Symbiotic system
as a new social infrastructure based on intelligent interaction among the society, human beings, and information systems

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World trend of the 60 years in the future
Increasing population of elderly people

Japan
- Male
- Female
- 2011
- 2050
- Elder
- Young
- Population (in millions)
- 40% of Population Become elderly
- Isolation
- Disappearance of mutual assistance

United States
- 2011
- 2050
- U. S. Census Bureau International Data Base (2011)
Increasing isolation of elderly people in Japan

- 40% of elderly people don’t join group activity in local community  
  (The Cabinet Office, Government of Japan, 2010)

- 16% of elderly people lives alone  
  (Ministry of Internal Affairs and Communications, Statics Bureau, 2011)

- Increasing solitary death of elderly people  
  (Urban Renaissance Agency, 2008)

Elderly people: more than 65 years old

Counting by a housing management organization
Three important issues in the next 30 years

- Global Society
- Nation
- Community Organization
- Individuals

1. Open Globalization
   - Disappearance of traditional local community
   - Disappearance of a border around a traditional enterprise
   - Rapid increase of globalized business flow

2. Assurance and security of society
   - Disappearance of traditional local community
   - Disappearance of a border around a traditional enterprise

3. Global environmental problems
   - Big companies will vanish
   - Many independent workers will remain
   - Traditional national governments can’t stop the aggravation.

- Aggravation of global environmental problems
- Disappearance of traditional local community
- Disappearance of a border around a traditional enterprise
How to solve global problems

Limitations or misunderstanding on our current society keep it with unsolved problems.

Removing such limitations on the society will smoothly change to be free from the suppression by the problems.

<table>
<thead>
<tr>
<th>Problems predicted</th>
<th>Limitations to be removed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daily life</strong></td>
<td>- Daily life is restricted to limited places</td>
</tr>
<tr>
<td>- Increase in number of old people living alone</td>
<td>- Family members</td>
</tr>
<tr>
<td>- Increase in social welfare costs</td>
<td>- Older people are less active</td>
</tr>
<tr>
<td><strong>Work</strong></td>
<td>- Much tacit knowledge in an organization</td>
</tr>
<tr>
<td>- Fluidization of human resources weakens competence of</td>
<td>- Know-how collects in workers’ brains</td>
</tr>
<tr>
<td>company</td>
<td></td>
</tr>
<tr>
<td><strong>Society and community</strong></td>
<td>- Individual behavior does not influence society</td>
</tr>
<tr>
<td>- Indifference to social affairs</td>
<td>- People can’t sense gradual change</td>
</tr>
<tr>
<td>- Aggravation of global environment</td>
<td></td>
</tr>
</tbody>
</table>
People of 80 years old will actively contribute to the society.
This system enables family members to communicate peacefully with one another than that they live together.
Every person will be able to play an active roll by his own specialty. The system will assist people in collaborating with others to accomplish big business though they seem to be working randomly at a glance.

- Maximization of individual creativity
- Harmonization of individual activities and Feedback them to global society
- Maximization of intellectual productivity of open community
- Global tele-collaboration
- Technology issues
  - Open work-flow
  - Mechanism of inspiration
  - Intellectual productivity
  - Global human resource management
  - Community management
  - Coaching
  - Protection of originality
  - Global tele-work
  - Assisting life-time education
  - Global human resource management
  - Community management
Global collaboration system promotes all of the people to collaborate for solving the global problems coming in the future.

The system removes many barriers such as ones in inter-cultures, ones in inter-generations, ones between individuals and the society.

- Giving suitable information to individuals
- Assisting comprehension of global problems
- Overcoming barriers of mutual understanding

Tech issues

- Dynamics of information explosion
- Cross-cultural collaboration
- Comprehension of global problems
- Activity monitoring
- Analysis of complex mutual dependency
- Coordination of opinions
- Personal adaptation improves information literacy
- Evaluation of information reliability

- Assisting spontaneous behavior.
- Spreading individual activities
- Reporting contributions to individuals
Symbiotic technology
Key idea is based on “Shift from Ownership to sharing”

- Sharing and utilizing social resources:
  - (like virtualization of computers)
  - Human resources (connection of people)
  - Town resources (Transportation, Distribution, Energy supply, Food & water supply, Environment, Health, Houses)
  - Information resources (data, IDs, knowledge sharing)
Integrated city infrastructure

Social functions will be virtualized and shared by people in a city or people in many nations

