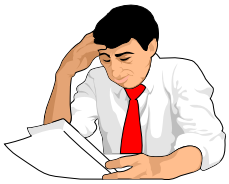

Methodology of Research and Development

From Research of Satellite Communications to General Research

❶ Competition Predominance and Researchers' Attitude

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In this opinion column, it is intended to argue how to conduct research and development (R&D) on satellite communication, especially for national security. This is why we step forward in the 21st century of the chaos which was determined by the terrorist attacks to the U.S.A. on September 11, 2001, and in order to deal in a century of chaos, R&D of national security, especially satellite communications becomes particularly more and more important. On that occasion, an R&D methodology in general R&D as well as one of satellite communications is argued based on experience of the management of Communications Research Laboratory of the author's former job. Therefore, the content may be based on the author's own dogmatism and prejudice, but please forgive me because of an opinion column.

At this series No. 1, because it is natural to aim at a world's best study for competition predominance when the study is pushed forward, the method for such a purpose is discussed. In this paper, it is considered what attitude researchers should have to do study and what study they should do, after competition dominance and innovation are considered. Finally, it is intended to show start of argument what kind of revision should be given to the study management due to the last East Japan Great Earthquake Disaster on March 11, 2011.

In the following, there may be some mixed descriptions for young people and/or senior ones charged of the management, but, such descriptions should be understood that young people will become senior ones someday later and how to contact for the young people is shown for the senior ones.

◆◇ Competition Dominance and Innovation ◇◆

A word "innovation" was remarked flourishingly in Japan's technology policy several years ago. This seems to be because this is influenced by so-called Palmisano Report [1] (cf. **Fig. 1**) taken out in the U.S.A. in 2004. According to this report, it seems to be written as "What grant competitive advantage is not other than innovation" [2]. In this case, the innovation means technology and structural reform to lead to development such as economy and industry. It changed global society, and should have changed a direction of the history; particularly in the interim report [2] of Palmisano Report it was written to think about 5th century B.C. Athens of Greece, Renaissance, or the "seven Asian Tigers" in 1980s and 1990s. Here, "Seven Asian Tigers" means Singapore, Malaysia, Indonesia, Thailand, Korea, Taiwan and Hong

Fig.1 Palmisano Report [1].

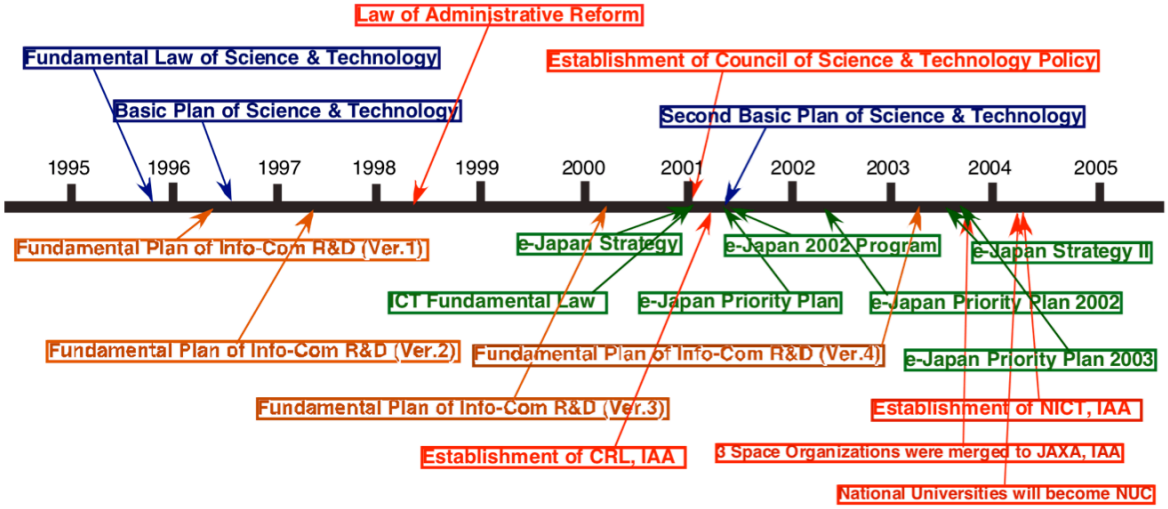

Fig. 2 Diagram of Japanese Political Reform in 1995-2005.

