

Improving R&D Performance through Networking – Lessons from Canon and Sony

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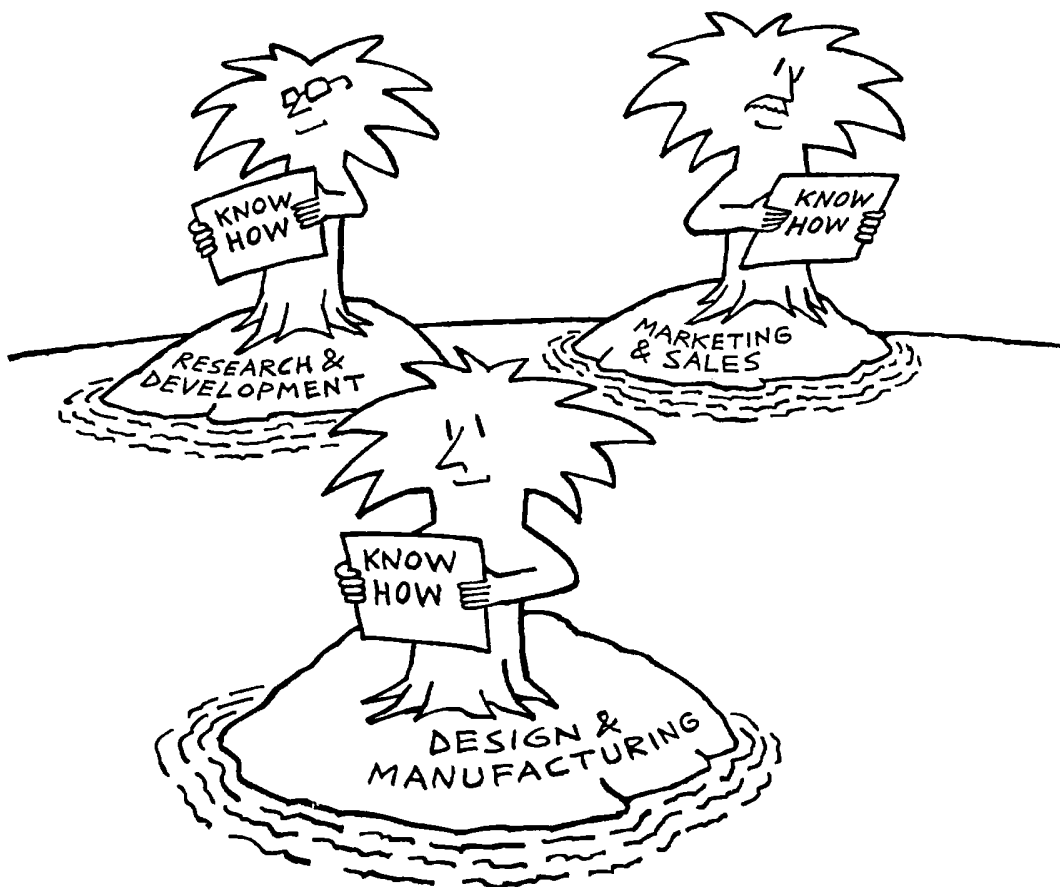
The cost and complexity of R&D efforts today, coupled with accelerating technological change and shrinking product lives, create an urgent need to improve R&D performance. Canon and Sony do this by focusing their internal R&D efforts on the commercialization of technology, while going outside to source specialized technologies and competencies. In this article, we will argue that external sourcing of advanced technologies and their related competencies actually enhances a company's ability to perform market-driven R&D and to commercialize these technologies. We first examine how Canon and Sony keep their R&D activities responsive to market needs, and then discuss the link between R&D and Manufacturing.

Rooting R&D in Market Needs

Like most Japanese companies, Canon and Sony view the principal role of central research as one of training and education. Their capability to learn from external centers of excellence replaces excessive internal efforts to develop specialized technologies. Instead of too-narrow specialization, their internal R&D staff acquire a highly cross-functional competence base that focuses on seamless innovation and commercialization.