Smart Society

Virtualization of social functions

Rebundling

Real-time social simulator

Time sharing/ function fractionalization

management system for Ecology-conscious community

Dynamic arrangement of social resources

Problem Detection, Education, Policy decision implementation, Security / Safety, Quality guaranteed, Communication methods, Information providing, Energy production and supply

Stock, Distribution, Food production, Leisure, Service providing, Traffic, Energy supply

Management of social resources

Energy production and supply

Agriculture, Forestry, fishery, Broadcasting, Telecommunication, Manufacturing industry, Transportation, Commerce

Government, Schools, Police & Fire station, Agriculture, Forestry, fishery, Broadcasting, Telecommunication, Manufacturing industry, Transportation, Commerce

NEXPIRATION

C&C Innovation Research Laboratories
Open Co-creation platform

Virtualization of business process will realize business activities by floating organizations.

Solution of global problems by human networks

Measurement and evaluation of Intellectual productivity

Segmentation, record, communication of Workflow

Global transactions and distribution of intellectual properties

Global restructuring of business process

Fractionalization of transactions

Platform for open business process

Rebundling

Business by compound companies

Time sharing/ function fractionalization

Current business process

Personal Small / Medium enterprise Large enterprise Local government Educational system
Total Guard system
Two dims. of symbiotic technology

The next stage is to combine socio-technology and scientific technology.

Fusion of artificial systems and social systems

Heterogeneous artificial systems

Distributed system

Terminal devices (Fixed and mobile)

Environments (Internet of things)

Change of social structures

Change of social values

Change of social behaviors

Intellectual productivity

Intention communication

Intelligence, mind (Co-Creation)

Response capability to social change

Autonomous control under strong interaction

Social dependability

Sustainability

Adaptability

Structuralization

Technology development

Social dynamics

Non-schematic DB

Fusion of artificial systems and social systems

Terminal devices (Fixed and mobile)

Environments (Internet of things)
Convergence of the real and cyber worlds

Two dimensions: characteristics and size of party

- Holistic social system
  - Social dependability
  - Smart Grid
  - Social monitoring
  - ITS
  - Intelligent agriculture
  - BPM SCM
  - Wisdom of crowds
  - Monitoring of intellectual activity
  - CoPs
  - Visualization of business situation
  - Persuasion Behavior induction
  - Creativity

- Organization community
  - Sensor network
  - Probe car
  - Physical sensor
  - Biological sensing
  - Behavioral sensing
  - Emotional sensing

- Individuals each objects
  - Physical characteristics
  - Behavioral characteristics
  - Intellectual characteristics

- Creativity

- Social monitoring

- Physical sensor
Hetero-systematization

- Individual systems grow and are entangled.
- Design method of huge-scale integrated system is necessary.
Architecture of symbiotic system

Combines dynamic control of social hard-ware and promotion of spontaneous human activity

- **Sensors**
  - Acquisition of demands
  - Estimation of mental states

- **Modeling**
  - Demand
  - States
  - Characteristics of response
  - Dynamic coordination of demands

- **Monitoring real worlds**
  - Demand
  - Situation
  - Characteristics of interaction
  - Acquisition of demands
  - Analysis of causality and interaction

- **Monitoring**
  - Demand
  - Situation
  - Characteristics of interaction

- **Human behavior (Cognitive activity, Intellectual activity, daily behavior, social behavior)**

- **Dynamic distribution of social resources**
  - Dynamic generation of control programming

- **Interaction**
  - Generation of Interaction scenario
  - Estimation of probabilistic behavior
  - Dynamic generation of local control target
  - Local real-time control

- **Interaction with real world**

- **Real objects and social services**

- **Situation**
  - Support for understanding surroundings and situations
  - Stimulation on mental states

- **Probabilistic change of behaviors**
  - Support for understanding surroundings and situations
  - Stimulation on mental states

- **Dynamic control**
  - Local real-time control
Technology development and Field evaluation
Inter-disciplinary collaboration

For developing symbiotic technology (fusion of socio-technology and scientific technology), interdisciplinary collaboration is essential.
Future exploration

- We extract structure of dynamics in the real world by using natural language processing and multi-dimensional pattern processing.

- Understanding of reciprocal influences in the real world helps us to predict issues which will occur in the future.

- Chronological event (CE) retrieval
- Causal network analysis
- System dynamics
- Multi-agent simulation

- Workshops in our future center
**Chronological event (CE) retrieval**

Extracts future or past events from a huge amount of documents.

