



# Dream Devices from BEANS

### Devices that BEANS Researchers Would Like to See Ten Years from Now

The BEANS Project was not established to develop any specific device. We simply cannot designate any specific target device because devices so innovative as to change the way we live are beyond our imagination today. Thus, trying to develop innovative processes is much like feeling our way in the dark, but we expect that such processes will eventually lead us to produce innovative devices. By the same token, you cannot take a journey without knowing your destination, and we cannot develop manufacturing processes without giving any thought to a target device. Therefore, we decided to dream up some innovative devices for the future by thinking about what we truly wanted to achieve and, when our entire research staff gathered for the Annual Meeting of the BEANS Project on June 16, we held a brainstorming session.

### Format of the Discussions

The BEANS Project is currently composed of four major research centers: Center A involved in the biomedical field, Center B involved in organic materials and nanostructures, Center C involved in 3D micromachining and low-damage etching, and Center D involved in non-vacuum large-area deposition and nanofabrication of fiber substrates. Since R&D conducted by integrating dissimilar fields (heterogeneous integration) is a defining feature of the BEANS Project, discussion was performed among groups intentionally composed of members specializing in different fields. Members were divided into four groups, and three thirty-minute sessions were held while shuffling the group members between each session. In Session One, the groups were asked to identify from various perspectives the difficulties, inconveniences, or frustrations that they as individuals or society as a whole deals with in today's world. In Session Two, the groups were asked to discuss what type of device could be used to solve the issues identified in Session One. In Session Three, the final session, groups were asked to devise a road map needed to link the attainment of the target device clarified in Session Two with research currently being performed at the BEANS research centers.

### Dream Devices Conceived by Our Young Research Staff

While the composition of the groups arranged to come up with dream devices through heterogeneous integration may have had some influence, the proposals showed a particular bias toward devices that integrate bio-related fields developed by Center A with micromachining by Center C, with very few proposals linking organic materials developed by Center B and large-area deposition processes or fiber substrates developed by Center D with other technological fields. Below are some representative examples of their proposals.

**(1) Brain wave response device:** While the group referred to their device as a "psychokinesis (telekinesis) remote controller" in their discussions, this device is not designed to use psychic abilities like psychokinesis or telekinesis but rather detects faint

brain waves with great sensitivity and uses the detected data to communicate or to control an external device. Hence, by using this device, a person could manipulate a tool by thought, or two people could communicate with each other without speaking. In the case of an implanted device, a biocompatible membrane could be used to cover the device, and a mechanism could be devised to generate power from heat or glucose in the body to drive the device without a battery, thereby involving bio-related fields. The brain wave sensing function could be configured of either a) a very sensitive magnetometer such as a superconducting quantum interference device (SQUID), requiring a technology for forming a room-temperature superconducting wire into a micro-coil, or b) a biosensor capable of detecting hormones and neurotransmitters.

**(2) Hayabusa drug delivery:** Much like the unmanned spacecraft Hayabusa, which was controlled to land on an asteroid far away from Earth, the proposed system would deliver a drug directly to a very small affected area within the inner "space" of the body with pinpoint accuracy. As in the film *Fantastic Voyage*, a drug capsule 4–400 nm in size would be injected into the blood vessel, and the capsule could be configured of means for navigating through the bloodstream and for releasing the drug once the capsule reached a desired target. Here, the drug capsule must be manufactured with high precision of nano order. It is apparent that a capsule too large or too small could not navigate safely or with stability in the bloodstream.

**(3) Flexible device:** A great advantage of using organic materials in electronics is their flexibility. The domain of wearable devices similar to clothing stimulates the imagination. There is no limit to the vast number of applications for devices that can be fibrous one minute and membranous the next, such as an organic EL display, thin-film solar cells, and polymer batteries. Organic semiconductors may also be used to configure the drive circuit. Thus, this device is likely the exclusive domain of Center B, which is investigating nanostructures of organic materials and nanofabrication. However, the technologies being developed by Center D for the nanofabrication of fiber substrate surfaces inspired proposals for designing ambient clothing formed of fibers whereby the color of the fibrous surface could be changed at will, and a simple method to nanoimprint hair, enabling people to change their hair color easily.

**(4) Portable thin-film spray:** Based on the non-vacuum thin-film deposition technology developed by Center D, one group proposed a portable device that could be carried anywhere to apply thin films in much the same way as a spray gun is used to paint a wall. Such a device is significant in that it would allow us to coat walls and roofs with solar cells and to apply a solar cell coating on cars. One day we might even see campgrounds offering a service to spray your tent with solar cells.

At any rate, for one day we were allowed to wonder whether devices such as those mentioned above would be taken for granted ten years from now.