

We are improving development efficiency while strengthening marketing in R&D.



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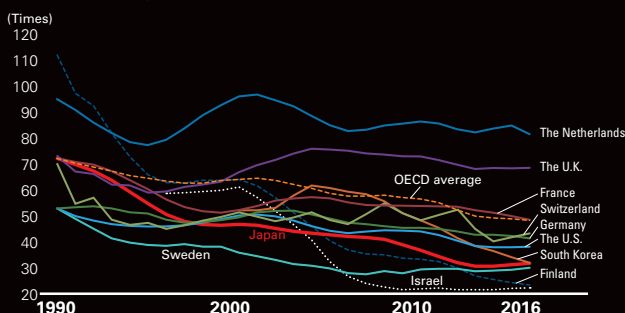
Megatrends

■ Rising Interest in R&D Efficiency

Around the world, interest in improving R&D efficiency has grown in various industries alongside advances in the globalization of the manufacturing industry, including the chemicals and electronics industries. According to research by the Organization for Economic Co-operation and Development (OECD), R&D efficiency at Japanese companies is lower compared with other advanced countries. Improving R&D efficiency has become a priority at TOK and other Japanese companies amid labor shortages caused by declining birthrates and an increasing elderly population, as well as greater demands for better capital efficiency.

TOK is strengthening marketing in the development divisions in addition to the marketing divisions, while continuing to focus on the development of higher value-added niche top products. At the same time, TOK is improving R&D efficiency by introducing elaborate methodologies for activities in each development project.

R&D efficiency in advanced countries



Source: Ministry of Economy, Trade and Industry, based on OECD Main Science and Technology Indicators (as of November 7, 2017)

* Corporate added value and R&D spending five years prior (purchase power parity conversion) is calculated using the ratios of trailing five-year moving averages.

Risks and Opportunities

■ Rapid Technological Innovation Presents Both Risks and Opportunities

In “unknown domains” not currently visible on the 5G and IoT markets, technological innovation is likely to proceed with a greater-than-imagined speed and disruptiveness.

Concentrating on the development of materials in cutting-edge semiconductor fields, TOK always engages in R&D amid competitive forces, and is well aware of the risk

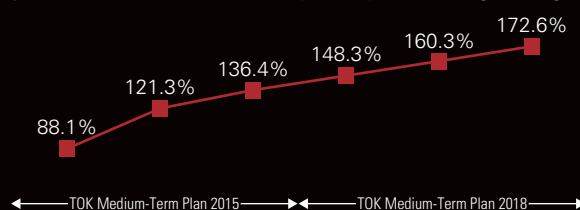
of losing customers to rivals in the competition to develop cutting-edge materials. When customers switch to new cutting-edge processes, we see this as a prime opportunity to propose and have new materials adopted by customers. The Company’s development divisions have been focusing on winning new business opportunities while working closely with the marketing divisions. Since its founding, TOK has developed business in niche markets, so sudden and volatile changes do not come as a surprise to the Company (change is normal). Change is viewed as an opportunity for the Company to leverage its strength in development capabilities.

R&D Strategy for 5G and IoT Markets

■ Capital Investment in R&D

TOK’s business model is based on the constant development of high value-added products for niche markets. As such, the Company spends roughly 8% of net sales on R&D, far higher than the averages of 2.7%*¹ for the chemical and petroleum industry and 4.0%*¹ for the electrical equipment and precision machinery industry. TOK will firmly maintain this policy in the future, and is keen to improve development efficiency to increase capital efficiency and corporate value with the outcomes of its development initiatives. The Company’s R&D efficiency*² has followed an uptrend over the previous two medium-term plans, the “TOK Medium-Term Plan 2015” (FY2014/3–FY2016/3) and the “TOK Medium-Term Plan 2018” (FY2017/3–FY2018/12), and we are turning our attention to the following initiatives to increase efficiency further under the “TOK Medium-Term Plan 2021.”

Uptrend in TOK’s R&D efficiency (five-year moving average)*²



2014/3 2015/3 2016/3 2017/3 2017/12 2018/12

*¹ Average of totals for FY2014/3 through FY2016/3. Source: Nikkei Smart Work Survey on April 20, 2018

*² R&D efficiency = Operating income in the most recent five years/R&D costs over the previous five years

■ Marketing Also Plays a Vital Role in R&D

Strengthening marketing is the highest priority in our aim to increase development efficiency. In the development divisions as well, the focus of our efforts is the company-wide strategy (2) “Strengthen marketing, increase understanding of the customers’ value creation processes and translate these efforts into new value creation” in the “TOK Medium-Term Plan 2021.”