Kong. I agree that Athens and Florence surely changed a flow of the history, but I wonder personally if seven Asian Tigers will be so. The U.S.A. is in a position of world No. 1 in the information industry. Therefore Council on Competitiveness, whose chairperson is Mr. Palmisano, CEO of IBM Corporation, was constituted to examine how to continue the American leadership in the 21st century and its report is called as the Palmisano Report. This report proposes personnel training, financial support, infrastructure maintenance as a policy, but it is said that the President Bush at those days seems to dislike Palmisano Report for some reason, while he appealed deregulation and legislation reform [3].

In Japan, Basic Law for Science and Technology is established for aiming at creating the nation of sceince and technology in 1995 [4], and Basics Plan of Science and Technology is made based on this law in 1996 [5]. The administrative reform was performed daringly in Japan for a decade of that time as shown in **Fig. 2** [6], and most of national research institutes including Communicatons Research Laboratory (CRL) and National Space Development Agency (NASDA) were reformed to the incorporated administrative agency. Omitting explanation about each term in **Fig. 2**, the policy related to science and technology in those days was felt to be open and easy to understand compared to the present status.

The third Basic Plan of Science and Technology were forged in 2005 [7]. According to Prof. Ikoma at that time of Japan Science and Technology Agency, the concept of innovation is included in the plan. The professor introduced innovation invoking Palmisano Report at a lecture conducted by him. An innovation policy is promoted in the fourth Basic Plan of Science and Technology made in 2011 [8]. But, as you probably know, in terms of space aerospace related R&D, the Basic Plan of Science and Technology seems to be not in favor of a big project such as a space development.

Anyway, needless to say, the rival of competition exists in the world, when R&D is performed. In this conjunction, one of conduct codes of policy of Incorporated Administrative Agency Japan—Aerospace Exploration Agency (JAXA); "We aim at world class research and development." is a very serious concept [9]. In addition, R&D of science and technology has two aspects. One is the R&D that has no meaning if it is not the world highest. Another is the base technology that we should have as the strength of our nation. It is a problem how to push the R&D forward. Furthermore, we should think existence of a military study, when we compete with the world. In other words, existence of a classified study is a big matter with space related study particularly. These will be mentioned later.

It is said that the R&D is categorized into fundamental one and applied one. About this point, there are some people who call the fundamental researches as a study of the upper stream, while the applied study as a study of the down stream. But I dislike such a categorization. The reason is why there is a nuance looking down on an applied study of the down stream from the upper stream

of the fundamental research. Actually, the reason is because the theory about research of upper stream and down stream is not appropriate, since the item which is conducted as a fundamental research could contribute to venture entrepreneur suddenly in the field of the information and communication that I was related formerly.

In another side of R&D, the industry-university-government collaboration was recommended flourishingly around the year of 2003. The industry-university-government collaboration aimed at coping economic recession. Such a thought is good, but I think that direct industry contribution is too expected. I think better to make universities or incorporated administrative agency research organizations perform more fundamental studies without haste and carefully aiming at an indirect effect to economics. In the case of space development, of course it includes fundamental studies, but it is important to accomplish a national project such as security, and there is a feeling of little irrelevance what aims at a direct industry effect.

Furthermore, "Principle of death valley" became popular in those days. There is the stage that needs much money to shift from a fundamental study to an applied one. Since it is difficult to cope this stage, it is called as a valley of death. I wonder if a valley of death was true [10]. Actually, one of my friends who conduct business said that there seemed not to exist such a death valley. It is said that even a company carries out a large amount of investment if the development is promising for some reason. When a valley of death was said, even a large company reduced a research section and an executive officer of the company claimed in chorus government budget to do fundamental researches. I thought that was very ashamed. I think that a valley of death has a dark image for some reason and there is nothing good.

Here, I would like to say about specialty of R&D in the space and aeronautics field. I think that R&D can be divided into studies by competition fund and big projects. A study by competition fund is an individual study basically, and a big project is an organization study. Unfortunately, the Basic Plan of Science and Technology seems to consider studies by competition fund to be more important than big project, that is, space development from those days until present (perhaps). Particularly, it is a problem that budget of big project is reduced to increase a competition fund. Originally, a big project is not in opposition to a competition fund. I believe that rockets and satellites do not succeed, no matter how many studies of competitive funds are conducted. A structure is necessary where money is channeled for fundamental research from a big project [10].

