The University and Information  
—Information Changes Learning—

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Information Changes How You See

- Machines $\leftrightarrow$ Robots $\rightarrow$ Life, Intelligence
- Functions and Structures of Protein $\leftrightarrow$ Visualization $\rightarrow$ Pharmacology

Information Changes How You Think

- Knowledge $\leftrightarrow$ Structuralization $\rightarrow$ Utilization of Knowledge
- Knowledge $\leftrightarrow$ Information $\rightarrow$ Sustainability

Information Changes our Senses

- Games
- New Art
Circumstances in Existing Disciplines

• Various disciplines are in a state of chaos.
• Can anyone grasp the big picture?
  Particle size of a panoramic view
• Information is borderless: it can cross borders in an instant.

- the Google Empire (Google dominates the field of creating order from knowledge chaos.)
  ⇨ arbitrary ranking
  A speed that exceeds the speed of thought.
  Possibility of “unexpected discovery” (serendipity) is lost.

Light and Shadow of Science
Human Knowledge over 1900 years

solar radiation

carbon gas

water

chlorophyll

oxygen

carbohydrates
Explosion of Knowledge!
Can Anyone Grasp the Big Picture?

Computer’s Y2K Problem
Nobody could.
Repeated Post Experiments
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Can a researcher or an engineer be trained who can overview all of these fields of knowledge?
Knowledge Structure of Material Science

Multiple Scale of a Condensed System Hierarchy
Knowledge Structure of Environmental Issues

form of load

regulations

human activities

environmental issues
“Structuring knowledge” is essential to utilizing knowledge chaos.

To utilize knowledge beyond the borders of disciplines.
Panoramic View of Environmental Problems

form of load

regulations

human activities  environmental issues
Implementation Example: Environmental Mandala (Itaru Yasui)

**Motivating human activities**
- Economic/social/institutional issues that go on regardless of "environmental problems in a narrow sense" such as population explosion, starvation, stabilization of economy/society, ethnic or religious battles.

**Form of load**
- Load items (LCI)
  - Emission of pollutants
    - CO2, CH4, N2O
    - CFC
    - NOx, SOx
    - PAH
    - Organic chloride
    - BOD, COD
    - N, P
    - Heavy metal
    - Solid waste
    - Noise
    - Heat waste
  - Radiation
  - Quantitative use of resources
    - Fossil energy
    - Mineral energy
    - Wood energy
    - Aquatic resources
  - Changing natural environment
    - Coastal reclamation
    - Burden alteration
    - Building artifact
    - Hunting wild animal
    - Habitat alteration
    - Landscape alteration

**Environmental issues**
- (mainly from environmental performance assessment, classification of indicators)
  - Climate change
  - Ozone layer destruction
  - Acidification
  - Eutrophication
  - Sea pollution
  - Chemical pollutant
  - Urban pollution
  - Local environment
  - Landscape destruction
  - Chemical fuel depletion
  - Mineral resource depletion
  - Water resource
  - Forest resource
  - Soil degradation
  - Biodiversity decrease

**Categories of environmental impact**
- Finiteness of environment as a sink for wastes
- Circumference of nature
  - Effect on human survival/health
  - Finiteness of environment as a supply source of resources
  - Health of the ecosystem

**Sustainability**
- Species level
  - National/generational fairness
  - Independent level
Image of Knowledge Structuring

Panoramic View, Detail View

overview
(panoramic view, distant view)

sectional view
(close view)

detail view
Weight Control Feedback System

- inhibition signal
- medulla
- regulation
- food
- Intestine
- body
- exercise
- Internal heat
- basal
- metabolism
- obesity signal
- hypophysis
Sectional View: Signal Transduction for Obesity Regulation

1. **Obesity Detection System**
   - Fat
   - Blood flow

2. **Primary Transduction System**
   - Leptin
   - Neuron (Arcuate nucleus)

3. **Secondary Transduction System**
   - Melanocortin
   - Neuron (Nucleus paraventricularis)
   - Hypophysis
   - Blood flow (Nucleus tractus)

4. **Appetite Regulation System**
   - Hormones

† (Hajime Nishimura, “genomu igaku nyumon” 2003, Nippon-Hyoron-sha Co.,Ltd.)
Image of Knowledge Structuring 3
Panoramic View, Synthesis of Disciplines
Birth of Biodiversity

- agriculture : environment biology
- literature : ecological ethics
- mathematics

⇒ One of the sustainability sciences
-Information Gives New Expressions to Academic Disciplines-

• Expression of academia is no longer words alone.

