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TRANSFORMING A PARTICLE ENGINEERING LAB: FROM "FAST" ADVANCED MATERIALS TO "SLOW" AGRICULTURAL STUDIES

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Japanese companies are becoming more dependent on universities for basic research. Materials processing and particle technology are my areas of expertise. While working for around 9 years at Hiroshima University, our research group (led by a Japanese professor) collaborated with more than 20 companies on projects related to functional materials (e.g., for LEDs or batteries) with particle sizes between ~10 nm and 1 μm. The collaborative speeds were "fast" because most of the companies use a quarterly system. This speed sometimes influences the learning style of graduate students who perform the related experiments. An advisor's micromanagement to maintain a "fast" schedule can cause students to have few opportunities to learn how to deal with failure. In the case of engineering systems, the researchers can play the role of the "core" of the project. We preferred to design laminar flow reactors (chambers) with well-controlled temperature gradients to obtain homogeneous products. Besides developing production processes, we discovered a water-based ion cluster (a commercialized product that became a long-term bestseller), thanks to sophisticated measuring tools and serendipity.

When I started a research group at TUAT (2007), I stopped all joint research with companies that had formed in Hiroshima and set a new direction. The turning point in my group's target-setting occurred in the first year. Because our target size was similar to the size range of air pollutants, I co-initiated a project on "particles & plants" (2008-2013), together with colleagues at the school of agriculture. With graduate students, I designed a chamber for growing plants and realized that the "core" of the project was the plant, not the researchers. Daily experiments were performed for almost two years. The plants grew from 10 to 200 cm. Heterogeneous leaf surfaces and an air-conditioned (24 h) chamber created "turbulence" points. Prediction of the material flow was difficult, even though a 3D fluid dynamics simulation was also performed. Through agricultural projects, we learn much about "risk" before designing and also while running the experiments, and we obtain engineering clues from plant systems. After we modeled the interaction between "dynamic" airborne particles and "static" leaf surfaces, we expanded our studies to develop a sensor system for on-site detection of pesticides (including those on dead honey bees) and a low-cost particle collector for remote areas. The speed of agricultural research was "slow". There were no personal obstacles like nationalism. An "organic" interdisciplinary project is a good medium for engineering students to learn a system in micro- and macro-scales and to consider the "good" and "bad" sides of the matter.

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