

### Creation of an Endless Upward Spiral of Research, Development, and Commercialization

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Innovation can be defined as creation arising from the process of research, development, and commercialization that is based on accumulated knowledge and experience and from interactions between highly motivated groups. The potential for innovation is greatest when barriers between groups are removed. Furthermore, a team that has been successful in fostering innovation earns the right to challenge itself to become even more creative in its endeavors. An organization that creates an endless cycle of research (R), development (D), and commercialization (C), which we might call an upward RDC spiral, can expect an avalanche of innovation and a dramatic increase in competitiveness.

The industrial revolution provides a good example of the process of innovation. In that era, engineers applied the steam engine to various industrial machines, systematized the principles of its operation in the science of thermodynamics, and extended those principles to the development of the internal combustion engine. In a similar manner, it is not hard to see how the birth and development of electronic circuits and devices including ICs (integrated circuits) and LSIs (large-scale integration chips) were driven by technology and work in scientific fields such as electromagnetism and quantum mechanics. Two key issues related to the formation of an upward RDC spiral involve finding a way to improve the quality of accumulated knowledge and speeding up each process. Here, basic research is essential if we are to accumulate knowledge, but such research is extremely time consuming because we must explore unknown areas. It is also important to maintain continuity in basic research, but this does not coexist well with the need to increase the pace of the upward RDC spiral.

NTT Basic Research Laboratories (BRL) has been active in a wide range of fields, including semiconductor properties, quantum optics, nanoprocessing technologies, materials science, and bioscience, and has been playing a leading role in basic research at the international level. Its strength comes, in part, from the large accumulation of scientific and techno-

logical knowledge and experience that it has inherited. However, we should continue to improve the quality of our research to enhance this strength. To achieve this, all researchers must be acutely aware of the significance, problems, and potential of the research themes that they are pursuing and explain their research to their colleagues. At the same time, these colleagues must recognize that they have an obligation to provide appropriate and constructive feedback. Actions such as these help formulate research strategies that include prioritizing, downsizing, or discontinuing research or increasing cooperation. For an organization, the construction of a system that allows information sharing and feedback like this is the first step towards increasing the pace of the upward RDC spiral and gaining trust from both inside and outside elements. To improve research efficiency, it is also vital to collaborate with external research institutions and establish mutually supportive relationships. Moreover, these research activities and their related management must be subject to external evaluations. These evaluations should lead to changes in the workplace, enabling a reliable and trustworthy research laboratory to be established. BRL will work to strengthen its research capabilities by establishing ongoing information sharing/feedback, collaboration, and evaluation in conjunction with organizations both inside and outside NTT and will create an upward RDC spiral. By becoming more competitive in our R&D efforts, we hope to contribute to NTT's business and to the acquisition of knowledge that will have universal benefit.

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