In addition, we must not forget a military study in the field of space and aeronautics in particular as mentioned above. The Defense Advance Research Project Agency (DARPA) was born from a Sputnik launching shock in 1958 in a purpose of doing "To prevent technological surprise (to the U.S.), to create technological surprise (to our enemies)" [11]. Most of military studies probably are classified, but we must be careful that new technology seemed to be result of a secret study appears to the public suddenly. Internet was so, too, and Iridium satellite communications system is so, too. These were studied as a survival communication system in a nuclear war. As an example, the budget of DARPA in 2007 was $3 billion scale [11]. The R&D budget was $73.2 billion and weapon supply costs $84.2 billion in the U.S. defense budget of $439.3 billion. It can be understood that a large amount of fund is spent in R&D related project [12]. It is not clear what percentage of total R&D budget is spent in space related research, but around 20% are estimated to be space-related. By the way, it is said that $1.9 billion a year is invested into R&D of communications satellite in the U.S. Armed Forces [13].

As for the base technology that the nation must possess as mentioned above, it is not only important for the research organization of the incorporated administrative agency, but also its demand is large. However, it is important that a study of base technology must be pushed forward by excellent talented persons. Therefore it is vital to include fundamental researches into base technology development in order to secure incentive. In other words, the R&D of base technology must be conducted in cooperation with high technology including bio, nano, and quantum communication. This is because the space development originally led R&D of cutting edge technology. This point needs to be reviewed on the basis of a shock of the East Japan Great Earthquake Disaster. I would like to mention later.

◆◇ Researchers' Attitude ◇◆

R&D is really pushed forward by persons, namely researchers. It is important for them to be conscious of the researchers in the world. In other words, the competitive persons exist in the world, not in their organizations. It is important to conduct research with that intention. However, I am afraid whether researchers might have a tendency to content with their position if their work to do is fixed in a project. In particular, the Basic Plan of Science and Technology establishes the system that study items are fixed for five years, and a necessary budget is distributed. Since the researchers think that their own study is exactly placed in the science and technology policy, if the budget is distributed even for young researchers and graduate school students, I wonder if the researchers have a tendency to become content with it. Because, where is the spirit of rebellion? The reason is because technology innovation originally comes out from the spirit of rebellion and/or breaking a conventional system.

One more, there are persons who expect to the top of their organization excessively. This is because they consider that the top must show the vision or the top must show what he consider. But is this a proper idea? There seems to be such a trend in many organization, and it seems to be said strongly that the top's vision or thought need to be penetrated. Therefore, the company's top studies by reading books strenuously and seems to be going to say something. Of course, if the vision of the top matches the direction of the organization, it would go well to raise a motivation of the organization. However, it seems to be usual that such an act is nothing useful. On the other hand, I did not want the top to say anything and did not want to hear anything from the top, if I recall when I was young. Since I wonder whether I was impertinent, I talked to one of my colleagues joining to Ministry of Posts and Telecommunications at the same period of me. Rather, we found that we worked to make the top understand our thought in our times. I think it might be the spirit of the age. I wrote this story in a column of ISAS News of May, 2003 [14]. It is important that the top listens to subordinates well, and it is essential to show a bright vision if a vision is shown [15].

Well then, how researchers should be brought up? I would like to insist that researchers are not fostered by being taught. Apart from whether I was brought up as a good researcher or not, when I look back in my case, I do not remember that I have been taught by professors or bosses since I got my job through graduate school student, although this may be impolite expression. But I have learned some things. I remember that I learned how to write a paper and/or a way / a manner of presentation very much. For example, do not talk with having shoved a hand in a pocket.

In addition, the leadership of research is categorized into two ways: one is to make all researches be bound under guidance of a leader and another is to make a research do freely. About the former, I have heard that Dr. Leo Esaki talked in this way. About the latter, Dr. Akira Furusawa, Associate Professor, University of Tokyo, said such a way in the NHK-TV program, who runs the world's leading quantum communication [16]. In fact, I always said to the staff of CRL to work freely at the time of my former job post [17].

The type of leadership seems to be categorized to the next 3 types [18].

(1) Consideration type leadership: Type of consideration for subordinates' situation and emotion well.
(2) Work centric type leadership: Type of managing and controlling subordinates severely to achieve the aim.
(3) Innovation type leadership (Entrepreneur type): Type of proposing new ideas, trying new methods and making network inside and outside the organization by relating a study team to policy and strategy of the organization.