• New words
  Simulation and visualization
Knowledge Structuring 1: Panoramic View

- Education principles of the University of Tokyo - text: ontology: research
- Substance process - process: structure: function: application

Knowledge Structuring 2: Detail View

- Feedback system of human obesity
- Technologies for sustainability - detail view of a detail view

Knowledge Structuring 3: Synthesis

- Ecological science (agriculture) + educational ethics (liberal arts) + math
- Electricity generation: bicycle: wind mill: waterwheel: thermal power: nuclear power
- Quantum mechanics, Boltzmann equation, Navier-Stokes
Example of Simulation
-The structure of genomes and medicine—

The Steric Structure of Proteins

- Gene sequence determines protein “sequence” and protein sequence determines the steric structure (the function of protein).
- Their virtual structure can be seen on a PC.

- Bcr-Abl kinase inhibits binding with substrates.
  → Abnormal proliferation is inhibited.
- Bcr-Abl kinase specifically reacts.
  → No side-effects.
The New Form of Academic Disciplines

-Knowledge structuring changes learning.-

• Simulation, visualization
  New methods of knowledge transmission. Information independent of words

• Academic discipline to deal with the needs of the 21st century.

• Considering how to use knowledge is one academic discipline.
  A new method is born from matching knowledge with intelligent values, economic values, social values, and cultural values.
The 21st Century University Model

• Creation of knowledge
• Creation of value
• Transmission of structured knowledge
Concept of “Knowledge Structuring”

- Intellectual Value
- Social Value
- Economic Value
- Cultural Value

autonomously distributed and created knowledge
Concept of a “Knowledge Structuring Center”

Intelligent Value-Related Research
- Evolving textbooks
- Digitization of an all-campus syllabus and “UT all-campus knowledge structuring” using MIMA search techniques
- Science and technology literacy for Japanese people
- Visualization of university education and research

Structuring Method Development
- Development of knowledge-structuring methods
- Liquefaction and crystallization of knowledge expression
- Semantic computing
- Structuring Knowledge from the Web

Social Value Related Research
- Idea-supporting systems for problem solving
- Structuring and visualization of medical knowledge
- Structuring of compliance issues

Economic Value-Related Research
- Material nano-technology knowledge basis
- Workshop for business knowledge structuring

Cultural Value-Related Research
- “New Encyclopedia” Project
- “Wisdom and Tree of Media Analysis” Project
- Structuring of NHK archives and educational navigation
Komiyama’s Conviction

Educational resources should be concentrated in Komaba.

The results of knowledge segmentation remain at the forefront for all people

the answer: textbook ⇔ ontology ⇔ research

Research and education should be linked in real time.

environment: energy: sustainability: science of aging: ocean
brain science: nuclear power plants: giant earthquakes, etc.

the answer: knowledge structuring + education institution
Knowledge Structuring

- Knowledge has a network structure.

