



Title of Project : Constructive Developmental Science: Revealing the Principles of Development from Fetal Period and Systematic Understanding of Developmental Disorders

Yasuo Kuniyoshi
(The University of Tokyo, Graduate School of Information Science and Technology, Professor)

【Purpose of the Research Project】

How does human mind develop? What causes developmental disorders? Recent studies suggest the importance of the fetal period in human development. However, study of human fetuses is strongly constrained by technical and ethical difficulties. This project aims at understanding the principles of human development by analyzing and modeling it from the fetal period. Integrating robotics, medicine, psychology, neuroscience, and *Tohjisha-kenkyu* (person-centered, peer-supported research), we establish a new interdisciplinary research field called Constructive Developmental Science. Its contributions include a new understanding of human development and its disorders, comprehensive diagnostic methodologies, and truly appropriate assistive technology.

【Content of the Research Project】

This project consists of three research areas described as follows:

- A. Constructive approach: It aims to model human development from the fetal period to infancy by integrating the evidences and hypotheses obtained in B and C while it provides B and C new technologies to measure development. Assistive systems for developmental disorders will also be designed using the technologies.
- B. Human science: It aims to analyze the longitudinal development of children with developmental disorders as well as normal children. Comprehensive diagnostics will be established so as to reveal not only the development of each function (e.g., motor, perception, social abilities) but also relations between functions.
- C. Tohjisha-kenkyu: We support the hypothesis that the essential characteristic of autism is the difficulty to integrate sensory-motor information rather than in social interaction. This research area intends to verify the hypothesis, develop systems to assist developmental disorders, and to facilitate

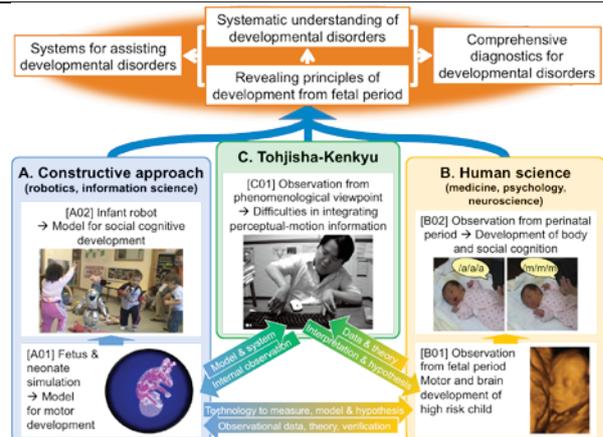


Figure 1 The goal and three research areas research in A and B by providing evidences and interpretations of their perceptual and motor experiences.

【Expected Research Achievements and Scientific Significance】

This project promotes the new interdisciplinary research, which integrates modeling studies in robotics, observational studies in human science, and phenomenological analysis in Tohjisha-kenkyu. Our project will go beyond existing research areas and establish systematic understanding of human development, which can be applied to the comprehensive diagnostics and truly appropriate assistive systems for developmental disorders.

【Key Words】

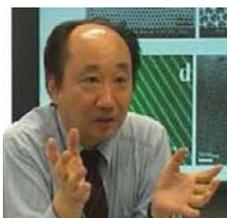
Constructive approach: An approach to understanding a mechanism by modeling, simulating and evaluating it under various environmental conditions.

【Term of Project】 FY2012-2016

【Budget Allocation】 1,093,300 Thousand Yen

【Homepage Address and Other Contact Information】

<http://www.isi.imi.i.u-tokyo.ac.jp/devsci/>
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**Title of Project : Innovative Materials Engineering Based on
Biological Diversity**

Masatsugu Shimomura
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【Purpose of the Research Project】

Biological diversity is the result of a long evolutionary process for adaptation to various environments. This diversity has been acquired by “biological processes and techniques” including “production processes” “operation principles” and “operation systems”, all of which differ from “human technology”.

“Sub-cellular structures” that are often observed on the surface of insects and plants possess characteristic functions. The study of the “biological processes and techniques” yielding these characteristic structures and functions will help to solve urgent issues involving the environment, resources, and energy, and will lead to a paradigm shift in human technology, known as biomimetic engineering.

This project, a interdisciplinary project based on the study of natural history, biology, agriculture, materials science, mechanical engineering, and environmental science, will open the door to a new system through the combination of lessons learnt from both “biological diversity” and “human wisdom”, and from the viewpoints of environmental policy and comprehensive technical governance. Through the design and fabrication of materials and devices based on knowledge obtained from biological diversity and a biological process, we aim to make a platform for innovation and new industry to develop a “biomimetics database” as well as train a new generation of talented scientists with expertise in biology and engineering.

【Content of the Research Project】

Our research area consists of three branches. In group A01, “Biomimetics database”, we aim to build a “biomimetics database” that will become the basis for an initial innovation platform based on the compilation of biological diversity. The other aim of this project is to train a new generation of scientists with expertise in biology and engineering.

