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Japan Prize News
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# JAPAN PRIZE

# 2010 Japan Prizes Awarded to Prof. Shun-ichi Iwasaki for Breakthrough Hard Disk Technology and Prof. Peter Vitousek, Leader in Biogeochemistry

### "Industrial production and production technology" field

**Prof. Shun-ichi Iwasaki**

### "Biological production and environment" field

**Prof. Peter Vitousek**

The Science and Technology Foundation of Japan has decided to award the 2010 Japan Prizes to Prof. Shun-ichi Iwasaki, Director, Tohoku Institute of Technology and Prof. Peter Vitousek, Professor of Biology, Stanford University.

Prof. Iwasaki won the award in the "industrial production and production technology" field for his contributions to high-density magnetic recording technology by developing a perpendicular magnetic recording method. Prof. Vitousek, who helped establish the methodology and concepts of a new research field called biogeochemistry, won the award in the "biological production and environment" field for his contributions to solving global environmental issues based on the analysis of nitrogen and other substances' cycles.

The laureates deserve the honor because of their significant roles in the advancement of science and technology that contributes to the peace and prosperity of mankind.

The laureates will be honored formally at an award presentation ceremony to be held in Tokyo on April 21, 2010.

## Japan Prize

The Japan Prize is awarded to world-class scientists and technologists who were credited with original and outstanding achievements and contributed to the advancement of science and technology, thereby furthering the cause of peace and the prosperity of mankind. No distinction is made as to nationality, occupation, race, or gender. Only living persons may be named.

Fields of study for the prize encompass all categories of science and technology, with two fields designated for the prize each year in consideration of developments in science and technology. Each Japan Prize Laureate receives a certificate of merit and a commemorative medal. A cash award of 50 million yen is also presented for each prize field.

**Field: Industrial Production and Production Technology**

**Achievement: Contributions to high-density magnetic recording technology by the development of a perpendicular magnetic recording method**


## Prof. Shun-ichi Iwasaki

Born: August 3, 1926
Director, Tohoku Institute of Technology
Professor Emeritus, Tohoku University



### Summary

LSI (large-scale integration) and the HDD (hard disk drive) which records information have played major roles in the progress of computer technology in the 20th century. It is not an exaggeration to say that the miniaturization and the increasing capacity of the HDD have created the information society through the Internet. Furthermore, what is giving behind-the-scenes support to the attainment of the next-generation system such as cloud computing is the ever-increasing capacity of the HDD by means of the perpendicular magnetic recording method. Prof. Shun-ichi Iwasaki, through inspiration from the research of the magnetic recording principle, has developed the perpendicular magnetic recording method, which is more advantageous in attaining higher capacity in comparison to the conventional horizontal magnetic recording method. Since he advocated this method to the world in 1977, he has continued research and development for the practical application thereof.


### Higher capacity hard disk as the goal

The HDD was developed as a magnetic recording device for the U.S. computer "IBM 305 RAMAC" in 1956. Its structure was 50 magnetic disks of a 60 cm diameter stacked one on top of the other, and the overall size of the device was equivalent to 2 large refrigerators. Despite its size, the data capacity was about 4.8MB. Thereafter, with the progress in computer technology, miniaturization and higher capacity HDD was attained, and in the 1990's, even personal computers (PC) came to be equipped with HDDs of approximately 20MB. In the latter half of the 1990's, music, graphics and videos came to be saved onto files, prompting an even further increase in capacity. Presently, HDDs of approximately 500GB are used for home PCs, which is 100,000 times that of the "IBM 305 RAMAC."

As mentioned above, HDD has been progressing with higher capacity as the goal, but from around the year 2000, theoretical limitations to this progress were pointed out. With regard to magnetic recording, the horizontal magnetic recording method was used from the advent of tape recorders. However, with this method, further capacity increase was difficult. Then, a generational change from the horizontal magnetic recording method to the perpendicular magnetic recording method took place. Prof. Iwasaki developed the perpendicular magnetic recording method more than 30 years ago, and has continued a steady and persistent research ever since. When it was found that the horizontal magnetic recording method could not keep up with the developments in the information society, the potential of the perpendicular magnetic recording method came to be recognized.