Reintegration by knowledge fragmentation and analogy

adding value to knowledge

understanding of a broad knowledge base
reuse of knowledge

social technology

application

academia

energy

environment

solar battery

fuel battery

lithium battery

chemistry

physics

biology

knowledge matching
“Organisms are diverse”

- **Bacteria**
  - spirochaete
  - microbe

- **Amoebas**
  - amoeba
  - flagellates

- **Algae**

- **Protozoa**
  - amoeba
  - flagellates

- **Mycota**
  - fungus
  - yeast

- **Plantae**
  - moss
  - fern
  - gingko, cycad
  - chrysanthemum
  - orchids
  - wheat
  - nut pine
  - rice

- **Animalia**
  - jellyfish, actinia, coral
  - sea urchins, asterids, trepang
  - crustacea
  - insects
  - reptiles
  - mammals

- **Porifer**

- **Echinodermata**
  - sea urchins, asterids, trepang

- **Mollusca**
  - shellfish, squid, octopus

- **Annelida**
  - earthworms, lobworms

- **Arthropoda**
  - spiders, scorpions

- **Chordata**
  - amphibians
  - birds
  - mammals

- **Plantae**
  - angiosperm
  - gymnosperm

- **Fungalia**
  - fungus
  - yeast
Accumulation of knowledge about ageing

Gerontology

Reduce new knowledge from collaboration to society

Mind
- memory
- character
- accomplishments
- values
- time concept
- etc.

Physiology
- genes
- cells
- intestines / skeletons
- nutrients
- exercise
- etc.

Geriatric Medicine
- chronic disease
- clinic
- medicine
- discharge support
- cost
- etc.

Politics
- concern for politics
- voting
- motive for voting
- behavior theory of senior groups
- etc.

Economy
- income difference
- tax system
- social security
- public assistance
- senior market
- modernization
- etc.

Society/ Culture
- youths’ view on seniors
- seniors’ view on youths
- media’s view on seniors
- public servant systemic reforms
- structure and functionalism
- etc.

Living Activities
- usage of time
- leisure
- same-generation counseling
- lifelong learning
- etc.

Human Relationships
- husband and wife
- parents and kids
- brothers and sisters
- friendship
- etc.

Working/ Retirement
- desire to work
- retirement and health
- mandatory age
- flotation after retirement
- work sharing
- etc.

Household
- income
- outcome
- family saving
- asset management
- inheritance
- etc.

Habitat
- whom to live with
- replacement / removal
- barrier-free
- reverse mortgage
- etc.

Death/ Ethics
- understanding death
- preparation for death
- bereavement practice
- things after death
- death with dignity
- Hospice care
- etc.

Nursing Care
- prevention
- assessment
- care plans
- service model
- public insurance / private insurance
- adult guardianship system
- etc.
Purpose of Scientific Integration - Project “Earth”
Show the relationship between various academic disciplines concerned with the Earth. Make them easy to understand for freshmen and the general public, stratify them so that the top level would be in laboratories. Show them on the Web so that anyone can see them in libraries. → Make possible various simulations and models.

Highly Complex System and the Role of the University
- Hundreds?
- (UT instructors: 4000!)

Dynamics Frame
- Earth model
- local climate model
- ice cap model
- earth surface model

Physics/ Chemistry Frame
- gas chemistry model
- particle chemistry model
- cloud physics model
- light transmission model

simulation

Earth simulator

Reproduction of Vapor Distribution by a High-Resolution Atmosphere Model
Reproduction of Air Pollutants and Sand Aerosol Distribution

Reproduction of an Intermediate WaterJet by a High-Resolution Model Using an Earth Simulator
Role of Information in Education

- Relationship between a trend of knowledge and higher education
- Relationship between a trend of knowledge and elementary and secondary education
  The next generation will solve today’s issues.
- Relationship between a trend of knowledge and continuing education

⇔ Humans share “structured knowledge” in real time
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\[
\text{the answer: a knowledge-structuring + education institution}
\]

This gives birth to and fosters genuine learning.
Parents can support their children’s learning by accessing “the ideal textbook (for parents)”, an educational tool for parents developed by “educational institutions”. Parents can participate in education.

Children can learn according to their interests using an online “ideal textbook” linked to the basic textbook.

Teachers look for more effective teaching methods on their own using educational contents such as “the ideal textbook (for teachers)” and faculty training materials developed by “educational institutions”.

Infinite number of educational contents are on internet.
Real-time Dissemination of Structured Knowledge

Generation and dissemination of knowledge

Structured knowledge