Continuing Innovation for Future Electronics Industry

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Introduction

To encourage an understanding of our technology among a numerous and wide-ranging public, the Nitto Denko Group regularly publishes the Nitto Denko Technical Report. The present 2008 edition (No. 89, Vol. 46, June 2008) is the first since 1998 (Vol. 36-1, May 1998) to focus on electronics-related technology.

In this foreword, I begin by reviewing changes in the electronics environment over the last ten years, and then outlining the way by which we can ensure continuous delivery of value to the electronics industry of the future, with special attention to the coming changes in social trends.

Changes in the Last Ten Years

Let us compare conditions in the electronics industry in 1998 and ten years later in 2007. It goes without saying that the appearance of mobile phones, which are wireless and can be carried around everywhere, has changed our daily environments enormously. The number of mobile phones in use in the world in 1998 was a mere 2 to 4 million units, but the number of users in 2007 is said to be between 2.4 and 2.6 billion and the demand for mobile phone handsets has also risen to above one billion units a year. Once simply a portable phone, it is now regularly equipped with ringtones, a camera function, an MP3 music player function, and even the ability to receive television through terrestrial digital signals. Recently, it has also become the norm for new books to be downloaded onto mobile phones, for publishing priority to be given to books that are downloaded frequently, and for mobile phones to be used as electronic dictionaries. A service for paying bills by mobile phone, available mainly within Japan, has also become popular. There has thus been a marked evolution toward a multifunctional mobile phone terminal.

At the same time we should not forget that underlying the introduction of these novel services on the mobile phone is the evolution of the Internet. The number of Internet users in the world rose from 270 million in 1989 (when access via personal computer was the main form) to more than one billion at the end of 2006. Considering the strong correlation between rates of Internet connection in different parts of the world and gross domestic product per head, there is no doubt that economic growth in the BRIC nations and other countries will be accompanied by growing rates of Internet connection. The bandwidth supplied is progressing from narrow band to broadband and mobile telecommunications speeds are set to reach 100 Mbps in the fourth generation, equaling the speed of a fixed LAN high-speed broadband connection. These various technical innovations seem set to finally realize the concept of the 'ubiquitous' society, one where there will be an access from anywhere, at anytime, to mass volumes of data.

What are the Changes in the Social Environment Driven by Technological Change?

For the advent of the ubiquitous society to be realized fully, one essential is an easy-to-carry mobile phone handset with advanced functions as abovementioned. The evolution of these devices is likely to accelerate in the future. At the same time, the home environment will also change greatly; it will probably become possible to use mobile handset from outside to control digital household appliances networked around the television set. It will also become possible to gain access at anytime, from anywhere, to the range of data stored at home. This has already begun with experimentation and testing carried out in monitored environments equipped with these advanced appliances to identify new issues. As the importance of new telecommunications technology to drive forward this creative intellectual activity continues to grows, so too will the need to establish technology to provide personal data security and safe and reliable infrastructural technology that cannot be knocked out by cyber terrorism or major natural disasters.

These major changes in the social environment of electronics seem likely to drive needs for hitherto unimagined new services, and there will naturally be ever greater demands placed on electronics-related technology to provide highly advanced solutions to meet these needs.

Driving Technology Research and Development to Create Products that Can Deliver Value

As outlined above, the electronics industry of the future is likely to become more and more advanced in level. For enterprises delivering products to support this development, the question of how to acquire novel technology that realizes advanced functions is important. Naturally, enterprises need to make timely investment in research and development to acquire novel technologies. However, in a situation where change and evolution are accelerating exponentially, recouping the research and development funds invested as quickly as possible and reinvesting them into the next novel research and development project is a way of minimizing financial risk.

If we accept that technology is a way of allowing a desired function to be operated freely and at will, then we can say that research activity itself constitutes acquisition of technology. It follows that our mission is not to pursue science for its own sake as in university-level research, but to use science to develop technology. For this purpose, the enterprise needs to imagine from the initial stage of research the countless possible fields of application contained in the research and use surveys and experiments and other forms of academic inquiry to narrow down the range of fields of application.