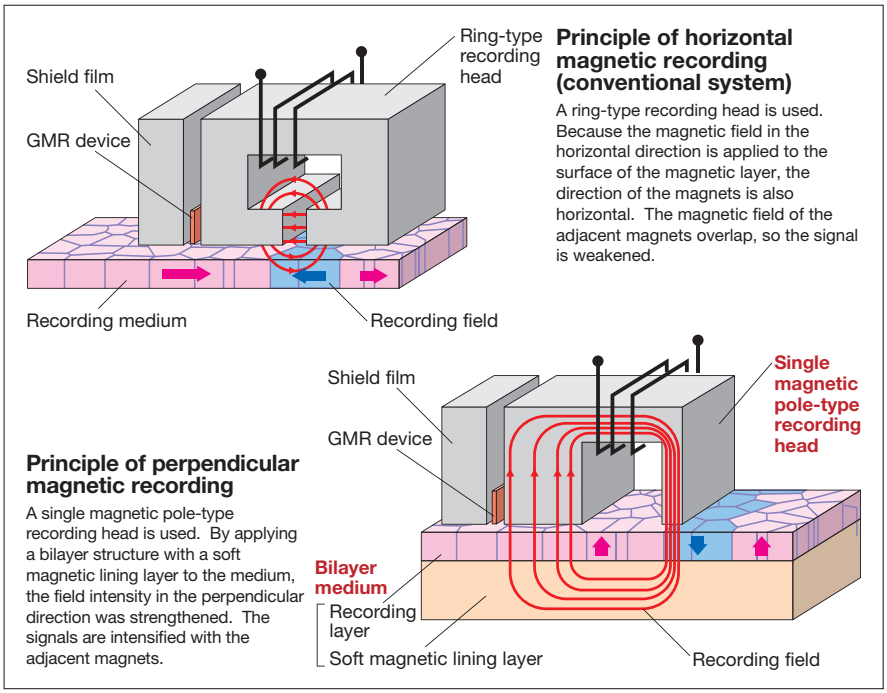
### Shedding light on the basic research of magnetic recording

After graduating from the School of Engineering at Tohoku University in 1949, Prof. Iwasaki joined Tokyo Tsushin Kogyo (now Sony Corporation). However, at the recommendation of his professor and mentor Prof. Kenzo Nagai, who is known for the development of the magnetic recording method (AC biasing method) which is used in tape recorders, he decided to go back to the university in 1951 to further pursue his studies in magnetic recording. Prof. Iwasaki worked in analysis of alloys which are used as magnetic material for magnetic tapes in audio recording. As a result of his research, miniaturization and improved sound quality of tape recorders were achieved. However, Prof. Iwasaki's interests extended to the clarification of the magnetic recording principle itself.

Tapes and disks which are used for magnetic recording have a magnetic layer on the media surface. Small magnets are considered to be aligned on the surface, and by means of an external magnetic force, the direction can be changed to record signals. With conventional technology, the direction of these magnets is parallel to the tape and disk surface, thus called the horizontal magnetic recording method. Prof. Iwasaki accurately verified the state of the magnetic material recorded under the horizontal magnetic recording method. As a result, he discovered that a magnetic layer exists not only in the horizontal direction but also in the perpendicular direction as well, and depending on the balance, the magnetic recording can be done in a horizontal direction. At that point, Prof. Iwasaki's thought was, "if the balance were to be changed, the magnetic recording can be done in a perpendicular direction."

At that time, it was thought that if the magnets could be aligned in a perpendicular direction, theoretically, the signal recording density would be dramatically increased. In addition, if the magnetic layer were to be magnetized to record the signals, the south and north poles on the signal magnet would be magnetized one next to the other, thus increasing the recording density in a steady manner. However, little progress was seen in the technical research into the practical application of these findings. In order to

### Horizontal magnetic recording method and perpendicular magnetic recording method



verify his ideas, Prof. Iwasaki repeatedly made prototypes of magnetic heads and magnetic layers, and at last he became confident to the point that he could say, "the perpendicular magnetic recording will bring about a revolution in magnetic recording." He received an enthusiastic response when the results of his studies were presented at the international conference in Los Angeles in 1977.