Three key principles ensure that all R&D activities respond to what the market really wants:

- A license to do R&D always requires experience from Marketing and Sales (M&S), and most R&D people remain in frequent contact with customers.
- Product planning and important M&S functions – often staffed by engineers with rich technical experience – are in continuous contact with R&D.
- Frequent forums of interaction bring people from R&D and M&S, as well as product managers and strategic business unit (SBU) managers, together for joint brainstorming on new product concepts.



Specialized know-how can't contribute to overall R&D efficiency while it remains locked in isolated functions.

A license to do R&D always requires experience from M&S. Canon and Sony give their new R&D entrants, including senior researchers, at least three months of M&S training. According to Dr. Makoto Kikuchi, who was Sony's research director for almost 15 years, this is – together with production training – the most important part of researchers' education. If the market demand should fall and Sony experience overcapacity within development or production, engineers can easily be sent back to sales again on a temporary basis. Dr. Kikuchi stated that „in addition to the necessary understanding of customer needs, our company members realize Sony's vulnerability in respect to changing market demands.“

R&D interaction with sales units is a continuous process, as explained by Miho Fuji, who demonstrates products in the Sony Building on the Ginza, an important Sony outlet in Tokyo: „Five days a week we have meetings with people from the Marketing & Sales Department to discuss customer reactions. Development engineers of course take part in these meetings as well. The project leader of a new product always comes to see us before his product is launched, so that he can explain its characteristics. After the launch, he comes back regularly to get feedback on customer reactions.“

To promote further cross-functional learning from the customer reactions, the showroom staff writes monthly reports that are distributed to all R&D departments, product groups, and marketing departments.

Product Planning and important M&S functions are in continuous contact with R&D. „At Canon, Inc., we don't have many company members with business school backgrounds. Instead, we let our engineers move into planning and marketing divisions, in order to gain experience there. Afterward, these engineers are better at bringing back knowledge from the market to the team.“ (From an interview with SBU Manager Kawashima)

Each of Sony's business groups has a resident Japanese product planner in each important market, who is in daily phone contact with the development division of his or her product group. These product planners also make monthly trips back to Japan, thus supplying a continuous flow of information on competing products, customer feedback, and market needs.

Expatriated product planners are typically engineers, as they must understand the engineering capabilities of their development divisions back in Japan. They must also be able to weigh the business opportunities that the subsidiaries bring to them and communicate these strategic considerations to SBU managers and R&D people in Japan. Similarly, planning and marketing functions at Canon are mainly staffed by engineers who have been transferred from a research, development, or production-plant function, with which they remain in frequent contact. Consequently, key participants throughout the value-creation process all have enough cross-functional skills to ensure seamless communication between M&S and R&D.

Frequent forums bring people together for brainstorming on new product concepts.

„The critical factor of any R&D management is to make sure that researchers, development engineers, and product group managers meet as much as possible, so that both competencies and technologies can spread throughout the organization“ (Kikuchi, interview). The Research Planning & Coordination Group at Sony creates a strong interface between Sony's top management and all important technology developments. This group works as an executive group, reporting directly to the President of Sony on a weekly basis.

Every Tuesday morning, the Research Planning & Coordination Group organizes a visit to one or several of Sony's most interesting R&D projects. Afterward, a long lunch meeting is held among the members (i.e., 18 top managers, usually including the Chairman, the President, the Research Director, and the managers of the most important product and marketing groups). The lunch is often followed by a Research Report Meeting, with focused presentations made by researchers on their specific achievements and their possible practical applications. These presentations help senior management make strategic decisions on whether to keep the project in the Research Center or transfer it to a product group's development division.