To express the value of technology, we often use the

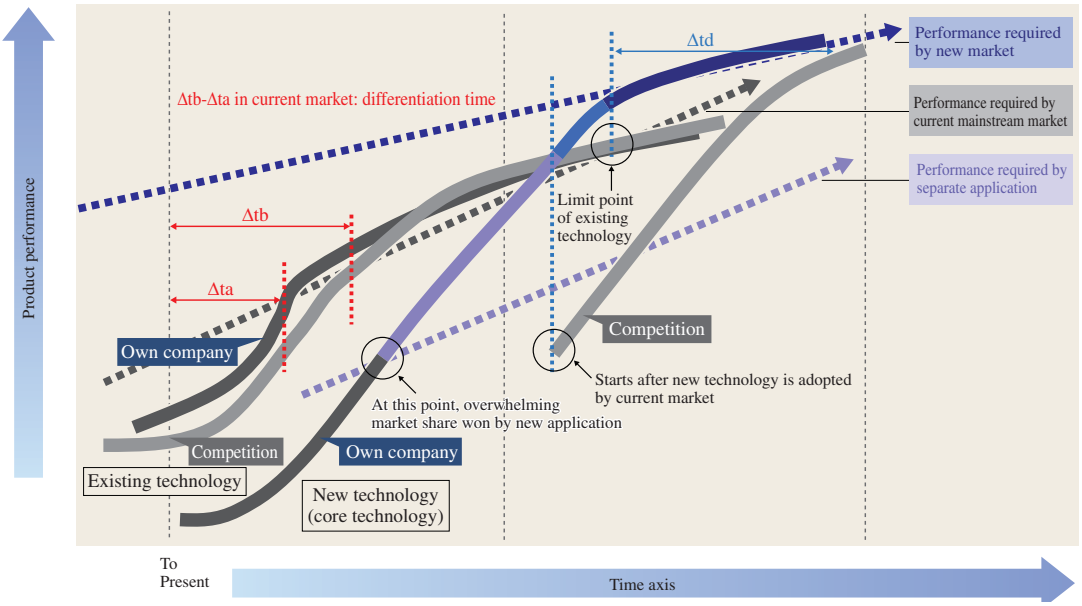

Fig. 1 Diagrammatic representation of 'differentiation', an important aspect of corporate research and development activity

word 'differentiation'. However, the definition of this 'differentiation' is surprisingly vague, and it can be said to represent a kind of implicit knowledge with different interpretations from individual to individual. Disregarding the danger of misunderstanding with an attempt to define 'differentiation', we can say that it means not achieving a state of uniqueness but reaching the number one position and maintaining a lead of at least one and preferably two years (**Fig. 1**).

Of course in a perfectly competitive market where 'dead heats' are widespread and scale is decisive, there will be environments to which the curve shown in **Fig. 1** (differentiation curve) does not apply, but at a company like ours which proclaims a Global Niche Top strategy, I think that pursuing differentiation-conscious research and development is crucially important.

The differentiation curve itself signifies core technology which has potential for wide-ranging application and development. From the initial stage of research and development, there is a need to be strongly aware of the application and development of new core technologies to multiple markets and to work to satisfy the functions required by combining in the core technology a number of component technologies specific to individual fields of application.

Of course, in order to realize the functions required by existing markets, it is important for manufacturers to progress with continuous routine technology development. In the technology development teams of departments engaged in promoting competitive strategies, there is a need to improve the proportion of resources allotted to this continuous technology development. However, the demand from society and the market for increasingly advanced functions is unceasing, and the timeframe within which the expected values have to be realized is being drastically shortened. It is envisaged as a result that the realization of functions using existing technology alone will become difficult. Under these circumstances, a major mission of corporate research and development is to prepare promising technologies able to realize advanced functions that cannot be achieved with existing technology and which have the potential for wide application and development in the future not only to existing markets but also to latent markets of which there is not yet a great awareness.

In the initial stages after work begins on this kind of discontinuous innovative technology development, it is generally the case that the functions it is able to realize are inferior to those of current technology. However, there is a high likelihood that the high potential inherent in the technology will in the near future allow it to supplant the current technology. These technologies need to be fostered with faith in their potential, but early recouping of investment costs is nevertheless an important issue. Therefore time should not be spent merely in making this discontinuous novel technology fit the future required functions of existing markets; there is also a need to consider adaptation of the technology to other markets where it can be applied practically at an earlier stage. This is the timepoint at which lead users of the innovative technology are identified and it is important by this time to have set up a basic intellectual property barrier to protect the company's interests.

