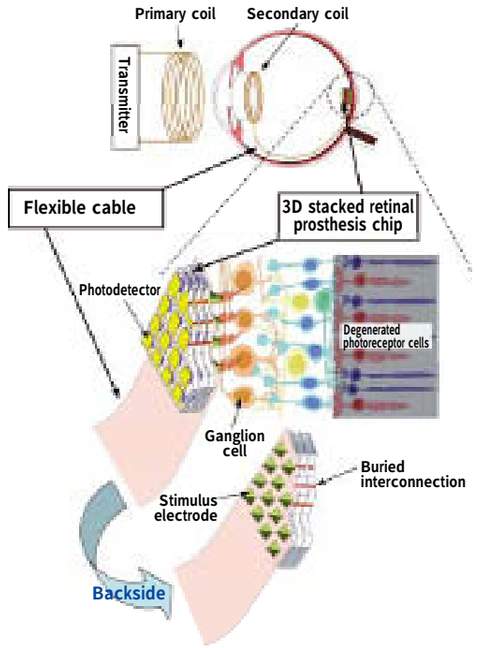
Nano-Machines Help Restore Functions to Partial Areas of the Eyes and Brain

The Koyanagi and Tanaka Laboratory makes full use of the latest semiconductor technologies to carry out research in the areas of biotechnology and robotics.

A retinal prosthesis chip and a brain-type computer represent the research achievements of this laboratory. A 3D stacked microchip for retinal prosthesis has a structure almost identical to that of a human retina. It receives image information which is then processed in a fast and sophisticated manner using the image information processing system.

Professor Koyanagi refers to his future research by saying, "It will become possible to have a blind person recover his or her vision by implanting a retinal prosthesis chip into the eyes and applying an electric stimulus to the retinal cells. In the same way, it will also become possible to recover brain functions lost due to an accident or a disease with a brain computer."

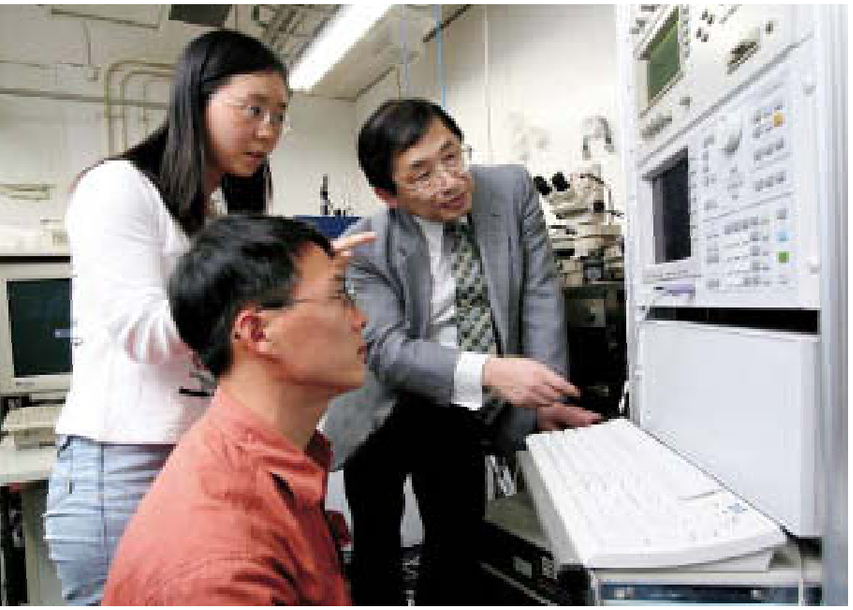
In 2006, Professor Koyanagi was awarded the IEEE Jun-ichi Nishizawa Medal by the Institute of Electrical and Electronics Engineers (IEEE), USA.



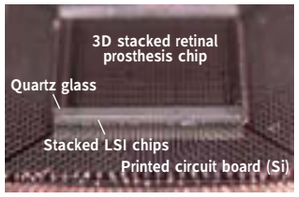
【Advanced Bio-Nano Devices】

Professor **Mitsumasa Koyanagi**

Born in 1947, he completed his Doctoral Course at the Graduate School of Engineering, Tohoku University. He then worked for Hitachi Ltd., and U.S. Xerox Corp. In 1994, he assumed a position as a professor at the Faculty of Engineering, Tohoku University. (picture on the right and in the back)



A brain computer aims to substitute some of the brain functions, such as cognition, by means of integrated-circuit technology. The retinal prosthesis chip will simulate the functions and structure of the retina, making it possible to construct a complex parallel processing system, similar to a human brain mechanism.



