The Role of the Research Director (ERATO)

TAKAO SOMEYA
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING,
THE UNIVERSITY OF TOKYO, JAPAN

The Exploratory Research for Advanced Technology (ERATO) program was established in 1981 in the Japanese Research Development Corporation (JRDC), which is now known as the Japanese Science and Technology Agency (JST). ERATO is the flagship program of the JST. As outlined in the program overview of the JST, the objective of ERATO is the realization of a "human-centric research system" that fosters research communities and respects the creativity and leadership of the research director. I had the honor of serving as the research director of the Someya Bio-Harmonized Electronics Project from August 2011 to March 2017. I would like to talk about my experiences during my time as the research director.

ERATO is not just a contractual research program with a large budget. Our unique organization can handle numerous challenges that no other organization can. How are we different from other systems? Briefly, it is in our "human-centric research system." I will explain this after I present three concrete examples.

Before I introduce the first example, I will describe our research organization as it was during the proposal stage. We were making progress on research when we sought to apply a rubber-like elastic device to machine-based skin sensors. ERATO proposed shifting our focus from machines to humans while developing this concept. We concentrated on flexible and biocompatible organic materials instead of on conventional inorganic materials like silicon. We aimed to develop a novel bio-organic device that could strike a balance between organisms and electronics, with applications in the healthcare and medical industries.

Initially, the main theme was the development of our elastic device and implantation applications for brain measurements. We succeeded in manufacturing the world's thinnest flexible organic device in the first half of our project phase, and published three articles in rapid succession in *Nature* (2013) and other sister journals. These three journal articles were cited 2810 times (Google Scholar) as of July 2019. While still a long way off from identifying implantation applications, we anticipated numerous potential applications in the short- and medium-term for the device as a comfortable and wearable biosensor. We decided to change our research direction, adding a new unit called the Interface Group focusing on research that expedites wearable applications of our product.

The second example is our intellectual property (IP) program. Our objective in the practical implementation of the elastic device was clear from the inception. We played an active role in seeking IP protection and applications. This began with our IP management structure. A persistent issue associated with the public implementation of university research initiatives is the insufficient sense of organization with which an invention or development is seen through to the rights acquisition or application stage, partially because of the lack of sufficient IP personnel and the lack of awareness of licenses and patents. A major challenge in the early stages of our project was strategically handling IP issues with respect to groundbreaking technologies such as our elastic device.

Therefore, we solicited the help of IP Strategy Producers within the National Center for Industrial Property Information and Training (INPIT). We created an IP Working Group (WG) that supported the research advancement

director for the management of our IP, and included our patent attorney and IP Strategy Producers within it. The budding inventions were tasked to the IPWG and, in line with individual hearings, to researchers, while they were simultaneously managed for academic conferences and journal publications. We regularly surveyed patent applications worldwide in the field of bioelectronics, and readily adapted our IP strategy with every new development. We also regularly surveyed market behavior and incorporated it into our patent application planning process. This information gathering and planning was conducted jointly with the group leader committee, general committee, and researchers. We communicated with the JST regularly through our meetings, and addressed the patent applications and the planning processes involved. Thus, we were able to successfully file a patent for the essential components of the elastic sensor and associated inventions in subsequent filings. With this, we amassed a critical mass of patents necessary for our work.

The third example is our commercialization initiative. We began to take serious steps toward commercialization with the establishment of the Commercialization WG simultaneously with the Interface Group. We investigated numerous scenarios for transitioning from our research and development results to commercialization. We envisaged a venture company-based model that would work closely with local application system businesses to develop a new biosensing information market. We also investigated the financing, market channels, and IP applications necessary for the development of the venture company.

Even during this time, the battle lines were always shifting. In the same year that ERATO established our project (2011), the Apple iPhone 4 made it possible to watch videos on a high-resolution display, and the concept of ubiquitous computing was on the rise. In 2015, halfway through our project, Apple released the Apple Watch, and the wave of wearable computers and the Internet of Things (IoT) swept the world with astounding speed. Seeing this trend, we pushed ourselves to develop our venture company rapidly. We faced strict conflict of interest restrictions because of ERATO. We remain thankful for the numerous systems that were in place at the time, particularly our lawyer's counsel. When the Interface Group was added in 2013, we planned to start our venture company after the end of ERATO. However, we were ultimately considerably ahead of schedule and founded the university-launched venture company Xenoma in November 2015. Xenoma oversaw the practical implementation of a wearable motion capture system in 2018 and served as our first success story in the application of the project IP.