A major difference between technology research and development now and in the past is that the timeframe until identification of lead users has become much shorter and it is no exaggeration to say that the success or failure of product commercialization depends on how quickly multiple strands of technological knowledge can be acquired. For the purpose of this acquisition of knowledge of 'desired' technologies, it is important to move away from the conventional research style in which everything is undertaken in house to a strategically implemented style embracing global coordination with exterior entities. At the stage of recognition by lead users, it is also important to maintain at least the overwhelming lead in market share, if not a monopoly, which will make it possible to raise capacity in production technology in a monopolistic fashion in line with the learning curve. As a result, it will be possible to establish high-quality brand strength among customers.

How Marketing Can Add High Value in Advanced Function Societies?

A phrase which has become part of the Nitto Denko corporate language is *Sanshin Activities* (meaning 'three new activities') which describes an approach to creating new products (**Fig. 2**). This approach is very simple and convincing. By accurately inferring next-generation needs from the periphery of current technology and adding new component technologies, new products that appropriately meet customer requirements are created. In some cases,

this can mean taking existing products based on current technology and developing them for new markets or new applications to create new demand. As will be clear from this description, an important aspect in this field of activity is to gather information faster than competitors from a wide range of customers. In connection, a strong point of Nitto Denko marketing is that the periphery of the markets in which it deploys its products are extensive; without exaggeration it can be said to consist of the intangible asset of the customer relations it has built up in the past with several tens of thousands of companies. Naturally, this marketing technique still operates powerfully today and in the future too it will be important to maintain still stronger customer relations. However, one parallel phenomenon which has become increasingly important is a growing reality where even customers do not know what functions will be needed in the future, or, if they do, nevertheless do not know how to realize them in product design. In this way, the degree of complexity of the technology that is required to create advanced functions that far exceed expectations has itself become ever greater, so that there are now cases in which the conventional *Sanshin Activities* alone are not sufficient to deliver new value.

In such cases, in addition to the materials and parts technologies in which Nitto Denko has a strong tradition, it will be important to acquire an understanding of a wide range of technologies from devices and modules through to appliance design and to acquire the ability to offer solutions that make customers think 'we never realized that was possible!' As mentioned above, under these circumstances, it will be necessary to effect global sharing of the maximum amount of knowledge and expertise irrespective of corporate boundaries. Also, to realize advanced functions, it will not be sufficient to utilize a single scientific discipline which has been established independently hitherto; ideally, a number of specialist fields will be fused at an advanced level. For instance, in realizing high-speed signal processing in the electronics of the future, a part will be played not only by electronics but also by a combination with optics technology. The ideal situation would be for researchers with a highly differentiated set of specialization of similar values working together in one team on advanced research and development activity to create future value. This team would include chemists and electrical and electronics specialists who can supply the materials, and physicists, who explore why things happen the way they do, and biochemists and biologists, who help us understanding natural structures which have evolved over long periods of time. It would not be going too far to say that robotics is a collection of