More specifically, we will roll out development strategies with an eye on the future, scrutinizing target markets and communicating closely with the marketing divisions from the initial stage of project inquiries. After the start of each development project, due attention is paid to changes in customer requests and technological trends in the market, and functional definitions are refined for new high value-added products by both the marketing and manufacturing divisions.

■ Toward Long-Term Sustainable Growth with “Continuous Growth” and “Discontinuous Growth”

Marketing in the research and development divisions is approached from both “continuous growth” and “discontinuous growth” perspectives. We aim to maintain “continuous growth” by pulling ahead of the competition in the current market where development competition has already begun (i.e., red ocean strategy), while also attaining “discontinuous growth” by agilely addressing newly emerging needs (i.e., blue ocean strategy). We believe both strategies will lead the Company toward sustainable growth over the long term. On the 5G and IoT markets, TOK will firmly address recently emerging issues at customers and technological needs. In the “unknown domains” of IoT sensors, advanced packaging processes, and high-frequency devices, we will rapidly respond to emerging needs.

■ Combination of Agile Development*¹ and Waterfall Development*² Methodologies

We are focusing on agile development methods as a specific way of rapidly responding to needs. As a recent example, we used an agile development approach to develop EUV photoresists for the 7nm node for a Taiwanese customer. For the development of clean solutions for the 10nm node for a North American customer, we used a combination of agile and waterfall development methodologies to successfully realize high added value in this cutting-edge field. We will also apply these methodologies to “unknown domains” in the 5G and IoT fields.

*1 Agile development: Mainly used in short-term projects, this approach to development is a repeating process of immediately responding and adjusting to frequent changes in development requirements.

*2 Waterfall development: Mainly used in long-term projects, this approach to development defines final specifications at an early stage, and then follows carefully laid out plans.

■ Introducing AI to Enhance Efficiency of Discovering and Verifying New Materials

To further enhance development efficiency, we have been creating a structure for visualizing our knowledge and expertise accumulated over many years in semiconductor photoresists and high-purity chemicals, and then sharing

this data throughout the development divisions. Since April 2018, the Company has concentrated its efforts on Materials Informatics (MI), which uses AI and big data in material development to increase efficiency in the discovery and verification process for new materials, and has also been putting its legacy knowledge into databases. During the “TOK Medium-Term Plan 2021,” the Company aims to build databases in cutting-edge fields and produce results from the partial utilization of these databases.

Strengths in R&D

■ Human Resources with Deep Pools of Talent

TOK launched its photoresist business in 1968 as a pioneering manufacturer of photoresists in Japan. Since then, the Company has made numerous technological breakthroughs while painstakingly fulfilling customer needs in each generation of miniaturization, from novolac photoresists (g-Line and i-Line photoresists) to chemically amplified photoresists (KrF and ArF excimer laser photoresists, EUV photoresists), building strong relationships of trust with customers around the world. As a result, our human resources represent deep pools of talent earned from extensive experience and know-how accumulated over past generations of technology. By passing down and further honing this strength, we will lay a rock-solid foundation for sustainable value creation.

■ Measures to Develop Human Resources Specializing in Development

TOK has the Level-based Training Program and the TOK Global Practical Training for Selected Members as its education programs for all employees across the divisions. In the Research and Development Dept., we have our own unique human resource development curriculum, in addition to these other programs. In the “TOK Medium-Term Plan 2021,” the company-wide strategy (3) is to “Strengthen human resources who can perform research, make decisions, and take actions on their own initiative.” This has been the aim of the Research and Development Dept. before this new medium-term plan even began. In addition, we have identified the “10 qualities of successful development,” such as “Continue to take the initiative until successful without giving up.” From this perspective, we are committed to developing human resources who can continue to produce results on development projects in cutting-edge fields. We are currently working to further systemize and visualize these education systems, and tie them into employee evaluation systems.

Outline of Human Resource Development Measures in the Research and Development Dept.

“10 qualities of successful development”

1. Think, research, decide, and take action on your own initiative
2. Continue to take the initiative until successful without giving up (3. onward omitted)

[New employee training] Basic training program for 2 hours a week (includes tests)

[Section manager training] Training on how to guide and educate subordinates in development projects

[General manager training] Exclusively developed training based on MOT (Management of Technology)