### Paving the way for the next-generation information society

Coming into the 80's, universities around the world formed research centers for the study of the perpendicular magnetic recording method. Japanese electronics manufacturers also embarked on the research and development thereof, but implementation seemed still far into the future. Unlike the horizontal magnetic recording method with an approximately 100-year history, with the perpendicular magnetic recording method, it was necessary to start research on the magnetic heads and recording media from scratch. In addition, there were technical innovations with the horizontal magnetic recording method as well, and higher capacity storage devices were being achieved. There were very few researchers willing to venture into the field of the perpendicular magnetic recording method.

In such an environment, Prof. Iwasaki who continued to pioneer the perpendicular magnetic recording method with Tohoku University as his base, had a conviction. He called it, a "20-year rule," adding that "in order for a technology to pave the way to a new generation in the true sense of the word, it would take more than 20 years for it to be established." In this way, he spurred young researchers on to continue the research. Additionally, he continued to advocate to the world the superiority of the perpendicular magnetic recording method by revealing its technology.

It was not until after the year 2000 that the "times" finally caught up with this innovative technology. The Internet has become widespread to the point that anyone can access the enormous amount of information around the world, and not only characters and images but also videos have come to be used tremendously. Further increase in capacity was sought after, and once again the limitations of the horizontal magnetic recording method were evident. With the horizontal magnetic recording method, the magnets are aligned in the magnetic field direction, thus affecting the nearby magnetic force. Therefore, it is not possible to reduce the size of the magnets beyond a certain level.

Meanwhile, as research into the perpendicular magnetic recording method had been conducted in persistent and steady manner, researchers were able to commercialize their technology at this turning point. In 2005, a Japanese electronic manufacturer was the first in the world to develop an HDD using the perpendicular magnetic recording method. In 2006, major global HDD manufactures began production of HDD using the perpendicular magnetic recording method, and in 2007 the production of such reached 500 million worldwide, resulting in a significant generational change in HDD. In the year 2010, it is estimated that all HDDs produced worldwide will be switched to the perpendicular magnetic recording method.

At present, "total digitalization" where all intellectual properties around the world are shared via the Internet, is being proposed. The perpendicular magnetic recording method founded by Prof. Iwasaki shall continue to make contributions to society as the basic technology which will achieve the dream of the new information society.

**Field: Biological Production and Environment**

**Achievement: Contributions to solving global environmental issues based on the analysis of nitrogen and other substances' cycles**

## Prof. Peter Vitousek

Born : January 24, 1949
Professor of Biology, Stanford University


### Summary

Since the Industrial Revolution, human economic activities have continued to expand, making the earth a relatively smaller place. Prof. Peter Vitousek, an expert in ecosystems ecology, has been studying the material cycle of such nutrient elements as nitrogen and phosphorus in the ecosystem. Based on the aforementioned research, Prof. Vitousek has made pioneering achievements in the field of "biogeochemistry," which analyzes how various factors influence the ecosystem. From his achievements, he has pointed out the serious effects human activities have on the global environment as well as potential solutions for solving global environmental issues.


### Environment from the perspective of the material cycle

Living organisms survive by adapting to the environment, but at the same time they affect the environment in one way or another. The academic field which sheds light on the interrelationship between the environment and living organisms is ecology. The English word "ecology" was coined in 1866 by a German biologist Ernst Haeckel. Thus, the concept of ecology has quite a long history.

Furthermore, what led to further development in ecology was the great discovery in the field of chemistry in the 19th century of the nitrogen cycle. Nitrogen is an essential element which constitutes protein, but most living organisms are unable to use the nitrogen in the atmosphere. Nitrogen-fixing bacteria which have the ability to fix the nitrogen from the air, and produce ammonium and its derivatives and which are then consumed by plants. In turn, animals which consume the plants are able to use the nitrogen, and through the food chain, nitrogen accumulates in the ecosystem. Thereafter, through the activity of denitrifying bacteria, nitrogen is again released into the atmosphere, and the cycle continues.