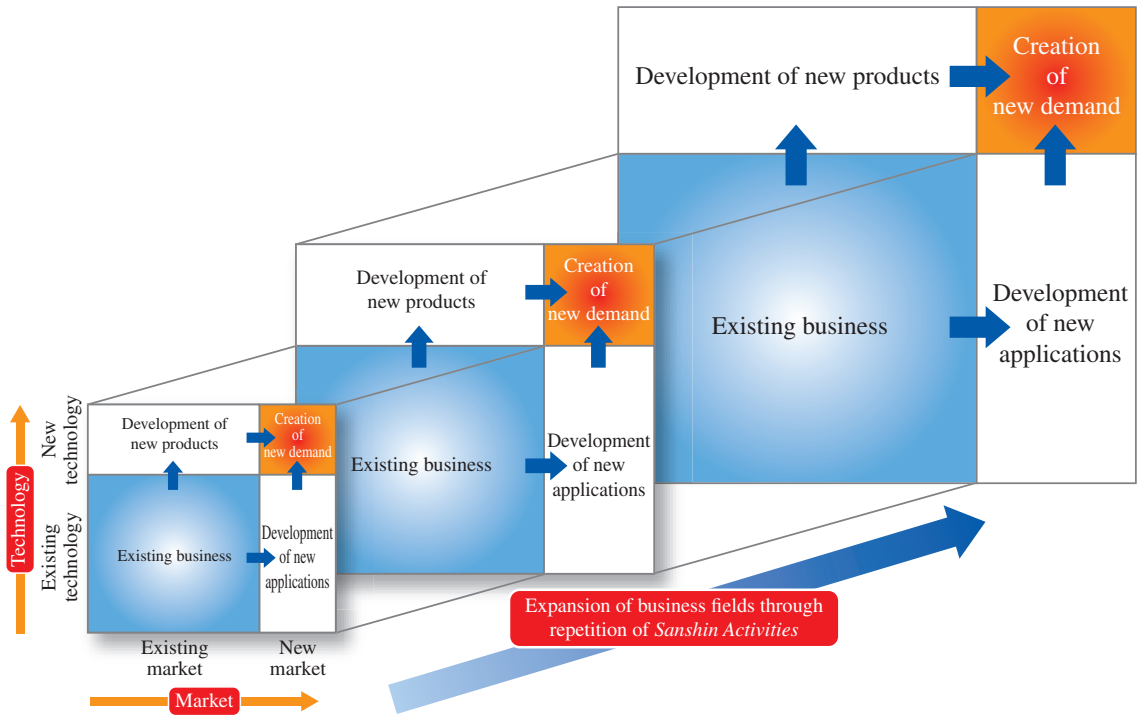

Fig. 2 Diagrammatic representation of Nitto Denko Group's *Sanshin Activities*

high-level fusion technologies derived from industrial mechanical engineering, which has created artificial intelligence based on the translation of neuroscience into electronics language and uses precise control of the signals produced to operate artificial muscles, artificial joints, and other parts derived from materials engineering. Elsewhere, the creation of humanoids equipped with the five human senses using biosensing, odor sensing, and related technologies would not be possible without multidisciplinary fusion. In the process leading to actual business creation, likewise, the vertical integration of a range of fields of knowledge and expertise seems essential, and it is important for departments ranging from marketing, research and development, production process development, production, and sales, through to coordination of customer operations to effect sharing of knowledge and expertise from an early stage to allow them to progress operations concurrently from an early stage (**Fig. 3**).

In order to efficiently fuse different fields, different sectors of industry, and multiple cultures in this way, it is important to visualize more vividly the kind of direction in which we need to proceed. This is where visualization technology for expressing an idea in concrete images, shapes, and figures is important.

Advance of Globalization and Standardization of Technology

In the past, the standardization of technology was normally a process which began at the start of the growth phase following market formation, but in the open and global electronics market conditions of recent years, it is frequently the case that the standardization of cutting-edge technology with a high degree of complexity is progressed in parallel with research and development prior to market formation. Outside the electronics sector too, in the nanotechnology and medical fields, and also in environmental technology, increasing attention is being devoted to technology standardization. In the Agreement on Technical Barriers to Trade (TBT), the members of the World Trade Organization (WTO) have agreed that where a worldwide standard exists or where such a standard is about to be put in place, that standard or the relevant parts of it will be accepted as the preferred standard. Because of this, standardization needs to be progressed from the technology research and development stage and this needs to be emphasized not least for reasons of reinforcing the international competitiveness of technology and products. Because this change in the environment has proceeded rapidly, it is now necessary to secure intellectual property rights relating to the standardiza-

