NPO Think Tank Nippon
Director S.Honna

A social system that responds to rapid changes in science and technology

1. Purpose

In the situation where science and technology continues to progress rapidly, the speedup of change in various fields has been realized. The theme related to the influence and its response to human society which such rapid change will give is considered more important from now on.

In this study, we focus on the essence of change and future science and technology etc, and aim to explore how we should oppose the era when human race changes acceleratively.

In the future, I hope that discussion will deepen in various fields.

2.Meaning of "science", "technology", "science technology"

Based on the literature survey, the keywords of "science", "technology", "science technology" are summarized below.

2.1 Meaning by Kojien

① Science

- Systematic rational recognition that empirically can be argued, with a part of the world and phenomena as a target area.
- Natural Science: A discipline to deal with objects belonging to nature and to clarify its rule.

② Technology

- Works on things. Skills. Acomplishments.
- Works which we will apply science to practical use, modify and process natural things, and use it for human life.

③ Science and technology

- Science and technology have been said to have been carried out for a long time to modern times, basically as separate activities, without interaction with each other.
- We have created situations that make it impossible to distinguish science and technology as pure "elucidation of the law of nature" and "application" to its reality, and science activities also have advanced technology. It is said that It is becoming increasingly difficult to distinguish science and technology from scraping clearly as it used to be, such as increasing reliance on experiments and observation methods used.

2.2 Science and technology described by Atsunobu Ichikawa (Honorary Professor Tokyo Institute of Technology)

A) Science: Activities to map the real world to the linguistic world

B) Technology: Activities to map the linguistic world to the real world

- Activities to make tools to extend human innate abilities
- The desire of "what kind of tools do you want" was born in the language world, technology is that to be realized.

C) Since an era without science, technology was born and developed in all societies, and since the birth of science it came to be "science and technology".

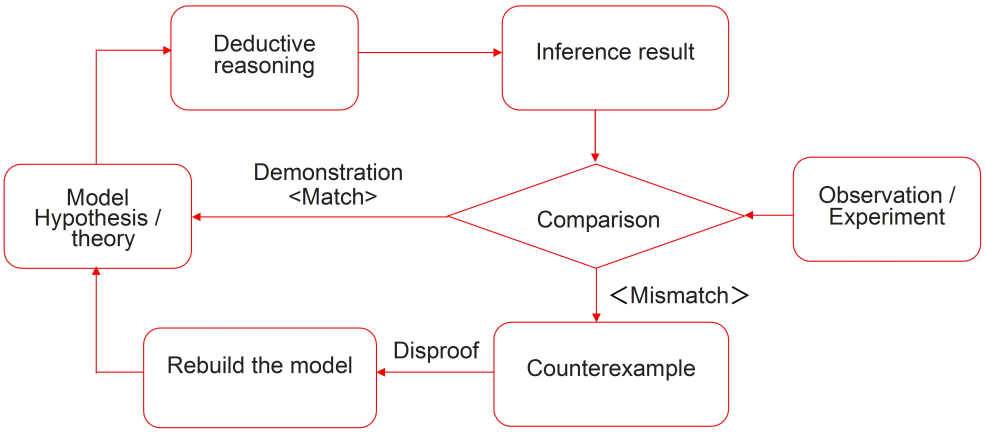
- Formation of Science ~ Early 16th Century (Copernicus Giant Theory)
- Formation of technology ~ 50,000 years ago (occurrence of technology characterizing current living human beings)

D) Characteristics of scientific discoveries after the 17th century (model verification method)

① Verify by experiment whether a certain theory is correct or not.

② When a certain theory seems to be correct, use that theory to guess what is unknown.

③ When a certain theory does not agree with the observation or the experiment result, we abandon the theory and make a new theory.



Note) How to draw conclusions. : A deductive reasoning: We will chase the logic that "××, so it is ○○"

Source) "Five conditions that science evolves" Professor Emeritus Tokyo Institute of Technology Yoshinobu Ichikawa

Figure 1 Flow diagram of model verification method

3. The essence of change

3.1 Form of evolution of science and technology

There are three types of science and technology considered as follows.

Type 1: Technology that disappears
Type 2: Technology remaining at the bottom
Type 3: Evolving technology

For these three types, the graphs in which the horizontal axis is time and the vertical axis is the evolution level of science and technology are shown below. In this paper, we focused on "Type 3: evolving technology".