- **Future of "Photovoltaic cell (PV)"**
- **PV ▶ (2011 ▶ 2012 ...)**
- **Presenting events as a list**
- **Search API**

**Search**

- **Extraction**
  - **Denoising (SVM)**
  - **Clustering (sets of similar events)**
- **Selection**
- **Structuring**
  - **Presenting events as year expression**
- **Visualization**

**Presenting events as a list**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Organic thin film PV accounts for 30% of solar cell</td>
</tr>
<tr>
<td>2020</td>
<td>Market size of solar cell will be $100 bil.</td>
</tr>
<tr>
<td>2030</td>
<td>Solar cell efficiency 40%, ¥7/kWh</td>
</tr>
</tbody>
</table>

**Degree of attention**

- **Solar cell efficiency 40%**

**Timeline**

- **1950**
- **1975**
- **2000**
- **2025**
- **2050**
We introduced expansion of query terms for improving recall rate.

<table>
<thead>
<tr>
<th>expansion</th>
<th>Future</th>
<th>Past</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time determiner TD</td>
<td>till, until, by, in, before, etc.</td>
<td>In, of, till, from, since, etc.</td>
</tr>
<tr>
<td>Time expression TE</td>
<td>From ** to **</td>
<td>-</td>
</tr>
<tr>
<td>Context term CT (frequently added words)</td>
<td>prediction, target, estimate, increase, decrease, future, down, up, peak, etc.</td>
<td>origin, source, first, start, discover, establish, foundation, completion, etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expansion</th>
<th>Precision</th>
<th>Recall</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.648</td>
<td>1.000</td>
<td>0.786</td>
</tr>
<tr>
<td>UG (Unigram)</td>
<td>0.798</td>
<td>0.851</td>
<td>0.824</td>
</tr>
<tr>
<td>UG+LM+CT</td>
<td>0.807</td>
<td>0.861</td>
<td>0.833</td>
</tr>
<tr>
<td>UG+LM+CT+SS+IY</td>
<td><strong>0.825</strong></td>
<td>0.873</td>
<td><strong>0.848</strong></td>
</tr>
</tbody>
</table>
Causal network analysis

Causality analysis can be applied to extract dynamic relationship in the real world.

- It can extract structures of knowledge by integrating a lot of partial information in WWW, documents, and the real-world.

- It helps us to understand complex interactions of even, objects, economic trend, and changes in the society.

Similar knowledge is extracted and is systematized.
Causal network extraction by a natural language processing

The progression of global warming can increase temperature and increase the number of abnormal climate.

A fact: a combination of noun phrases (NPs) and trend verbal phrases (TVPs) which represent changes, actions, behaviors and movements of NPs.

Bootstrapping method for generating a causal network

Other causality can be extracted by using the same pair of facts.

- As global warming progresses, temperature will increase.
- Other facts can be extracted from sentences including both of representations of the same causality and the same fact.
  - The progress of global warming will cause rise in the sea level.

Extracted facts are added to the causal network.
Example of causal network

We can understand multi-paths between "industrial development" and "economic growth".
Intellectual activity analysis for open co-creation

Method to measure intellectual productivity and improve intellectual productivity.

Multi-modal activities of researchers are sensed and analyzed for extracting intellectual productivity of each researcher and idea created from interactions between researchers.
Intellectual activity analysis for open co-creation

- Method to measure intellectual productivity and improve intellectual productivity.
- Multi-modal activities of researchers are sensed and analyzed for extracting intellectual productivity of each researcher and idea created from interactions between researchers.

Integration & Analysis

Mental health care in offices

Workflow management

Facilitation of creative communication

Facilitation of idea creation

- Activity of PC operation
- How long to stay in the same position
- File accessed last
- Communication within an hour
- File accessed last
- Communication within an hour

Symbiotic system
Automatic segmentation of workflow generates a set of elemental works, the meaning of which are labeled semi-automatically.

Meaning of each activity is added to an elemental work based on a daily report.

