SIDE VIEW

Using Computer Power to Create New Academic Disciplines and Technologies

20th Anniversary

Sony Computer Science Laboratories, Inc.

Searching for ideal cooperative relationships between people, the real world, and networks.
Aiming to understand the truth about mankind and life itself using computer power.
At the Sony Computer Science Laboratories (Sony CSL),
top class researchers from Japan and around the world work on original research
in an environment that respects freedom and independence of thought.
While working on research themes that span a wide range of areas,
these researchers stimulate each other
while aiming to contribute to a truly international society.
This year, CSL marks the 20th anniversary of its establishment.
This article presents events that celebrate that establishment
and a roundtable discussion on CSL's past, present, and future.

■ Research Structure

●Fundamental Research Laboratory (FRL)
Carries out basic research in Computer Science and other areas for which Computer Science holds the key for transformation.

●CSL Paris
[Established in 1996]
Studies human recognition, especially from cultural perspectives

●Interaction Laboratory
[Established in 1999]
Investigates the issues and possibilities when humans interface between the real world and the networked information environment.

■ Sony Computer Science Laboratories, Inc.

Established in 1988 as a wholly owned subsidiary of Sony Corporation

Purpose
To contribute to humanity, society, and Sony through fundamental yet applicable research related to computers.

Principles
- Small, elite group (under 30 researchers)
- Research proceeds at the individual discretion of the researcher
- Interaction with related external researchers
- Unique hiring process (candidates make a presentations to all CSL researchers)
- Yearly contract (renewable), salaries determined annually

Results
- CSL has produced many technology transfers to the Sony Group. These include an object-oriented OS used in entertainment robots, the "POBox"*1 predictive input function for cellular phones, and "PlaceEngine"*2, which is included in the Sony Computer Entertainment PSP® *3
- Active joint research and personnel exchanges with Sony Corporation itself
- Creating and leading new academic fields such as systems biology, systems brain research, and econophysics

*1: POBox: Text entry assistance software developed by Sony Computer Science Laboratories, Inc. POBox predicts and displays the remaining parts of words based on the part entered, word frequency, and the user's previous input history.
"POBox" is a registered trademark of Sony Corporation.

*2: PlaceEngine: Technology that can measure, in real time, the current position of WiFi equipment. This technology can determine the position of equipment even in locations where GPS is not available. "PlaceEngine" is a registered trademark of Koozyt, Inc. This technology was developed by Sony Computer Science Laboratories, Inc. and is licensed by Koozyt, Inc.

*3: "PSP" and "PLAYSTATION3" are registered trademarks of Sony Computer Entertainment, Inc.

■ CyberCode™
: THE EYE OF JUDGMENT™
Jun Rekimoto, Ph.D.
Director, Interaction Laboratory

"THE EYE OF JUDGMENT" represents a new class of games that fuse the trading card game and PLAYSTATION® 3 experiences. PLAYSTATION® Eye produces creatures that jump out by reading cards that have cybercodes written on them.
Technological assistance: Yuji Ayatsuka, Associate Researcher
THE EYE OF JUDGMENT™ ©2007 Sony Computer Entertainment Inc.
*: "CyberCode" is a registered trademark of Sony Corporation.
"CyberCode" was developed by Sony Computer Science Laboratories, Inc.

■ Bubble Click
Hiroaki Tobita, Ph.D.
Associate Researcher

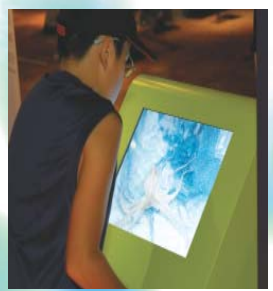
This system recognizes, using infrared light, the motion and bursting of soap bubbles created by visitors, and provides interactions. Fireworks are set off on the floors and walls at the instant a soap bubble bursts and the sound of the bursting reverberates.

In conjunction with this exhibition, we also held a workshop with CSL researchers as instructors that supports the summer self-study projects of schoolchildren in a variety of scientific fields. The photograph shows the "Let's Become a Doctor!" project with Tetsuya Shiraishi as the instructor. We had the children stitch a "wound" in an "arm" of the type that surgeons actually use for practice. "Recently, the tendency for students to avoid the sciences has become a social issue. Since I feel that "life" is an area that fuses the sciences and the liberal arts, I think that the most effective way to resolve this issue would be to start by instilling interest in the "wonders of life" in students, and then having them proceed to the study of a variety of scientific areas." (Shiraishi)

Sony Computer Science Laboratories 20th Anniversary
Open Science
「研究するということ」

If one thinks that one has solved a puzzle, one finds that another puzzle arises immediately. I have realized the depth of science, which knows no bounds to where it may go, and the joy of technology.