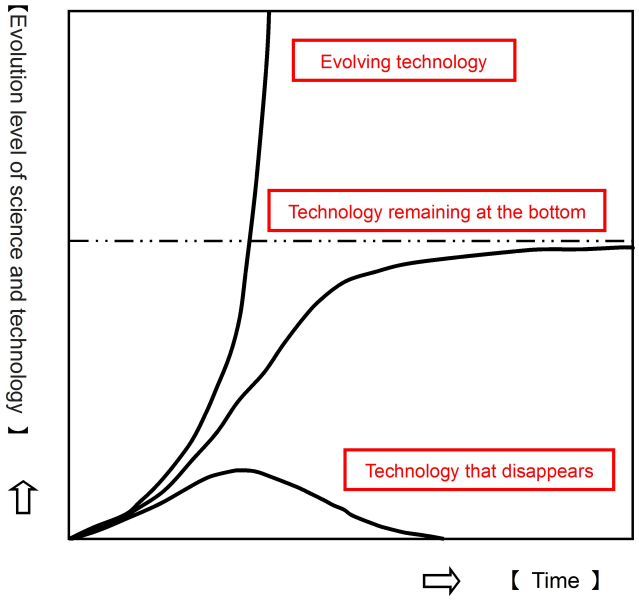


Figure 2 Form of evolution of science and technology

3.2 Mathematical meaning of exponential evolution

I think that the evolutionary tendency of "Type 3: evolving technology" can be represented by the exponential function shown below, and decided to grasp the mathematical characteristics.

[Expression function expression]

$Y = \exp(t)$, $dy / dt = \exp(t)$

Here, $e = (1 + 1 / n)^n$ $(n \rightarrow \infty) = 2.716\cdots\cdots$

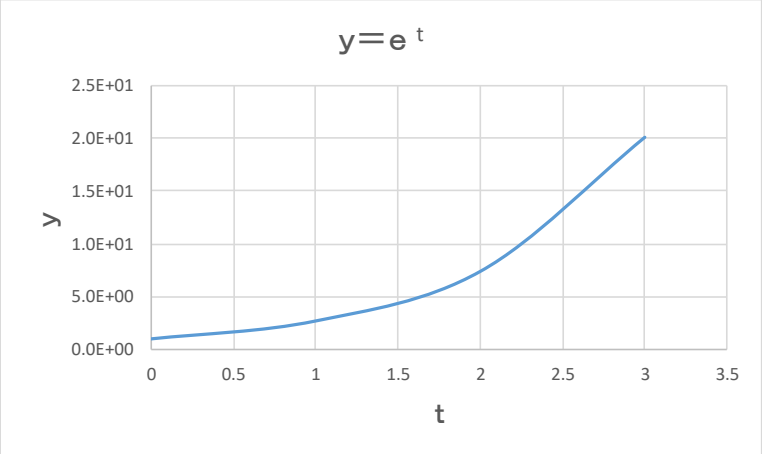
If we use the above equation and assume that the unit of the time axis (t) is a year, Figure 3 shows the range of the graph in three patterns of 3, 10 and 30 years.

According to this, it can be seen that a sudden change occurs from the second year at t ≦ 3 years, but when we look at the graph of t ≦ 10 years with the same formula, there is still no rapid change from the second year and from 8 years past rapid change is taking place. Such a tendency can be read also in the graph of t ≦ 30 years, and it can be easily imagined that it will continue over the future.

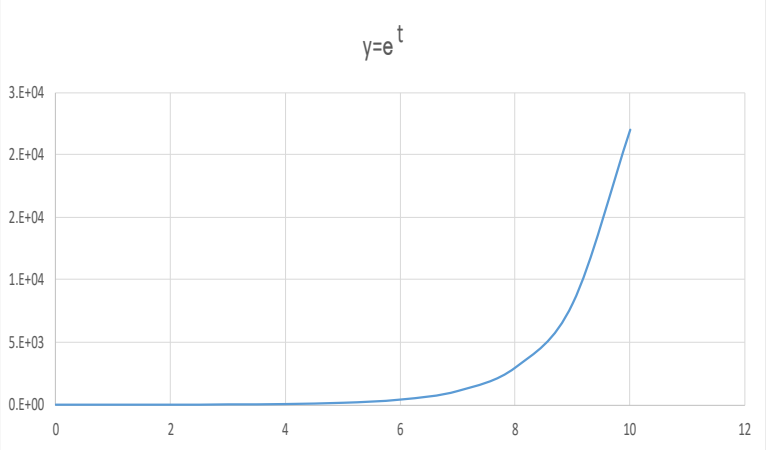
This difference arises from the fact that the values of the vertical scale are different in each graph, and even if it is seen as a sudden change in the sense of seeing several years ahead from the present time, from a point of view it will be several years ahead I feel like a similar change in the image. In other words, for a society that evolves exponentially, the rapid change a few years ahead finds that this exponential function expresses a situation that does not recognize the degree of change so much at that point .