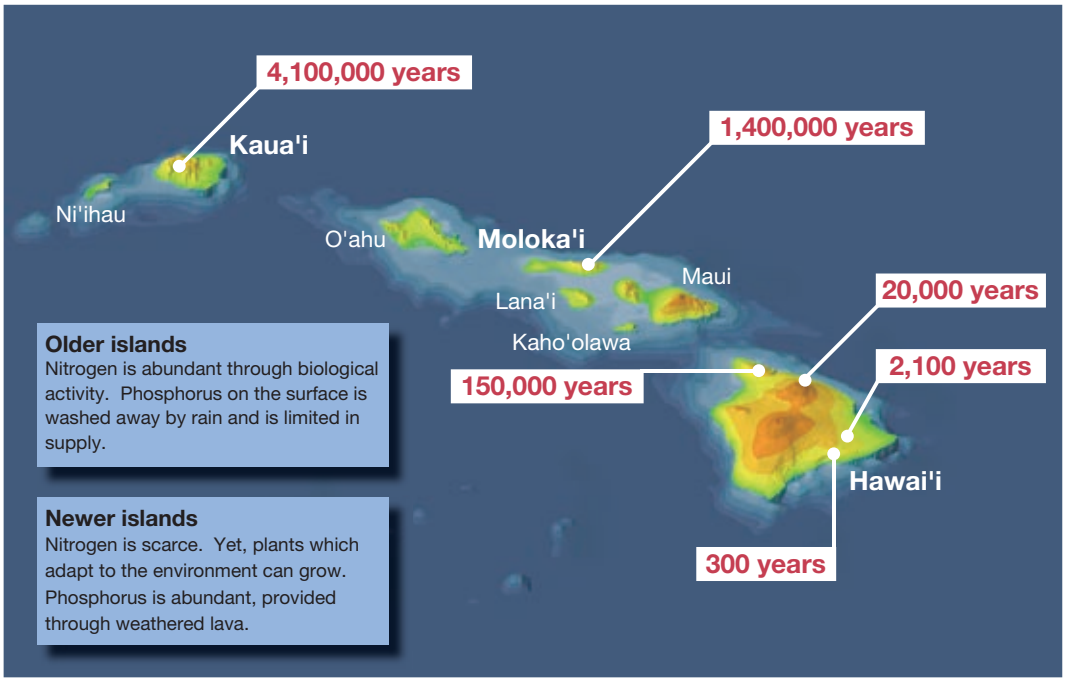
Within the study of ecology, ecosystems ecology focuses mainly on the energy-matter interaction which occurs between living organisms and non-living matter. This academic field has presented numerous methods of ecological analysis one after another.

### The ever-changing ecosystem

Prof. Vitousek, is presently known as a leading authority in the field of ecosystems ecology, but he first obtained a Bachelor of Arts in political science in 1971. Thereafter, he took an interest in ecology and earned Ph.D in biological science in 1975. With such a diverse perspective, Prof. Vitousek has been seeking to find a new field of research in ecosystems ecology from that time. He has found that while conventional ecosystems ecology focused their research on the material cycle at the present time, his thought was, "just as society and economics undergo changes with time, the material cycle must also undergo changes with time. That is an essential part of the ecosystem."

The subject of research chosen by Prof. Vitousek in the 1980's was the Hawaiian Islands in the North Pacific. The Hawaiian Islands were formed by volcanic activity, and its characteristic is that it is situated in a straight line according to the order of formation. Through the study of the material cycle of the respective islands, Prof. Vitousek thought that the dynamics of the material cycle could be clarified.

**Formation of the Hawaiian Islands and changes in its material cycle**




The result was more than anticipated. Prof. Vitousek focused his research on the nitrogen and phosphorus cycle which are growth elements of plant life. However, on new lava islands which have only been in existence for a few hundred years, the plants only received a small supply of nitrogen from the lava. On the other hand, the older the islands became, the more nitrogen had accumulated in the ecosystem. In contrast, with regard to phosphorus which is supplied from the earth, the older the island, the more deficient it became, as it would have been washed away. In this way, it was observed that the material cycle in the ecosystem is not as stable as it was once thought to be, and that it is changeable, being affected by various environmental factors.