From July through September this year, Sony ExploraScience held an exhibition that introduced some of the varied research results achieved by CSL.



■ "Aha!" Experience
Ken Mogi, Ph.D.
Senior Researcher

"Aha, Change!" is content (an application) that allows users to experience the change from the unaware state to the aware state of noticing where an image has changed. The neurons in the brain become active at the same time for a period of about 0.1 s and as connections are strengthened one's awareness circuits are trained to be more sensitive.

* "Sony ExploraScience" is an experience-based science museum produced by Sony. Visitors can experience the results of research performed at CSL, such as "Bubble Click" and "CyberCode".
■ Location: Mediage 5F 1-7-1 Daiba, Minato-ku, Tokyo
■ http://www.sonyexplorascience.jp/english/index.html

NEUROSURGEONS AND COMPUTERS

Tetsuya Shiraishi
M.D., Ph.D.
(Systems Biology)
Researcher
Sony Computer Science Laboratories, Inc.

Before I joined CSL in April 2004, I worked as a neurosurgeon at Saga Medical School (which is now the Faculty of Medicine, Saga University), both treating patients and carrying out research on brain tumors. Previously in cancer research, researchers would focus on just a few of the over 20,000 human genes and analyze just those genes. They didn't know how the gene being studied related to the adjacent genes. Just as I came to think that we would never get an overall understanding of cancer with this fragmented research, Hiroaki Kitano wrote a book called "Systems Biology", and I immediately saw his approach as being a superb idea.

I first met Dr. Kitano in 2001, when the Japan Brain Cancer Conference was held in Beppu and he was invited to give a special lecture. It was due to this relationship that I joined CSL. Although Tadataka Ino (1745 to 1815) coined the phrase "a human life has two mountains", I wanted my second career to be dedicated to research.

My work changed completely. Although in my previous work I performed surgeries and saw outpatients, now I spend the whole day typing at a computer. At first, I found this disconcerting, but now I really enjoy working with the latest computers.

Cancer behaves as a new life form that is born from within one. Even in its extremely harsh environment, which, like the deep sea, has a high pressure and is lacking in oxygen, cancer evolves while rebuilding it's system. To understand this system, I introduced the concept of "molecular switch". This is the same idea as flash memory. In flash memory, after a pattern of on and off states is recorded, that pattern remains even if the power supply is turned off. Cancer is the same. I think that cancer multiplies by transmitting this on and off state pattern acquired by evolution, even if the "power supply" is turned off at the moment of cell division.

By analyzing several million related articles using the text mining technique, I have already been able to extract 6600 molecular switches. I would not have been able to make it this far if I had not come to CSL, where I can always make full use of the latest computers. I think that I will be able to explicate the role of these switches this year. In the future, this will be useful in the sort of diagnosis that predicts that a particular cancer will metastasize because it has a certain switch pattern. I also hope that it will be possible to weaken a specific cancer by switching a particular switch with a particular timing. This is similar to the way the black pieces flip to white in Othello.

Applying 21st Century Methodologies to 21st Century Problems

Open Systems Science: Grasping complex systems as complete wholes

Expanding Areas of Research

—Please tell us the details of how CSL was founded.

Tokoro: The year before CSL was founded (1987), I was working as an assistant professor at a university and received an unexpected visit from Dr. Toshitada Doi, who was then an executive director at Sony. He asked if there was something interesting that we could do. How about creating a laboratory for computer related research? I proposed that we create a world-class research laboratory so good that researchers from around the world would notice it and come to participate. A few days later, Dr. Doi came back and said "It's been decided. Will you accept the position of director of the laboratory?" Although I had previously had no experience with Sony, I thought it must be an interesting company.

—The range of subject areas is certainly wide: it includes brain science, systems biology, and econophysics.

Tokoro: CSL's history can be roughly grouped as follows: during the first ten years we mostly worked in pure computer science, for example, distributed operating systems. For the next ten years, we shifted our focus to asking how computers could be useful to society and mankind. Dr. Kitano and Dr. Takayasu, who are also here today, are doing world-class work.