List of people with whom a subject communicated:
- Doi
- Itaya
- Hideki Kawai
- Konishi
- Sakao
- Katsumi Suzuki
- Rie Tanaka
- Keiji Yamada
- Youki Kamiva

PC operation:
- Mozilla Firefox - 34%
- Unknown - 23%
- Tera Term Pro - 18%
- C:\Program Files\Evernote\Evernote3.5\Evernote.exe - 11%
- Microsoft Remote Desktop - 8%
- File Manager - 3%
Change of communication mount and knowledge sharing

Office layout may be related to activities of co-creation with mutual communication and file sharing.
Behavior for communication

varies according to way of management and location

<table>
<thead>
<tr>
<th>Ratio of communication style</th>
<th>Within group</th>
<th>Inter group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group X</td>
<td>0.474</td>
<td></td>
</tr>
<tr>
<td>Group Y</td>
<td>0.526</td>
<td></td>
</tr>
</tbody>
</table>

Next step:
How does the way of communication influence intellectual productivity of a research group?
Management of a meeting influences the efficiency of creativity.

Visualization of topic transition reveals the process to approach the agreements and understandings during a meeting.
Another topic transition in a meeting

There was no agreement at the end of the meeting.

This process was not good for decision, but might be useful for creation of various ideas.
It promotes users to clarify their opinions and help them to achieve an agreement.
Experimental results

Outline of the experiment
- 8 groups, 4 subjects for each group
- 4 groups: engineers, 4 groups: graduated students
- Session is an hour discussion, 4 sessions by each group

Results
- This system can help people who don’t have enough skills for discussion and drive them to produce decision with consent.

Easiness to comprehend opinions of others

Consent degree to decision (5-point scale)
Adaptive activity promotion based on mental attributes

- Totally activates personal behaviors to contribute the community and increase satisfaction to services.

![Diagram showing personal mental attributes and their influence on various services such as transportation, health care, and community activity.]

Balance of resources between demand and supply.
Mental attributes for ecological behaviors based on psychological investigation

classified into five factors by analyzing questionnaires on intention to save energy.

Increasing activities when seeing status according to types

Positive
- Cost conscious
  - Awareness of advantage
    - Reducing household expense
    - Saving money on electricity
    - Beneficial to the society
  - Need for admiration
    - Getting compliments from acquaintances
    - Able to pride
    - Expected by acquaintances

Cost conscious
- Justice
  - Inconvenience
    - Troubling acquaintances
    - Being embarrassed
    - Getting untrusted
  - Sense of impotence
    - Individual efforts cannot influence the society
    - No interest in energy saving by other people
  - Burden
    - Time consuming
    - Stressful
    - Mental fatigue

Negative
- Compeitiveness
  - TIPS for action

Motivating actions by showing tips and encouraging competitiveness
Promotion of energy saving activities in a community

- Visualization of community activities for energy saving
- Adaptive situation visualization depending on individual attribute type to motivate active ecological behaviors
  - For the earth, for economy, for health, for fashion

These technologies will be applied to traffic behavior, community activity, motivation for health, and business activity.
Adaptive activity promotion based on mental attributes

**Daily life assistance for aged people**

- Networked ambient agents activate aged people who live alone and make them participate actively in local communities.

- Tele-education (Mediation of communication, assisting lectures by aged people)

- Tele-medicine (consulting doctors)

- Wellness trainer (training robot, communication mediation)

- Sightseeing navigated by virtual robot

- Virtual robot

- Visible/Virtual types
Daily life assistance for aged people

The system acquires attributes and concerns of each person and modifies scenarios of interaction to promote him/her for participating in group activities.

From a set of interactions, the system updates his interests, his type of attributes, and current emotion.

At home
- Motivate to meet with others

Connected Services via Network Robots
- Local Organizations
  - Event Information etc.

Online
- Medics
- Friends
- Maintain Contacts
- Keep Relationships
- Family in Distance

Preferred Topics
- Wild Fire
- Baseball
- 

Build a Relationship
- Fire in CA..
- I was there once before...
- Scarily!

Mediate Conversation
- Provide suitable topics to participants

meeting room in a village
Experimental results

"Is there any changes in your life with the robot?"

- Going out: Increased
- Conversation with family: Increased
- Friends: Increased
- Others: Not changed

100 70 40 10
0
Summary

Symbiotic system and symbiotic technology: fusion of socio-technology and scientific technology.

- Intellectual productivity and creativity of open co-creation
  - This idea was tested in communication in an office and in management of meetings
- Adaptive activity promotion based on mental attributes
  - This idea was tested in promotion of ecological behaviors and activation of elderly community.

Next step

- We are testing them in a larger community.

Future work

- The way to use mental attributes for other applications
- The way to manage intellectual productivity
- “Quality of life” depends on cultures and countries
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