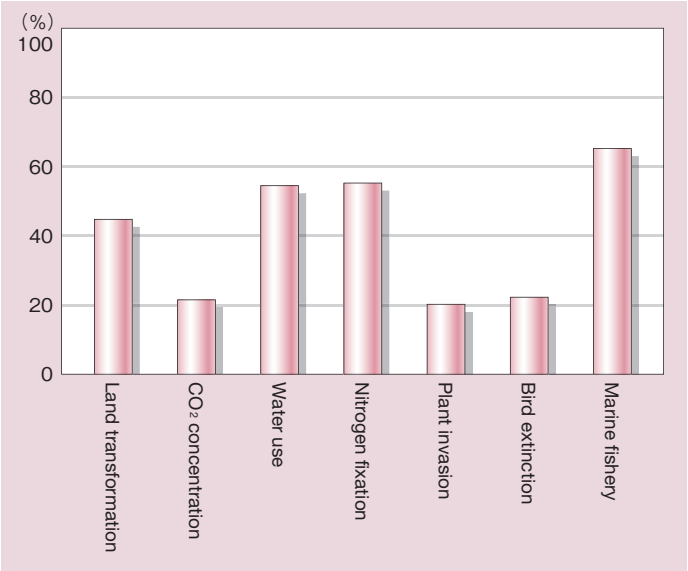
Among such factors that have the greatest influence at the present time are human activities. Prof. Vitousek made clear that plant life on the islands adapt to the material cycle, so when exotic plants are imported, the material cycle is altered, endangering them even to the point of extinction. In addition, the agriculture of the indigenous cultures after being influenced by the Europeans resulted in substantial effects on the material cycle of the ecosystem.

## The sizable impact of human activity

The foregoing research proved to be very influential on Prof. Vitousek's later research activities. The reason being, the changes in the material cycle of the Hawaiian Islands is the epitome of what has been happening on a global scale. Prior to the 19th century, nitrogen of the ecosystem was primarily taken in from the atmosphere by means of nitrogen-fixing bacteria from the soil. However, with the invention of chemical fertilizers in the beginning of the 20th century, an enormous amount of nitrogen, the same amount or more, would immediately be released into the environment. According to Prof. Vitousek's article compiled in 1997, the quantity of artificially-fixed nitrogen is up to 140 million tons per annum. Of that quantity, intensive legume cultivation in farms constitutes 25 to 40 million tons, 80 million tons are from chemical fertilizers and 20 million tons are from fossil fuels. Prof. Vitousek, in numerous study reports, continues to point out how nitrogen excess resulting from human activities have caused river and coastal pollution, acidification of soil and groundwater and decrease in biotic diversification. Subsequently, Prof. Vitousek has contributed substantially to establish a new field of research called biogeochemistry and analytical methods thereof.

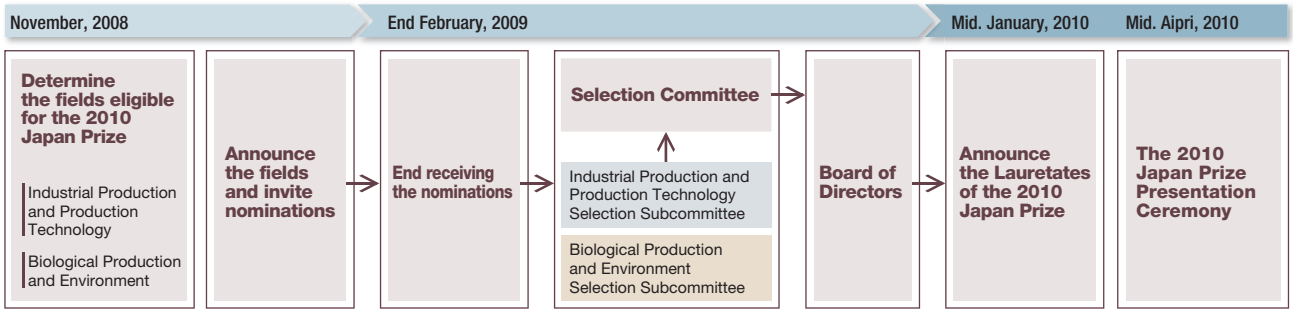
In the 1980's, various factors which threaten the global environment such as global warming, depletion of the ozone layer, acid rain and desertification were coming into light, making Prof. Vitousek's fear a reality. In order to clarify what issues face mankind, his endeavor was to reveal how much humans dominate the various services provided by the ecosystem to the planet earth. It was found that of the photosynthetic production of the terrestrial ecosystem, approximately 30-40% is used directly or indirectly for human activities. This and other changes in the ecosystem are something not perceivable by the human eye. Prof. Vitousek has revealed such through the material cycle data. His studies not only sound a warning about the profound effect that human activities have on the ecosystem, but provide an essential indication for policymaking pertaining to environmental issues.