In group B01, “Biomimetics design”, we will disclose the functions and formation processes of biological “sub-cellular structures”. Based on these biological systems, we will design and make innovative materials and devices.

In group C01, “Biomimetics sociology”, we will systematize engineering based on biological diversity as a new field of science and technology from the viewpoint of the social implications of environmental policy, and with the aim of contributing to the realization of and further innovation toward a sustainability society.

【Expected Research Achievements and Scientific Significance】

The cooperation between biology, engineering and social science are necessary will produce new research areas and contribute to the training of personnel to lead the next generation. Furthermore, for the creation of new industries to contribute to sustainability, the biomimetic-based technology must be accepted by society. A paradigm shift in innovation toward a sustainable society will be realized through biomimetic-based technology. Specifically, by focusing on the “movements,” “structures,” and “system operations” in nature, we will be able to develop new materials and systems that support low energy consumption, renewable energy, effective energy use and conversion and the use of non-rare elements. In addition, we will pursue the international standardization of biomimetics and contribute to the international competitiveness of our country.

【Key Words】

Biomimetics: The design and engineering of materials mimicking biological systems. For example, nylon is a synthetic polymer mimicking natural silk.

Self-assembly: Formation of ordered structures with various patterns or rhythms. Organs and tissues are sophisticated self-assembled structures.

【Term of Project】 FY2012-2016

【Budget Allocation】 1,076,500 Thousand Yen

【Homepage Address and Other Contact Information】

<http://biomimetics.es.hokudai.ac.jp>



**Title of Project : New Ocean Paradigm on Its Biogeochemistry,
Ecosystem and Sustainable Use**

Ken Furuya

(The University of Tokyo, Graduate School of Agricultural
and Life Sciences, Professor)

【Purpose of the Research Project】

With compelling evidence for global warming, ocean acidification and a host of other environmental threats, understanding and predicting how the ocean biogeochemistry and ecosystem responds to the environmental changes becomes one of the most urgent scientific pursuit. Since the ocean plays a critical role in sustaining human beings by providing a wide range of ecosystem services, ocean governance to maintain and manage these ecosystem services is crucial. However, our knowledge on biodiversity and material cycling in the ocean that form the foundation of the ecosystem services is extremely limited, particularly in the open oceans.

This research project aims to advance our understandings of ocean biogeochemistry and ecosystem dynamics in the Pacific Ocean for sustainable use of ecosystem services with particular attention to high seas. For this, the project sets three goals: 1) to establish a consistent set of pelagic biomes, 2) to evaluate ecosystem functions of each biome, and 3) to propose ocean governance for maintenance and management of ecosystem functions.

【Content of the Research Project】

The project consists of four research groups (Fig. 1). Group A01 will establish a consistent set of pelagic biomes in the Pacific Ocean based on physical oceanography, dynamics of bio-elements and molecular biogeography of plankton. Group A02 will investigate key processes of material cycling in selected biomes including primary production, dinitrogen fixation, and processes associated with microbial carbon pump. Group A03 will assess function and values of ecosystems in each biome by 1) examining population dynamics of migratory fish species based on ecosystem approach, 2) assessment of both market and non-market values of the ecosystem functions, and 3) establishing management objectives for sustainable use of the functions and values of biomes. Group A04 will design future social frame-works for sustainable use of the ocean.

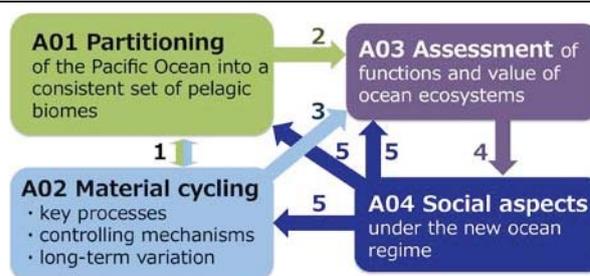


Fig. 1. Four research groups of the project. 1: joint oceanographic surveys, 2: pelagic biomes for regional units of analysis, 3: material cycling and biological productivity of each biome, 4: value of ecosystem functions of each biome, 5: key areas and items to be investigated.

【Expected Research Achievements and Scientific Significance】

Our knowledge on the biota and functions of pelagic ecosystems, particularly in the central and western parts of the Pacific Ocean, will advance significantly. A consistent set of pelagic biomes in the Pacific Ocean equipped with a comprehensive database on structures and function of ecosystems in each biome will be established. The database will stimulate model-based studies on ecological consequences of global climate change, and contribute to increasing the predictability by serving as a baseline for validation of model outputs. The biomes will improve ocean governance by providing conceptual and substantial frames for discussions. These activities will raise public awareness of the ocean.

【Key Word】 Ecosystem service: Life-supporting goods and services provided by natural ecosystems to human.

【Term of Project】 FY2012-2016

【Budget Allocation】 695,100 Thousand Yen

【Homepage Address and Other Contact Information】

<http://ocean.a.u-tokyo.ac.jp>