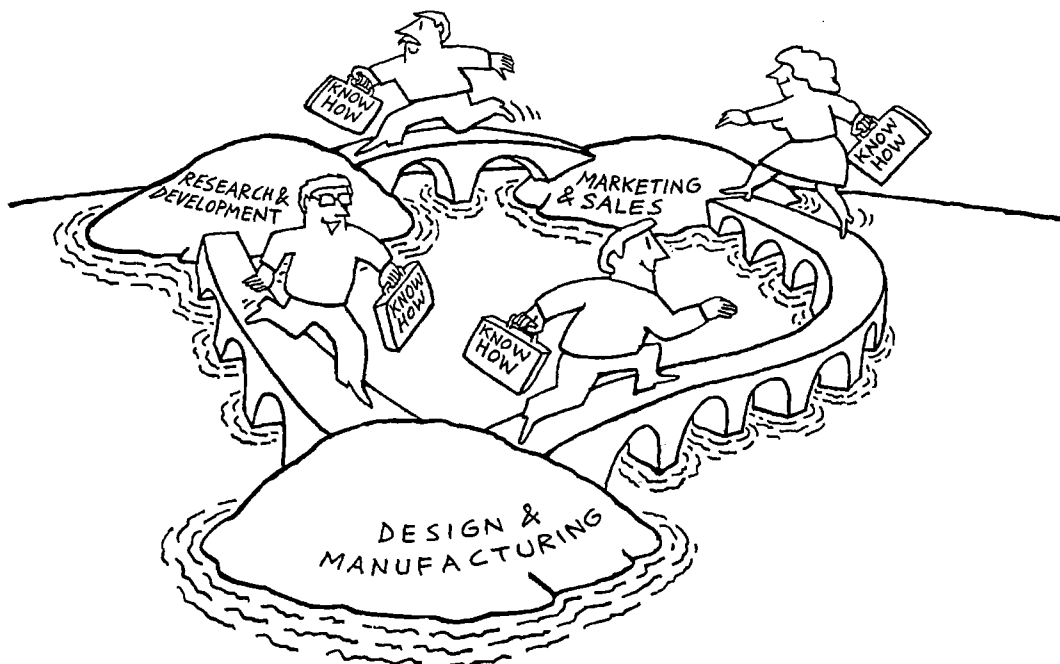
During the time that Dr. Kikuchi served as Research Director, he concurrently presided over the Research Planning & Coordination Group. His most frequently used method of spreading the technologies of his Research Center was to invite one of the product group managers, quite informally, to make a presentation on an ongoing project and „make them hungry for our technology.“ Thanks to the above lunch meetings, he knew all these managers and their technological needs, as well as their needs vis à vis the market. If the invited manager became interested in the technology, he would send a few skilled engineers from his business group to join the research group 6 to 12 months before the project's research stage ended. These engineers would then play a key role in the transfer of the project by setting up a similar project in their business group's development division and continuing with a practical application of the technology in question. In an interview with Sony's founder and previous Chairman, Akio Morita, he stressed the importance of having such a business-oriented Research Director: „Dr. Kikuchi is a very important person within Sony. Not only is he an excellent scientist, but also he is a good businessman. Above all, he has good foresight. These are all focal points of a perfect Research Director.“

The Research Planning & Coordination Group also organizes a large number of less frequent forums for interaction. For example, annual Sony Technology Exchange Forums offer an extensive presentation of Sony's technological capabilities by all researchers to all product, marketing, and sales managers, who are potential buyers of technologies or sponsors of research projects. The primary goal is to find practical applications for existing technologies and competencies as well as to enhance their cross-fertilization. As each important sales group also has a booth of experts, displaying sales volumes, trends, and forecasts for their respective products, R&D people learn more about market needs as well.

Bringing R&D Results to Manufacturing

Both Canon and Sony have seamless innovation processes that flow from Research through Design and Manufacturing (D&M). In these companies' terminology, „research“ mainly consists of building and trying a product prototype until it works. „Design“ usually implies the designing and development of a manufacturing process that can produce a perfect copy of the prototype. D&M runs and develops the trial manufacturing line until quality, speed, and costs are adequate. Three networking mechanisms support this process:

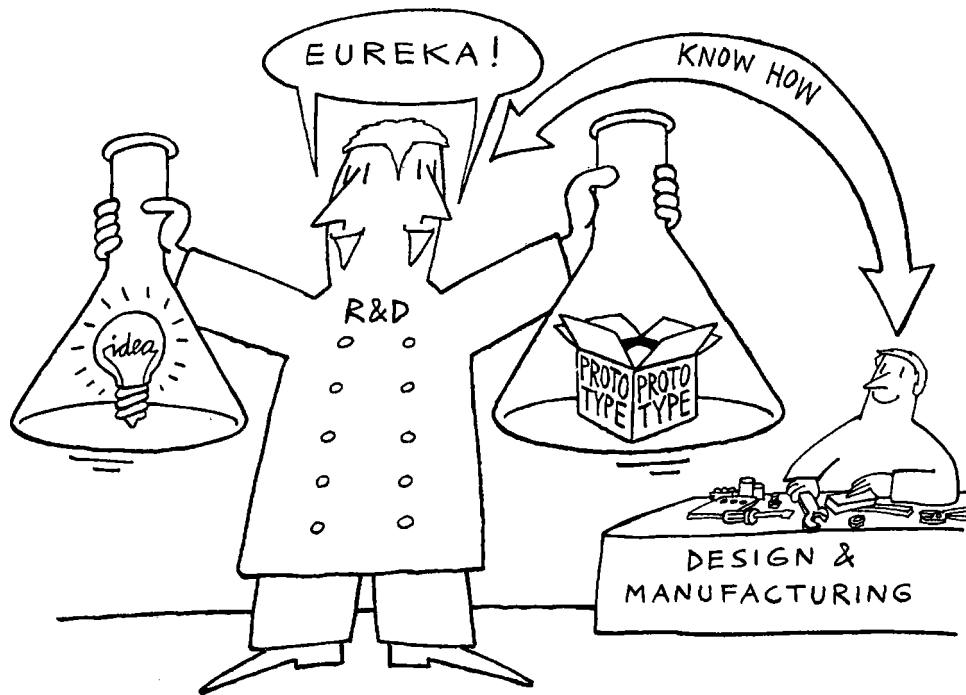
- Strategic training and rotation of engineers give every member of the innovation process a holistic understanding of the seeds of technology, the needs of the market, and the requirements of manufacturing.
- A focus on prototyping in the research stage encourages researchers to exchange knowledge with manufacturing upfront.
- Direct transfer of flexible researchers to the factory floor drives technological competence into production processes and products.



Strategic rotation of employees creates essential know-how bridges among R&D, D&M, and M&S.

Strategic Training and Rotation of Engineers.

The basic principle that lays the groundwork for the strong sense of partnership between Research and D&M is that of building multiple skills through job rotation. All researchers and engineers at Canon and Sony pass through an initial training program that begins with one to three months of work on a production line. (And all researchers and engineers know that they may be asked to return to a production line if extra production capacity should become necessary.) To increase learning within the Canon Research Center, most of the 200 engineers and researchers are relocated every six months for knowledge-sharing with new colleagues. At Sony, Semiannual Open-House Meetings gather approximately 1,000 people, including: managers of research divisions and their different research group leaders; sales, development, and production managers of all product groups; and patent engineers and patent attorneys. These people get together to discuss research projects and future technologies. Moreover, the Sony Technology Symposia gather between 150 and 200 engineers and scientists every three months. These corporate networking processes are aimed at knowledge-sharing both across functions and across business units.



Sony's *shanaï koubo* system supports open borrowing of development engineers across divisions. Individual development engineers are free to volunteer for specific development projects, regardless of which business group or research unit initiates the project. In addition to diffusing competencies across business units, this system appears to increase the chances that a project will be supported by truly motivated members.