**Human domination of earth's ecosystems**



## Nominations and Selection Process

- Each autumn, always in November, the Fields Selection Committee of the Science and Technology Foundation of Japan, designates two fields in which the Japan Prize will be awarded two years hence. Then the Foundation announces the selected fields and invites over 12,000 nominators from all over the world – they are prominent scientists and researchers – to nominate the candidates. The nominations are strictly by invitation from the Foundation. The deadline for receiving nominations comes at the end of February.
- In each field, a Selection Subcommittee conducts a rigorous evaluation of the academic achievements of the candidates. They then forward their conclusions to the Selection Committee, which conducts a wider range of evaluations of the notable achievements of the candidates including contributions to the progress of science and technology, and significant advancement of the cause of world peace and prosperity, and then thereby selects the candidates to be recommended for the Prize.
- The recommendations are sent to the Foundation's Board of Directors, which makes final decision on the winners.
- The nomination and selection process takes almost one year starting from the time that the fields are decided. Around the middle of each January, the winners of that year's Japan Prize are announced. The Presentation Ceremony is held in mid-April in Tokyo.

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(titles as of Jan., 2010)

# Fields for the 2011 (27th) Japan Prize Selected

**Area of Studies I**
mathematics, physics, chemistry and engineering

## Fields eligible for the award: Information and Communications

Background and rationale:

More than half a century after their invention, computers have developed through fusion with networking technology to yield information and communication systems processing almost all information arising in the real world. As an indispensable social infrastructure that supports civil life as well as socio-economic activities, these systems have greatly contributed to the further advancement of science and technology and the creation of new cultures. In view of such circumstances, the enhancement of reliability and security of information and communication systems is becoming increasingly important in ensuring the safety and security of society and convenience in daily life. Such new issues need to be tackled in order to develop and advance our knowledge-based society on a global scale. Moreover, it is hoped that information and communications technologies, both in the software and hardware aspects, will be further developed and widely disseminated.

Achievement eligible:

The 2011 Japan Prize will be awarded to honor achievements that bring about remarkable progress in science and technology in the field of ***"information and communications,"*** and make outstanding contributions to society by improving the safety and convenience of the lives of people through the creation of new industries, and improvement in productivity among other innovations.

**Area of Studies II**
biology, agriculture and medical science

## Fields eligible for the award: Bioscience and Medical Science

Background and rationale:

The progress in bioscience and medical science over the past half century has tremendously contributed to the understanding of biological functions, elucidation of the pathophysiology of various diseases and also to the development of new medical treatments and medicines. As a result, the average life expectancy has been drastically raised and the quality of life has been enhanced. However, there are still not a few diseases that are difficult to treat, and many patients are undergoing long-term care or suffering from the residual defects resulting in instability of daily life, poverty and the increase of burdens in the socio-economy. Furthermore, while malaria and tuberculosis are still raging, emerging and re-emerging infectious diseases including AIDS are also threatening our society. It is hoped that further progress in the fields of bioscience and medical science will help resolve these issues.

Achievement eligible:

The 2011 Japan Prize will be awarded to honor achievements that bring about remarkable progress in science and technology in the fields of ***"bioscience and medical science,"*** and make an outstanding contribution to society in the treatment of diseases or the improvement of human health through the understanding of biofunctions, creation or promulgation of new medical technologies, or the development or production of new pharmaceuticals.

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