Creation of values and synthesis

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Professor Masatoshi Ishikawa of the University of Tokyo stated that the creation of new social value is necessary in addition to the analytical pursuit of truth. As the Executive Vice President of the University of Tokyo from April 2004 to March 2006, he worked to develop a system for transferring highly original research results from academia to society. Professor Ishikawa, who practices such transfer that is also the aim of *Synthesiology*, discusses value creation and society with the former Editor-in-Chief Ono and Executive Editor Akamatsu.

***Synthesiology* Editorial Board**

Participants of the round-table Talk

Masatoshi ISHIKAWA	Professor, Graduate School of Information Science and Technology, the University of Tokyo
Akira ONO	AIST [Editor, *Synthesiology* (former Editor-in-Chief)]
Motoyuki AKAMATSU	AIST (Executive Editor, *Synthesiology*)

Akamatsu

Dr. Ishikawa states that in the intellectual production structure of the 21st century, there are the analytical method where "theory = truth" is established by the accumulation of experiments and logical evidences, and the synthetic method where highly original hypothesis is raised and the social value is created by verifying this hypothesis. Dr. Ishikawa also states that these two methods are not in contradiction but comprise a dual structure.

I feel his statement matches the objectives of *Synthesiology*. Dr. Ono, can you give us an introduction to this journal?

Ono

It is fully four years since the launch of *Synthesiology*. The journal is becoming recognized outside of AIST as well as within. Paper contributions from outside have been increasing.

The necessity of "synthetic" and "integrating" method, not only analytical and reductionist method, is well recognized when conducting scientific and technological researches. However, I don't think there have been systematic investigations on the particulars of how to conduct synthetic and integrated researches.

AIST has emphasized the industry-academia-government collaboration since its days as the former Agency of Industrial Science and Technology. In the eyes of academically minded researchers, however, such collaboration may have seemed to be mere side jobs. I think Dr. Hiroyuki Yoshikawa thought that was not right. There must be solid soul and logic in the so-called applied research and it is an endeavor worth doing the best for researchers. This can be highlighted so that such researchers contribute more to society at the greatest levels. That was the passion poured into this journal.

In the guidelines for submitting research papers to this journal, we ask the authors: to clearly set a research goal; to rationalize the relationship between the research goal and society or to state the social value of the research; to present a scenario to obtain the goal; to describe selected elemental technologies; to describe the relationships among the elemental technologies and the process by which they were integrated; and to self-evaluate the results and to discuss the future prospects. When tackling a complex issue that characterizes the present day, it is difficult to seek solutions within one technological discipline, and it is inevitable that technologies in diverse disciplines must become incorporated into the research. The motivation of research is realization of social value rather than academic curiosity. The solution obtained as a result of research is not necessarily unique, and there may be multiple equivalent solutions. Although some solutions might be better than others, that is not a matter of right or wrong.

Our next issue is value evaluation of synthetic researches. How do we evaluate whether a certain synthetic research

result is right or wrong? Based on what criterion should synthetic researches be evaluated? From what perspective should the reviewer evaluate it? Although these are difficult issues, we take a certain direction in doing the reviews. The value of conventional academic papers is evaluated by peer reviews. Researchers whose discipline is closest to the author's one are selected as peer reviewers. This is because a close researcher is the only one who can see whether the claim of the author is truly novel and logically sound. However, there is a limit to the peer review system. Peer reviewers often are unable to see society as a whole. They are able to see only the workings of a small community around them. I think this is one of the reasons that separate the academia from society.

We of *Synthesiology* call our review "merit review" because we think the people who receive merit by using research results claimed in the paper should review the paper according to the scale of the merit received. Specialists of the close fields are usually eliminated in our review system. Two reviewers, one from a related field and another from a different field, are selected as merit reviewers. We are quite surprised that such a review system can actually function properly. The names of the reviewers are publicized, and dialogues between the author and reviewers are placed at the end of the paper to help the readers' understanding. This has been very positively accepted by the readers.

Akamatsu

In the *Synthesiology* paper, we have people write a scenario of why the topic was selected and why the methodology was used to solve the selected issue. It is important to tell the whole story which is one fact of research, and the purpose of this journal is to accumulate such facts. I think it may help determine how research should be carried out.

The whole picture may be lost if the subject is segmented and studied in the analytically and reductionist manner. We are aware of what we should do to prevent ourselves from getting stuck in the foxhole.

True originality in value creation

Dr. Masatoshi Ishikawa

Ishikawa

What is lacking in science today is the world of "value creation." The organization theories and research methodologies are processes, and these are not enough. It is necessary to think about the values that can be created beyond them.

In this case, there are two issues: who will evaluate the "value" and how do we evaluate "creation." Aside from subjective evaluation, the researcher as an individual cannot evaluate the value objectively, and he/she is not in the position to do so. It is also, in principle, difficult for the organization to evaluate the value. Therefore, I strongly state, "It is society that evaluates the value."