A constant expectation in this project emerged from how the links between teams from several fields, including from the materials, processes, and product stages, can result in a synergistic effect. To produce unexpected synergistic interactions, it is necessary for young researchers to both remain in their narrow fields of expertise and jump into new cross-disciplinary fields. However, the risk seems high because it is difficult to grasp fields that are outside one's own area of specialization. An integral part of the role of the research director is to change this mindset of young researchers. I gave young researchers who bravely sought to jump out their own fields the authority to do so. I also encouraged them to pursue research driven by their own ideas. The role of the research director after delegating this authority was to act as the rearguard while still encouraging the researchers. As the rearguard, it was essential to deliver the resources necessary for the researchers to fight their battles on the frontlines.

The research director also played a crucial role by maintaining these supply lines. In addition to providing research supplies and environments, maintaining supply lines includes all other aspects such as reconnaissance, strategic IP planning, journal publications, and press release support. We would always be one step behind if we tried to develop new funding schemes with each new development, given the constant changes in the relationships between the public and technology, such as the management of conflicts of interest. Timely research and development would be impossible without on-site decisions on changes in research direction.

The extent of permitted flexibility with regard to project decision-making ultimately returns to the amount of trust and authority that the manager invests in the project. This transfer of trust goes from the taxpayer to the Ministry of Education, Culture, Sports, Science and Technology, which is the overseeing authority; to the JST, which is the funding agency; then to the research director at ERATO; to the group leader; and finally to the research staff. The definition of "human-centric," which lies at the heart of ERATO, comes from the delegation of as much authority as possible from the JST to the research director. As a result, there is enormous discre-

tion allotted to on-site decision-making, which allows room for speed and timeliness. Going beyond the three examples of the addition of new units based on changes in social need, repeated planning changes based on the analyses of patent and technology shifts, and the mid-project development of a new company, nothing has ever gone exactly according to plan. It was always necessary to make adjustments on-site.

Meanwhile, the responsibility that came with having enormous discretion also included the duty to provide direct explanations to stakeholders, including taxpayers. This was why there was a heavy emphasis during the project on information transmission and propagation of results. The results were comprehensively published in academic conferences and publications, including in 56 technical English-language journals (e.g., 1 article in Science, 2 in Nature, and 13 in other sister journals). We issued 17 press releases and published 76 articles in newspapers on the important aspects of our research. Our work was introduced online and in major international media outlets such as BBC and CNN. We introduced our novel technology in a timely manner through exhibitions and an emphasis on its propagation. We put up 13 exhibition displays in all (10 domestic and 3 international), including those in the CES (US), the IFA (Germany), Innovation Japan (Japan), the International Nanotechnology Exhibition (Japan), and the Healthcare Device Exhibition (Japan). We also established an integrated research promotion society called the "Flexible Medical IT Research Group" in 2013. We continue to provide an avenue for information sharing among industry, government, and academia across different industry types and fields, with the goal of developing a new industry of "flexible medical IT" that applies flexible devices to the fields of healthcare, welfare, and medicine. The society includes corporate members from over 100 companies. It continues to promote the active exchange of ideas. As a general outreach program, we have delivered 19 business and public lectures such as the Meisei High School Academic Lecture (1000 student participants in all) and have conducted laboratory visits and mock lectures with middle and high school students.

ERATO has continued to work for 38 years since its establishment in 1981. This is because it continues to seek the realization of the "human-centric" funding model that starts with trust in people. Since its inception, it has persevered with the enormous efforts of the people involved who seek to hand this spirit over to the next generation. While managing ERATO projects, I was always frantically trying to pass the torch on to the next generation. In retrospect, however, I have learned many things from my colleagues and co-workers, and it has been an opportunity to grow as a research director. I remain eternally grateful for this.

A professor at the Department of Electrical and Electronic Engineering, in the University of Tokyo, **Takao SOMEYA** is also a Chief Researcher at RIKEN and a Team Leader at the Center for Emergent Matter Science (CEMS). He has a PhD in Engineering, and specializes in organic electronics. His key area of research covers the application of thin elastic devices such as artificial electronic skins for machines and skin-adhesive sensors.