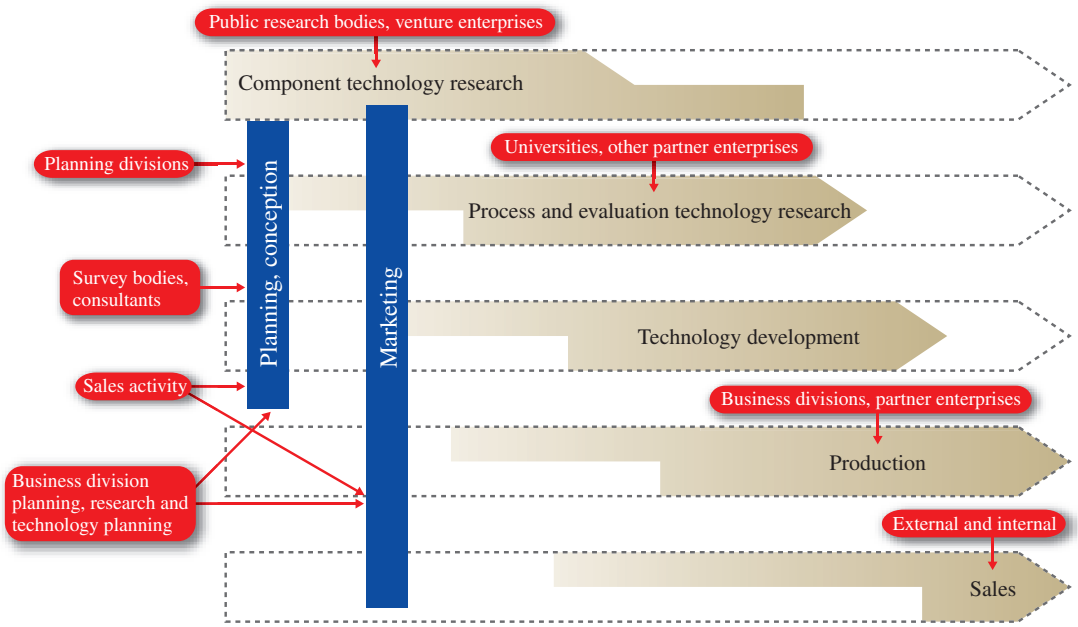

Fig. 3 Concurrent model of execution of operations from research planning to commercialization

tion technology, or to related technology with potential application thereto, in the initial stage of research and development (the period in the differentiation curve of **Fig. 1** from the initial stage to the stage of recognition by lead users). In some cases, where product development is carried out in accordance with these standardization technologies, technology including third-party intellectual property rights may already have been standardized, and in such cases, in a process known as open innovation, coordination with external entities and conclusion of strategic alliances will no doubt increasingly be used to create an environment in which the standardization technologies or related technologies can be introduced.

The main organizations overseeing international standardization, for instance the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and other influential international standardization bodies have each laid down separate patent policies. Since standards forums or standards consortiums have accordingly become the bodies that grant licenses, it is important to participate in these consortia from the initial stage and to monitor technical trends.

It has become essential from the initial stage of research and development to strive to build up an intellectual property portfolio, taking due account of strategic alliances, conformity with standardization technologies, intellectual property disputes, and other eventualities. This approach has become important not merely for technology research and development activities but as a factor directly influencing the future prosperity of the business which is essential for the opening and securing of new markets through business globalization.

Conclusion

From the above discussion, in order to meet the near future needs of the advanced electronic society, I outlined my approach to progressing research and development of technology with a high degree of complexity and to making it tie in with actual business operation. To repeat myself, a major difference between now and the past is that the speed of the initial phase of the differentiation curve has increased dramatically. Progressing all aspects in house as in the past will not allow us to win out over the global research and development competition and create technology that delivers future value.

In our everyday business, we need to maintain an adequate grasp of the core technologies that constitute our strength, to develop a concrete conception of the advanced functions that will guarantee the social needs of the future, to translate that conception into technology and then to visualize it. This makes it possible to obtain a clear idea of the amount of time permissible for acquisition of the required technology, which in turn makes it possible to smartly make the necessary strategic moves for technology acquisition according to a clear plan.

Within Nitto Denko, Nitto Denko Technical Co., a United States research base located in San Diego, California, explores the beginnings of the technology of ten years hence; in domestic research and development, meanwhile, we are devoting energies to increasing our bundle of core technologies with a view to practical realization of technologies and to combining these with a range of component technologies. Where necessary, the status of company-wide project (a company-level technology and business development system of project type under the direct control of the Chief Technology Officer) is declared so as to concentrate human, material, and financial resources to drive forward new product development under existing business divisions or in the form of new business promotion. Naturally, some time is required to complete this chain of activities, but in order to secure advantage and competitive edge in developing businesses that will make it possible to deliver value in the society of the future, knowledge transfer under conditions of external coordination at the initial stage is essential. Developing advantageous alliances in these conditions also requires the establishment of a strong intellectual property portfolio and enhancement of abilities in the areas of intellectual property protection, intellectual property evaluation, and the handling of contracts and licensing conditions based on a range of intellectual properties.

Looking ahead, we will continue to take forward our research and development activities, aware of the need to deliver value to the advanced electronics society, so that Nitto Denko products may be of use to the society of the future.