Column

Thoughts On Micromachines

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Some twenty years ago after completing my doctoral course, I was accepted to teach in a new department at the university. The new Department of Mechatronics was established in response to developments in mechatronics in the industrial world. The classes were very lively, as the students were attracted to the new field, and there was much expectation placed on the young instructors in the new department. Although micromachines (MEMS) was one of the fields that produced heightened expectations, we organized the course with a broader concept: an integrated mechanical engineering course. One goal of the course was to develop semiconductor micromachining into a mechanical field. News from America such as the trial production of a chromatography system on a silicon wafer drew much attention. With this background, dreams and hopes for micromachines began to grow.

Integrated circuits produced in semiconductors were also developing rapidly in Japan during this time. The level of integration of IC's increased by tens of percentage points each year, and as a result the performance of computers increased dramatically. While more recent increases in memory capacity from, say, 1G to 2G may seem to the ordinary user as merely an increase in an already sufficient memory capacity, back when people were trying to get by with very limited memory, an increase in 1M to 2M was extremely beneficial and a remarkable development in the semiconductor industry. However, the Japanese industry that has shown steady development is mechatronics. This field, which merges machines and electronic systems, demonstrates the superior ability of the Japanese in manufacturing, as is represented by the automobile and automated production equipment. If the equipment and technology could be established, mechatronics, which requires many variations and merged technologies, was expected to be more suited to Japan's capacity for manufacturing than integrated circuits, which are easy to mass produce. Japan is also good at making mechanical and electronic goods smaller and has shown its superiority to the rest of the world in manufacturing compact recorders, timepieces, and camera systems. However, I think that Japan should place more emphasis on micromachines, which can be considered an extension of mechatronics.

Processing techniques for micromachines have advanced considerably in the last twenty years. Flexibility in the 3-dimensional processing of silicon using developments in DeepRIE has improved more than in anisotropic etching of crystals. However, DeepRIE is only capable of about 2.5 dimensions, not the unrestricted 3-dimensional processing that is possible in macromachining. It is expected that 3-dimensional processing will be developed with a higher degree of freedom in the future. As these processing techniques improve, numerous sensors and microsystems are being proposed and experimentally produced. Since many problematic areas in processing must be resolved to complete such trial manufacturing, once a proposal for trial manufacturing is agreed upon, researchers focus on specific problems. Although researchers always like to concentrate on detailed problems, I believe that a broader perspective will be required when developing micromachines in the future.

In the near future, Japan and the world will be faced with such problems as environmental issues, the growing population, and the food shortage. Japan is only about forty percent self-sufficient in food, with about one-fourth of its entire food supply going to waste. Therefore, it is necessary to construct systems for using resources and distributing food that are not wasteful. What will our society be like twenty years from now? Striving for profits in the industrial world is the fate of humankind, but, while it is important to produce products that are at least somewhat efficient, shouldn't ten or twenty percent of our efforts be aimed at some aspect that can contribute to problems facing all of Japan twenty years from now? Since problems facing the environment are pervasive, the issue is somewhat diluted, as most individuals today don't feel these problems affect them. To understand these types of widespread problems, I think it is necessary to study sensing and mobility over a large area. Networks continue to expand in towns and throughout the world, and I believe network technology will be an indispensable means for understanding large areas. By incorporating microsensors in networks, we may be able to place these pervasive problems of distribution and the environment in a context that we can understand. It seems that micro-problems in science can be resolved by tackling them analytically. However, I think it is necessary to develop new techniques for solving macro-problems.

Perhaps you remember the catch phrase "Can you work 24 hours a day?" If the trend of today's fast-paced society continues, such a scenario may not be altogether out of the question twenty years from now. I think we must strike a new course toward an affluence different from the materialistic, hurried society of today. It is my hope that MEMS, a technology indispensable for providing input and output between various sensors and computer networks, can contribute to the solution of these problems.