As an example where changes in society occur exponentially, "Integration of ICs" and so on can be mentioned, but in understanding what the rapid change of mankind is due to mathematical understanding by exponential function, one I think that it will be an effective means.

【t ≦ 3 years】



【t ≦ 10 years】



【t ≦ 30 years】

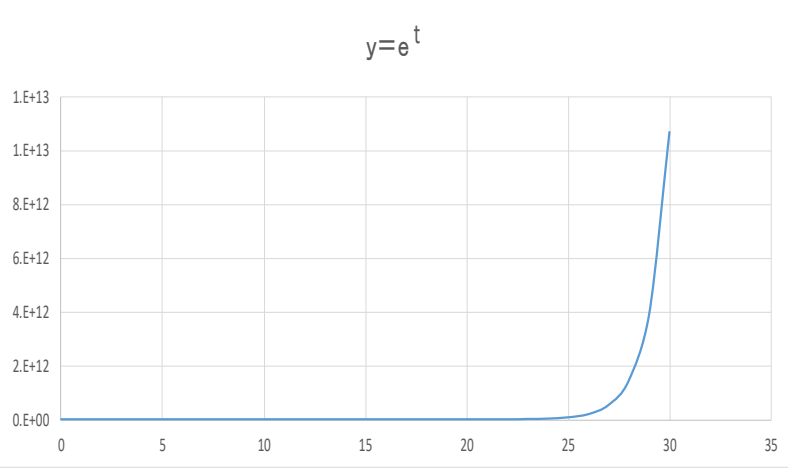


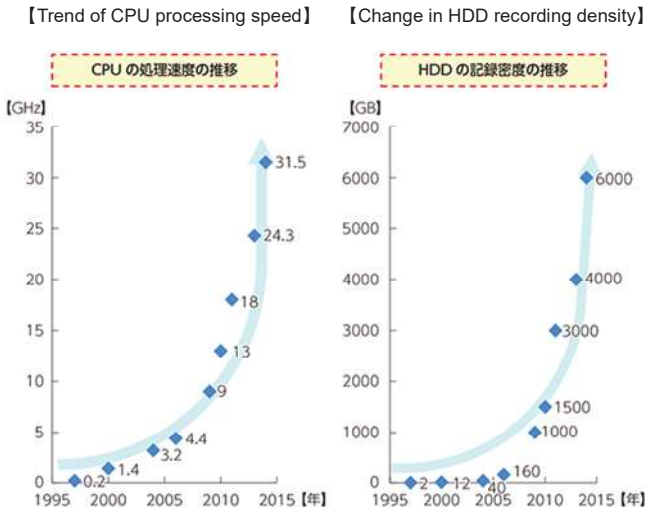
Figure 3 Characteristics of exponential change

4. Room to sudden change

In the circumstances surrounding the human race, we have listed cases for each of the following typical themes in terms of where there is room for sudden change in the circumstances surrounding the human race, with new recognition of the rapid change in society .

4.1 Integration of IC

- ✧ IC (Integrated Circuit)
  - ・ Connect numerous fine electronic elements (transistors, resistors, capacitors, semiconductors, etc.) on one substrate
  - ・ Perform complicated processing and data storage as a whole.
- ✧ LSI (Large-Scale Integration) Degree of Integration: 1000 to 100 thousand
- ✧ VLSI (Very Large-Scale Integration: VLSI) Density: 100,000 to 10 million
- ✧ ULSI (Ultra-Large-Scale Integration: VLSI) Density: over 10 million
- ✧ CPU processing speed and HDD recording density



[Source] Heisei 27: Ministry of Internal Affairs and Communications "Evaluation of communication policy after communication liberalization and Investigation research on the future image of ICT society "

Figure 4 CPU processing speed and HDD recording density

- ✧ 2045 problem (singularity)

  Vernor Vinge and Raymomd Kurzweil first presented the problem, and as computer technology continues to develop at the current speed, it is said that an "artificial intelligence computer" beyond human intelligence will be born, which is "2045 years" It is predicted.

