revolution.

In 2009, for example, the Japanese government began subsidizing eco-friendly hybrid cars, which lowered the price of hybrids almost to the level of conventional cars and have caused a boom in hybrid sales. It also provides “eco-points” for energy-saving goods such as DTVs, refrigerators, and air conditioners that can be used to buy other green products, giving impetus to the energy-efficient consumer electronics market. Similarly, the Chinese government has implemented the Jia-Dian-Xia-Xiang system, which encourages consumers in rural areas to buy goods with essential functions and uncompromising quality at a reasonable price according to income.

**ECO-TECHNOLOGY REVOLUTION**

We live in a new era of eco-technology revolution, which follows upon the 19th-century industrial revolution and the 20th-century information revolution. To realize a green, energy-efficient, and ultimately oil-free society, we must rebuild existing industries to more harmoniously coexist with the environment.

Eco-technologies should be achieved in part through the integration of device components. For semiconductors, there will be a battle against heat in the 32-nanometer era. If hundreds of millions of transistors on a chip are activated simultaneously, heat will become prohibitive. Energy-saving semiconductor device technologies are needed.

Power-saving software is also important, and mobile phones are the prime example. If 300 million transistors on one large-scale-integrated circuit are activated simultaneously,
you can use a mobile phone for only one hour in standby status; with a software controller that point by point shuts down circuits not in use, you can use the phone for 580 hours in standby status.

Energy-generation approaches vary, and each country must build a system best suited to its individual needs. Governments across the world are aggressively researching and developing smart grids that integrate electricity and IT infrastructure, utilizing renewable energies and liberalizing electric power itself.

The smart grid concept can be applied not only to countries or regions but to factories and houses. For example, smart houses can incorporate hybrid power supplies such as photovoltaic and DC power, fuel cells and storage batteries, and heat pumps as well as traditional electric energy. Panasonic is well on its way to creating such a zero-CO₂-emission house.

**ENVIRONMENTAL ADAPTABILITY**

Traditionally, embedded software has been used to control hardware devices and optimize the workload between software and electrical and mechanical devices. As Figure 1 shows, embedded system designers now must also factor in changes to the social environment.

For example, memory-card technologies such as image compression and communication are common across all product categories. An integrated-platform strategy makes it possible to share technology assets and efficiently develop high-quality offerings across a wide spectrum of areas and also create new functions and value.

As for embedded software, microcomputers for device control were used in consumer electronics products until 1990, when digital signal processing became popular and the operating system was created. After that, embedded systems designers introduced platform-based software along with networking capability.

In the past, development of energy-saving consumer electronics required the deployment of power-aware technologies across each individual fields. Digital consumer electronics manufacturers, on the other hand, have evolved from a product-oriented strategy to an integrated-technology-platform strategy that drives innovation.
It’s impossible to pursue spiritual richness from a materials-only perspective. A new value solution links embedded software with cutting-edge eco-technologies and environmental awareness. Komatsu, the world’s second-largest construction equipment manufacturer, offers a prime example of the benefits of this approach. The company has implemented an inventory-control system that uses embedded GPS and wireless networking technology to efficiently move its equipment around the world, thereby saving energy and reducing carbon emissions. Innovative environmental software gives us spiritual richness and is the most important way to the future.

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**Figure 2. Toward a new eco-technological paradigm.** The systematic integration of eco-technologies, combined with subsidies and other government incentives, could rapidly optimize energy efficiency at home and in society.

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