Kitano: When I joined CSL in 1993, AI was the main focus. I worked on an entertainment robot (which was later commercialized as AIBO*1) and managed RoboCup*2. Starting in 1994, however, much of my time was allocated to biological research. I did not expect to see any breakthroughs in AI for the next five years. I thought that it would not be too late if we immersed ourselves in biological areas for the near future and then returned to AI. However, what happened was that we simply remained focused on biological research.

Takayasu: It turns out that the vast majority of economic laws that we learn in economics have not been proved. Most are just hypotheses, and it is only recently that it has become possible to check, using real data, whether or not they actually hold. Nowadays, the "footprints" from economic activities are all retained in computers. For example, there are about one million products that are handled by supermarkets, but it is now possible to analyze changes in demand in detail using POS data*3. The amount of data that can be handled in economics has increased a million times due to computer advances.

— Does that mean that you are analyzing actual data using methods from physics and explicating the behavior of complex economic phenomenon?

Tokoro: In sciences up to now, the basic approach has been to break down the subject finely and drill down to simpler and simpler parts. However, the problems we are facing now are horrendously complex. These problems cannot be solved by just looking at the parts. Another issue is that some action thought to be helpful for a particular part turns out to be detrimental to another part of the problem. Environmental problems are truly of this nature, as are many problems in biology and economics. Developing approaches that use scientific standpoints and methodologies to handle complex problems has become an important theme at CSL.

Each researcher is given a private office and a laboratory.
There are even researchers who write their ideas on the walls.

Selection and Evaluation of Research Topics

—While the research targets are established by the researchers themselves, it seems that while there is freedom, the direction is firmly maintained.

Tokoro: We all share a common understanding that the problems we face immediately cannot be solved with traditional approaches. I think it can be said that the concept of "open systems science" became firmly established in this context in which such researchers can argue again and again. When we meet a new researcher, we hold thorough discussions and hire people who are sympathetic to our concepts. Thus we are highly accepting of a various desires within that range.

Mario Tokoro, Ph.D.
President
Sony Computer Science Laboratories, Inc.

Kitano: Research which proceeds by looking at individual phenomena can be carried out at universities and academic conferences. One strategy is for us to focus on research that can have a great impact because we are CSL. Although this may occasionally take 10 or 20 years, it can lead to research that is truly useful to humanity and the world.

Tokoro: This is because we do not look at things with an excessively short span.

— However, employment is on a one-year contract. When an annual contract is up for renewal, what standards do you use for evaluation?

Tokoro: By the sparkle in their eyes. If we can see that they put their reputation as a researcher on the line and adopt an approach that is different from that of ordinary people or if they have goals that are different from those of ordinary people, we ask them to continue that research. Also, CSL is an open lab, and all researchers take part in a variety of projects, both within Japan and overseas, and automatically become the leading player in their area. If that happens, we know. The level of a person's research becomes self-evident from the amount of external activity the researcher is involved in, the people they associate with, what conferences they are invited to deliver lectures at.

Hints Arise at the Points were Different Fields Come in Contact

—— While I understand that there are opportunities to present results to other researchers within CSL itself, in what way to researchers listen to discussions in other fields?

Takayasu: Despite myself, I sometimes find myself thinking "That's it!". For example, recently I have been analyzing the network of trading relationships between the one million or so companies in Japan, but there is a great similarity between this work and Dr. Kitano's work on mutual interactions between biochemical substances in immune systems. Especially when one makes graphs and considers quantities.

—— Networks often have a hub.

Kitano: That is one idea. I am also considering introducing economic models, such as portfolio theory and game theory, into the theory of biological evolution. There is also something I'd like to ask Dr. Takayasu about, namely, that when studying the economic crises of the past, there are a variety of stabilizers that are built in to in economic systems. But despite these, events such as Black Monday (the stock crash of 1987) and the subprime problem still occur. I think that the reason these occur is that the stabilizers inversely cause problems when they move in unexpected directions. It seems that derivatives, which were developed to hedge risks of market fluctuations, have become a source of instability in the financial markets. From my standpoint as someone who studies the fragility of living organisms, this looks very similar to the state where the excretion of cytokines*4, which are excreted to kill viruses, cannot be stopped and the excess cytokines cause pneumonia.

Hiroaki Kitano, Ph.D.
(Systems Biology)
Director
Sony Computer Science Laboratories, Inc.