4.2 Expansion of space entry

- ✧ Discovery of planetary exploration and extraterrestrial life
- ✧ Black hole mechanism
- ✧ Discovery of anti-matter and elucidation of the origin of the universe

4.3 Elucidation of the occurrence and evolution of life

Definition of life and key keywords are shown below

【Definition of life】 Those with the following functions.

① Function to maintain individuals (metabolism)

The ability to ingest materials and energy from the outside, to create and maintain the organization of their bodies, and to maintain this.

② Self replication

A function to make the same thing as ourselves.

[Key Keywords]

- ・ Genes, genetic information, DNA, RNA (ribozyme)
- ・ Age of life: 4 billion years

(Not focusing on the lifetime of the individual, but focusing on the genetic information continuing from the birth of life)

- ・ Amazing work of intestinal flora

(Effects of components released by intestinal bacteria on brain cells, expectations for various disease treatments, effects on personality formation, functions of antibodies that take beneficial bacteria into the intestinal wall mucosa, etc.)

4.4 Atomic world

The structure of the helium atom is shown in the figure below. The relationship between the sizes of nuclei and electrons will be described below by taking the Earth as an example.

・Nuclear Earth: Earth

・Electron: Ping-Pong Ball

Also, assuming that the nucleus is softball (about 10 cm in diameter), the first orbit radius of the electron is estimated to be approximately 3 km, and atomic world exists microscopically, but there is space that is distant .

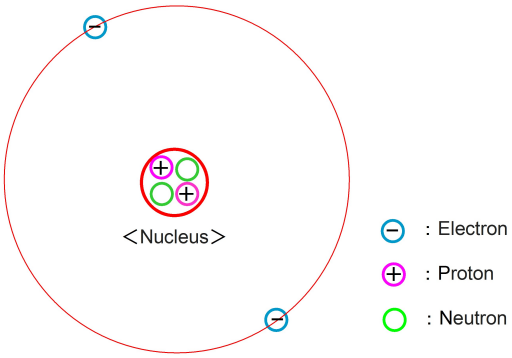


Fig. 5 Structure of helium atom (He)

4.5 Progress of Artificial Intelligence

The contents extracted from "Brain Mogi Kenichiro not defeating artificial intelligence" are shown below.

A) Essence and challenges of population intelligence

① Development of artificial intelligence

・Computers can improve themselves.

・Black box formation of artificial intelligence ability

② Artificial intelligence is said to be the last invention of mankind.

Two meaning of this "last" word

・There is no need to invent any more

・Human beings will be destroyed

Whether to control artificial intelligence not to runaway is a future task.

B) Three Types of Population Intelligence

① Oracle type (search type, question answer)

When asking something such as a search engine, the type in which artificial intelligence gives an answer to it.

② Jeanie type (task execution type)

Like wizards, this type of tasks and tasks that I ordered.

③ Sovereign type (decision-making type)

Artificial intelligence has the subjectivity, a type that makes various decisions and makes various decisions on its own.

C) Inhibitory Factors in Utilizing the Artificial Intelligence Opportunity

① Sticking to authoritarianism

It is important to see objective facts and essence of things, the idea that authoritarianism hinders it.

② Past success experience

In contemporary times when destructive innovations occur one after another, the idea that raising the risk by not being able to escape from past success experiences.

③ not having a feeling of speed

The idea that it is necessary to respond to the change of the times, to have a chance to work more humanely than the artificial intelligence era.

5. Future issues

5.1 Mechanism of rapid change

New technology development creates new discoveries in science. It is thought that the speed of change brings about a change to human society at a rate that exceeds the expectation of human (brain) and in a wide range of fields.

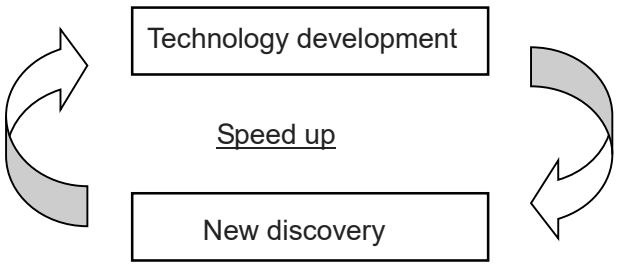


Figure 6 Mechanism of rapid change

In addition, the following points can be considered as factors that scientific discovery will explode in the future.

- By increasing knowledge, the number of combinations expands in a rat-like manner.
- The advanced technical tools leading to the discovery of new science will appear one after another.