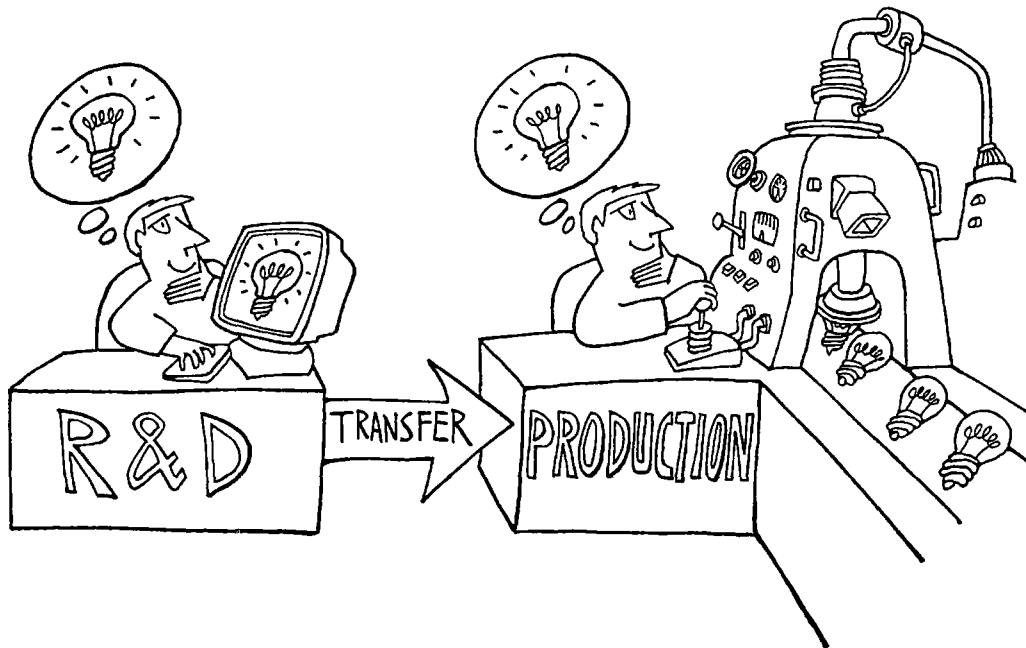
Focus on Prototyping in the Research Stage.

The Research for the D&M approach taken by Canon and Sony also implies that practically no research activity is approved unless the researchers have a commercial application in mind at the initial stage of the research proposal. This market-driven research is maintained through the practice of having internal groups sponsor individual researcher's projects, as demonstrated through prototypes. Initially, researchers have some liberty in choosing fields of research. After a certain time, however, they must find sponsors for their research. In order to attract sponsors, they prepare a „technical sample“ (a technical sample is a very raw „barrack-prototype“ without any box around it). If the researcher then succeeds in convincing a business group to sponsor further research, the researcher gets the necessary resources to develop his or her technical sample into an engineering sample (similar to the technical sample, but more presentable in shape, which usually requires that components are miniaturized, if possible, and put into a metal shell). If this sample can be successfully demonstrated to the sponsoring business group, and the business group has or can have a commercial use for the product, the researcher is sponsored to develop a commercial sample. At this point, new engineers with production expertise are commonly added to the project. At the end of this stage, the entire team is usually transferred to a factory for the development of a prototype production line. The power of this mechanism is that research that cannot find an application is discontinued early on.

Direct Transfer of Flexible Researchers to the Factory Floor. „When I was working as a researcher in France, the greatest loss of information occurred in the junctions between research, development, and production. What strikes me most at Sony is that not only the product but the entire team is transferred from research to production.“ (Interview, Dr. Le Bellégo, senior researcher.

Regardless of their own desires, most researchers are requested to join a development center after some period of time in research. At Canon, we observed that if seven to eight researchers took part in the most upstream stage of an innovation project, five of them typically remained through the different production stages. Approximately 50 percent of Sony's researchers are pushed out of the labs after 3 years and 80 percent of them after 10 years. Once they have left research, they usually do not come back. This implies that the upstream Research Center offers more a period of education than a long-term opportunity.

Sony's former Research Director Dr. Kikuchi stated, „Many of our engineers start their careers in the Research Center, where they usually spend three years doing fundamental research and experiments. We give these engineers some time for doing research. Even if it doesn't always bring results, it is fundamental for their training and understanding of technology.“



This quasi-institutionalized transfer of engineers from development to production is particularly useful for new technologies. If the technology of a product is new, none of the existing engineers in production are likely to have prior experience in the field. Consequently, the transfer of the original researchers becomes imperative.

For those researchers who consider themselves too talented or specialized to leave research, the firm usually identifies and sponsors a university research position, which is then used as an external center of excellence. Another solution is to offer specialists an opportunity to start a spin-off, supported and used in the same way.