IEEE Jun-ichi Nishizawa Medal

Professor Mitsumasa Koyanagi, Graduate School of Engineering http://www.sd.mech.tohoku.ac.jp/

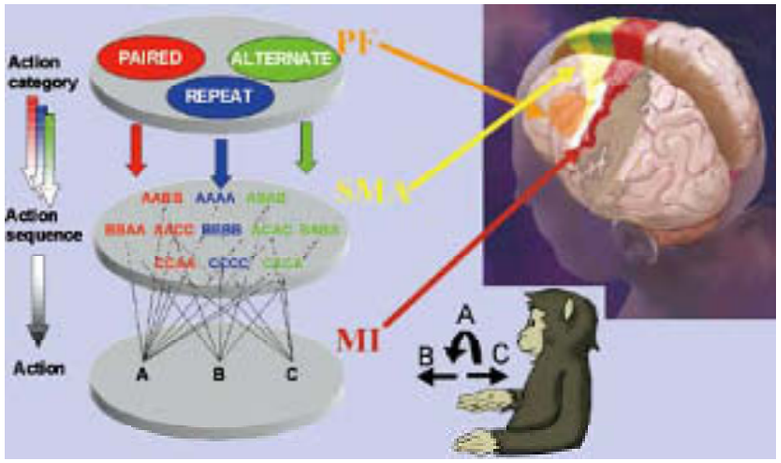
Elucidating Moments of Insight into Ideas Through Science

The research team lead by Professor Hajime Mushiake carries out studies on the neural mechanism of voluntary actions, exploring the mechanisms of higher cognitive functions in the prefrontal cortical areas, and has elucidated the role which this mechanism performs in problem-solving behavior. The brain cells in the prefrontal area set goals in problem-solving and generate a process to reach the goal swiftly. These cells not only integrate information received by the brain, but also lead to the emergence of the information which the brain deems necessary. The research team has elucidated the higher functions of the brain, called "insightful" behavior and the "Aha! Experience" in problem-solving.

Their research was conducted using an experiment in which monkeys were shown a map of a maze on a display device. The monkey moved a cursor to the goal by means of a controller and was then able to move around obstacles along the way. The monkey anticipated what would happen and decided upon the required action.

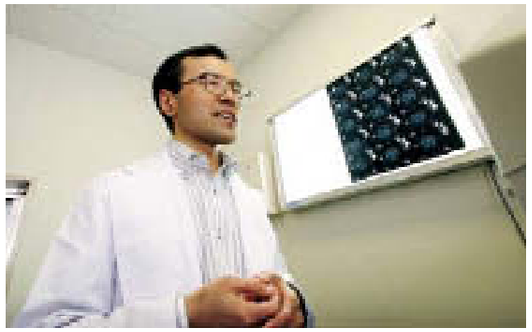
"The recent advances in neuroscience owe much to developments in engineering." said Professor Mushiake. His research team, in cooperation with the Laboratory for Mechanical Engineering and the Laboratory for Information Sciences in the university, assisted in the development of precise silicon electrodes which monitor the activity of the brain. This cooperation across the graduate schools has helped new technologies to evolve and deepened its research.

In 1998, Professor Mushiake was awarded the 30th Naito Foundation Research Prize for his research conducted in cooperation with Dr. Jun Tanji and Dr. Keisetsu Shima. His paper, written in collaboration with them, was entitled "Brain: Categorization of Behavioral Sequences in the Prefrontal Cortex" and was published in Nature (Vol.445 No. 7125, 18 January 2007).



The cells of the lateral prefrontal area act in specific ways for particular categories of behavioral sequences, and the cells of the prefrontal area express the categories of behavioral sequences in plan behavior.

A prototype silicon electrode was developed by the Koyanagi & Tanaka Laboratory, the Graduate School of Engineering, and the Laboratory for Information Sciences in collaboration with Yamagata Electronic Corporation.



【Medical Physiology】

Professor **Hajime Mushiake**

Born in 1958, he graduated from the Graduate School of Medicine, Tohoku University and worked as a researcher in the Faculty of Medicine at the New York State University. He then became a researcher at Sakigake 21, the Japan Science and Technology Foundation. He assumed the position of professor at the Graduate School of Medicine, Tohoku University in 2005.

Professor Hajime Mushiake, Graduate School of Medicine http://www.med.tohoku.ac.jp/~2sei/index.html