5.2 Background of speeding up evolution in science and technology

A) Deepening the issues faced by the international community

- Responding to the pressing global environment problems
- Population growth and food problems
- Stabilization of energy securing and improvement of reliability
- Unstableness of the international community due to competition among major powers
- Intensification of international conflict (regional conflict, terrorism)

B) Diversification and broadening of needs in Japan

- Responding to required change in industrial structure

・Removing from the manufacturing-centric structure (strategy for securing new employment)
・Longevity Overcoming disease and health-conscious in society
・Adaptation as tourism national
・Regional Revitalization / Regional Promotion

C) Development of technologies supporting society
・Improvement of information communication network, IT, progress of IOT
・Development of environment for utilizing big data (security maintenance, disaster response, new business model)
・Advances in life science and genetic engineering (tissue regeneration by IS cells, immunotherapy, breed improvement)
・Advancement of robot engineering (nursing care support, restoration support in case of disaster, deep sea exploration, space exploration, defense)

5.3 Responding to rapid changes that will expand

A) Cycle of science and technology change

Step 1: Combine various element technologies to create new technology
Step 2: Discovery of further scientific truths with new technology
Step 3: New elemental technology is born from the new scientific truth

B) Incompatibility between change cycle in science and technology and social system

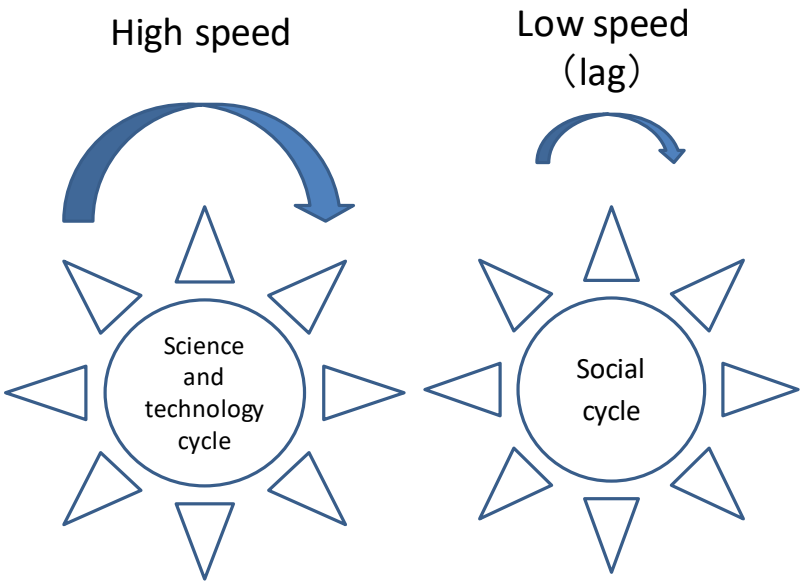


Figure 6 Differences in science and technology cycles

C) Reason for incompatibility between science technology and social system

- Citizens who do not want rapid changes
- Economic reason (It is not easy to throw away vested rights.)
- Time required for applied learning
- Missing target to be adapted（Lack of problem awareness）
- Shortening the life cycle of technology (the speed of obsolescence is fast, and new technologies take over before popularization).

D) Measures to fill the gap

- Function to store the discovery of science and technology once in a buffer
- Combination of knowledge and technology of various fields accumulated in the buffer
  ⇒ Discovering new value
- Discovery of past knowledge, technology restoration (application to other fields)
  (For example, robot development that imitated movement on animals)
- Miscellaneous technical integration
- Diversification of social needs for science and technology, response to wider areas
- Various educational systems (no differentiation such as age, gender, social status etc.)
- Importance of human interface (connection between sensibility and AI)

6. Resolved Issues

- ✧ Where should we put values as human beings in a world where continuous discovery of science and technology occurs?
- ✧ Will a small person who systematically gained knowledge be surrounded by a lot of information and it will win world?
- ✧ Multipolarization of specialized fields (a society not appraised by only one specialized field)
- ✧ Increase the importance of acquiring management capacity
- ✧ The arrival of a society that enjoys discovery
- ✧ It is a sensibility of evolving human beings to face the evolving science and technology, and understanding and construction of the human interface with science technology is important.

【References】

1. Kojien
2. Five conditions that science evolves: Yoshinobu Ichikawa
3. Thirteen mysteries still unsolvable by science: by Michael Brocks
4. Brains beyond artificial intelligence: by Kenichiro Mogi
5. Heisei 27: Ministry of Internal Affairs and Communications "Evaluation of communication policy after communication liberalization and Investigation research on the future image of ICT society "