Pushing researchers out of the labs after only a few years leaves little room for technological expertise to develop. The most important mechanism to support commercialization is therefore extensive networking with external centers of excellence and key suppliers. In this way, Canon and Sony avoid excessive internal research efforts by specialized researchers – who may refuse to leave their labs. Canon's project on ultrathin displays serves as an excellent example of sourcing a Western technology that nobody dared to invest in because of lack of manufacturing expertise. Canon's research in this area expanded from a three-person task force to a 200-person operation, with 90 percent of all R&D members located directly at the site of production. Instead of losing time developing extensive internal scientific expertise, they could use their external networks to acquire the necessary specialized skills.

It all began when Dr. Junichiro Kanbe – who was asked to identify Canon's future key-technology for displays – discovered FLC (ferroelectric liquid crystal) technology through an „Applied Physics Letter“ written by the inventors, Dr. Sven Lagerwall from Sweden and Dr. Noel Clark of the United States. Contacts were established between Canon and the two scientists, and Dr. Kanbe initiated a small task force to work on FLC technology. He had a lot of samples of the new FLC liquid formula prepared by engineers in the Central Research Laboratory, but it was through his close involvement with former colleagues in production that critical glass-plate prototypes for FLC technology were successfully prepared. Canon immediately sent some people to the University of Colorado and to Chalmers University for support in the science of physics. Professor Lagerwall and Professor Clark were engaged to make frequent visits to Canon, in order to provide the necessary competencies in material design and other related research activities. Canon also pursued joint development with a leading supplier and maintained R&D cooperation contacts with three professors at two domestic universities.

Senior researcher Hirokatsu Miyata joined the material analysis division of the Canon Research Center in 1989 to work on FLC materials but was soon dispatched to Tokyo University to learn new skills required for advanced material evaluation. On his return to Canon, he was assigned to the new-generation FLC task force, for which he now works three days a week, commuting between the research center and the production plant.

The Display Business Operations Manager Hirokuni Kawashima coordinated the knowledge-creation process by simply putting the right people together:

„Knowledge from external divisions is brought in, whenever necessary, by moving in members from these divisions. As a result, a project team is not rigid in form, but rather transitory and flexible through the continuous moving in and out of members.“

As FLC displays had never been mass-produced before, some additional manufacturing know-how, as well as new equipment, was necessary. Canon maintained close contacts with several suppliers of advanced production equipment for the purpose of remaining up to date on all state-of-the-art production technologies and increasing the competitive pressure on the suppliers. Equipment was not purchased until it had been confirmed for full-scale manufacturing, which left Canon with the flexibility to try different production technologies throughout the project.

Some of the interface software engineering activities took place in Canon's software lab in Shin-Kawasaki, but the larger part took place in the Canon Information Systems Research Lab in Sydney, Australia. Canon achieved effective know-how transfer through continuous rotation of engineers between these labs.

It is clear that most transfer of knowledge from inventive concept ideas to innovative production processes took place through the immigration of engineers from specialized and sometimes external units to a rather organic project team structure. Then, by transferring most internal researchers and engineers directly to the manufacturing floor, Canon ensured that all necessary competencies were effectively integrated into a production process, rather than remaining isolated in upstream research labs. This is how Canon succeeded in commercializing a technology that was invented, but never produced, in the West.

Hence, through a holistic network approach to R&D – drawing on global competencies and their cross-fertilization – Canon's Japan-based researchers and engineers could keep the manufacturing floor as core of the entire R&D process and thereby increase its performance in terms of commercialized innovative output. The stronger specialization focus of many Western organizations prevents them from achieving the same effectiveness in knowledge processing and cross-functional cooperation.

By excelling at identifying and acquiring external expertise, both Canon and Sony have been able to develop highly flexible organizational structures in which multiskilled engineers with common frames of reference come together organically whenever there is a performance challenge requiring collective effort. These flexible structures, in turn, have created a unique ability to spread knowledge effectively from Research to Manufacturing, while continually ensuring that it has value in the marketplace.



Leveraging know-who contributes to global learning.

Ultimately, the knowledge-creating R&D process is no longer limited to individual know-how, but draws instead on know-who – and unlimited global sources of invention that continually nurture internal learning and improve R&D performance.

Note: Most of the data for this article was gathered between 1992 and 1994. Some of the practices identified in the two companies may have changed since then. The Research for the D&M approach is described in more detail in Prism first quarter 1995.

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Illustrations by Arend van. Dam