It is said that the type of (1) and (2) makes results of research fall, and the type of (3) makes study achievements plus. In brief, I think that we would carry out a dynamic activity.

One more, I have heard that there are organizations where a researcher is brought up well. I mean the organization where a researcher is brought up just alone being there. I have heard that the Max-Planck-Institut in Germany is such a kind of research organization. In addition, the

research organization should be clean and comfortable for the researchers to stay. I stayed in the University of Colorado as a visiting professor for one year from 1991. I had an opportunity to visit the Hongo campus of the University of Tokyo just after my return to Japan and I was surprised to have an impression to "What a dirty university it is!".

◆◇ What Study should be Done ◇◆

The next item is what study should be done. I would like to assert basically that researchers should do the study that they want to do by themselves. In brief, the incentive of researchers is important. As for how the study theme is found, which is the most important for a study, the researchers should find it by themselves ideally. But the leader needs to show the comprehensive research theme and to have a judge capability that fosters a sprouting study to a big one.

In this point, there is a problem of eternity: Bottom up or Top down. However, it is necessary for the research manager to match the direction of organization somehow with what the researchers want to do. As one of solutions, I have heard "Organized Chaos" from Prof. Syun-Ichi Akasofu of University of Alaska [19]. In addition, Dr. Leo Esaki expresses a similar thing as "organized chaos" [20]. It means that individual researches are organized naturally without coordinating their subjects to detail, if toward a big purpose. When compromise never sticks, the researcher may do, for example, work of top down during duty time, and may do work of bottom up after the duty time.

Furthermore, it is important to liberate a researcher from restraint. It is said that "Make researchers swim." commonly. Paradoxically it is to "prepare environment making researcher swim". It might be a way of our country that the government binds researchers with rules in exchange for giving them fund of money. However, there seems to be an example that the researcher can do anything freely afterward, although an entrance giving money is severe. The Research Institute for Sustainable Humanosphere, Kyoto University [21] and Sony Computer Science Laboratories, Inc. correspond to such an example in Japan. In addition, although it is not a research example, Mr. Kensuke Yanagiya, Australian ambassador, said "I will take responsibility if all of you work hard and an any problem is produced as a result." [22]. This word corresponds to the thought of "Make researchers swim".

In conjunction with the freedom of research, I hope the researcher to conduct not only managed studies but also a lot of hidden ones. I think that any researcher certainly has an idea of any study item that he/she does not want to yet tell other person under self-confidence to be important so as to surprise others soon. The environment that can carry it out in secret is important. In short, it is important to make the atmosphere that can work at ease. But it goes without saying that researcher oneself needs to study with humility and cooperation.

Next, as for the researcher's attitude pushing forward study, I recommend that "Do research single-mindedly", when he is young. Because an outsider can not understand the study conducted at all and cannot get a budget in such a way, it is said that a researcher should study the way of speaking that a general public understands. However, such a thought is waste of time, and it is the most important to do research single-mindedly, and I think that the explanation that an amateur understands is unnecessary when he is young. Do not want to put unnecessary pressure to a young researcher. On the other hand, a researcher must have ability to explain outside person by his/her own way to understand the study of the research group to some extent, when he/she becomes senior and if he/she becomes a study leader. I think it is duty for a senior researcher. It is important for a senior researcher to have technology of getting budget.

Epilogue

The description of this series No. 1 is now over. I would be happy if I would have any comment from all of you. Finally, the unprecedented disaster, the East Japan Great Earthquake, occurred in Japan on March 11, 2011, and additionally an great accident of a nuclear power plant was also occurred. This great disaster gave a big shock to the R&D of science and technology. Therefore, it is considered that the policy of science and technology and the method of R&D so far must be

revised in many points. The greatest shock for a scholar of communications technology is that there was the request of help by showing the letter of "SOS" on the roof of public facilities like the letter of "SOS" drawn on the roof of Hikarigaoka Sanatorium, Kesennuma-city, Miyagi-pref., Japan [23]. It was a shock why a satellite telephone was not prepared even in such a public facilities. As for contribution of technology for the East Japan Great Earthquake Disaster, the other problem like that the robotics technology was not usable was exposed. The discussion based on the shock of the East Japan Great Earthquake Disaster will be made in this series No. 4 (the last of series).

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