Tokoro: This is the fragility of living organisms and the fragility of economics. If we consider this from the perspective of systems structures, there are aspects that are similar. Of course, there are differences as well. It is because these relationships are subtle that we can get hints from comparisons.

Kitano: Dr. Takayasu is always mentioning the point that all economic data is now stored on computers. Unfortunately, that is not possible in biology. But perhaps the theories I have can be proven within economic systems. I think that this is a theme that will hold much interest in the future.

Takayasu: The problem that I have been concerned with recently is malice. In the subprime problem, there have been people who thought up schemes in which only they would profit. Similarly, in the biological field, there are organisms that think that it is good if only their descendents survive. This is a difficult concept for physicists, since it is inconceivable that there would be malice between pairs of physical substances. However it may be possible to establish completely new intellectual issues if we approach this from the standpoint that even though the phenomenon itself is impossible, there may still be similarities.

Hideki Takayasu, Ph.D.
(Econophysics)
Senior Researcher
Sony Computer Science Laboratories, Inc.

Tokoro: Hmm, can we really say that physical substances have no malice? Anyway, note that we have used almost no technical terms in this discussion. This is the essence of "open systems science". I believe that there will be no progress in science if we do not step back to this level.

Science and Engineering

Tokoro: One thing I'd like to emphasize here is that the reason CSL has succeeded so far is that it is an environment in which researchers with a strong science orientation often discuss and debate with researchers who are closer to engineering. Dr. Jun Rekimoto, who worked as director of the Interaction Laboratory, has always maintained his lead in terms of number of patents acquired at CSL, and is also by far the top in the Sony Group as a whole. The "cybernetic earth" concept that he advocates is both close to science fiction and at the same time firmly positioned close to Sony's business. The point that these current business areas and fundamental research that could create new business domains are tightly intertwined is both a defining characteristic and a strength of CSL.

—— Dr. Kitano was appointed as the new director this July.

Kitano: I'm am often asked how I will impress my personality on the lab, but since CSL is currently doing well and producing results, I am not planning on making any major changes. One area that is, however, always on my mind is the energy and environmental problems that will be the major issues of the 21st century. What sort of societal systems will be required to respond to these issues and what sort of technological systems will be suitable? And, in particular, what sort of approach should CSL adopt? I hope to take action early in areas where we need corrections to our approach.

——Do you have opinions or ideas for Sony itself or for the semiconductor business?

Tokoro: I think the semiconductor business should take new and drastic actions. Including, for example, considering giving up silicon. One example would be business based on generating solar energy just by painting dyes on window glass. Furthermore, LCD shutters could be used for blinds.

Kitano: We should make all home and office building windows be solar panels. If necessary, we could even collaborate with universities, rival companies, and major construction companies.

Tokoro: If there's anyone reading this who would like to work on these problems, and feels in any way constrained in their current position, please, come to CSL. We welcome people who argue with their superiors.

*1 AIBO: An entertainment robot in the form of a puppy sold by Sony. "AIBO" is a trademark of Sony Corporation.

*2 RoboCup (Robot World Cup): An international joint research project for soccer played by robots proposed in 1993 by Japanese researchers led by Dr. Kitano. RoboCup is intended to promote and advance AI and robotics engineering research.

*3 POS data: Point of sale information management is a method for collecting product sales results in individual item units.

*4 Cytokine: The collective designation for biological activation factors that are produced by cells for all biological structures and that provide mutual interactions between cells.

Systems Biology

A field that aims at understanding biological phenomena not as individual parts but globally as a dynamic system. Systems biology considers, for example, biological robustness as a systems level principle. Based on this concept systems biology attempts to understand and modify cells at a basic level. It is furthermore applied in areas such as research on cancer treatments.

Econophysics

Econophysics attempts to explicate economic phenomena created from the complex entanglements of human actors using approaches from physics, for example chaos theory and fractals. Since financial market transactions are currently completely computerized, much as police investigators determine a criminal's activity from footprints, econophysics researchers can search for underlying principles lying hidden in economic phenomena from this transaction data. Econophysics methods are also used to analyze production yields in semiconductor manufacturing.

Cybernetic Earth

In addition to the increasing penetration of the Internet, when a wide variety of sensor data becomes available over the Internet, the real and the cyber (or virtual) become indivisible, and we reach a state where the earth must be seen as a cyborg. Since the elemental technologies already exist, the problem of how to construct that state is now at hand.