Considering the above, it is necessary to have the perspective of what is research that generates an outcome of which society will accept its value. It is also necessary to reconsider what is creation in a true sense, not merely as a means of catching up. Because society evaluates the value of research results, research organization must publicize to society the value in the manner that can be evaluated by society. At the same time, the organization must be able to accept the value that society recognizes, and there must be a mechanism to receive the social evaluation within the organization, but that is the difficult part. Many researchers think that if the research results are published at academic societies, they are evaluated as being valuable, but that is not necessarily true.

For example, even Nobel Prizes are sometimes given to synthetic accomplishments. I think the synthetic works include the X-ray CT of Godfrey Hounsfield and Allan Cormack, and IC of Jack Kilby. I think there will be more prizes given to such works. Though there may be objections to my statement, their research did not start from a given topic, but started from "I wish I can do this" fantasy. In addition to their accomplishment of realization, we should focus on their greatness as researchers who said, "This result can be achieved. The value lies there." This is something that must be done by any researcher, whether large or small in scale, and the "social evaluation" lies ahead. If the result is not employed despite the researcher's defense, as long as society does the evaluation and the researcher is not allowed to evaluate, I think it is a "justifiable failure." If it is justifiable to the point of stating something that is logically and technologically correct, and there is a potential for value creation, then the research should be done. Whether it actually has value will be judged by society, and the processes of writing the paper or filing a patent are intermediate steps. If it is transmitted to society and becomes valuable in society, it will receive some kind of acclaim, perhaps even a Nobel Prize. The researcher must understand this mechanism.

Concerning "creation," catching up is not creation. In ordinary academic papers, it will become highly acceptable for publication if one writes in the introduction, "This is what

society deems necessary. The other researchers did these researches but they are flawed. To cover the flaws, I used this new method to solve them, and achieved better performance." However, it is apparent that this is nothing more than solving a given topic and it is "catching up" from the perspective of new value creation, and there is no originality in such papers. I think a truly original paper, for example, says, "I think this is valuable but society does not recognize it yet. There is no other paper to make a comparison. But I think this can be accomplished, and I've already done part of it." The researcher should write such a paper. In reality, an excellent paper may fall somewhere in between, but the perspective of how to evaluate the ability to pioneer the future demand and market is a major issue that faces future science and technology. The presentation of a result in the form of a paper is, as mentioned before, only midway in the process of being evaluated. Therefore, if there is a justifiable and original statement at that point, it should be given full score of 100 points, but if society does not evaluate it positively after some years have passed, the full score should be retracted to 50 points. However, the activity of the researcher is justified. This is justifiable failure. Of course, if society recognizes the value, it should be given full score or even 200 points.

I think Japan must shift to a process where society properly recognizes "creation." This is easily said than done. To aim for "innovation" is a mere copy of the American innovation policy, and it is rather paradoxical to place this in the center of "original" science and technology policy. Creation is to go left when others say they'll go right. Originality stands only a step away from fantasy, and the point is how the organization or society recognizes this. *Synthesiology* says, "There is a theory and it is not just fantasy," and I think it is an interesting attempt. However, it is not about seeking quick answers, and it is necessary to have an attitude that how a research result will be evaluated by society is unknown. If it is known, it is just a catch-up research.

Evaluating "justifiable failure"

Ono
As time changes, a certain technology may come into spotlight, and we do not know which technology will become the best as society changes. Therefore, I think we should accept all of them although this might be very generous.

Ishikawa
If you accept that there are many justifiable failures and the future path will be determined by society, Dr. Ono's argument is great. However, if you assume that something that is not accepted in society is nothing but failure, then that argument is not right.

Ono
I see. It is not necessarily true that the research projects of AIST or the Ministry of Economy, Trade and Industry (METI) were all successful. Because we cannot talk about our failures to others and try to clean them up within our tiny logic, we lose our ability to step up to the next stage. There is the danger that people will shuffle around only in their small worlds.

Akamatsu
I think the idea of "justifiable failure" is good, but I think there is the problem of how to judge whether something is a failure. Positive or constructive things do not come out from analyzing failures, and I think there is a danger that people may offer justifications with small arguments that "ultimately the product could not be made because this and that went wrong." How can we overcome this?

Ishikawa
"Justifiable failure" here applies only to research that is original in its claim and has undergone a proper research process. The failure in the research process is nothing else but lack of ability. People with ability can always produce some kind of outcome if they engage in research. Until now, all research that produced outcomes was successful, but that is no longer true. When the outcome is presented to society and if there is a mismatch with the social evaluation that is yet to come, it is a "justifiable failure." Here, originality must be maintained, and justifiable failure has the potential of generating value with accumulation. After some years, it may be revived. Therefore, we must spend effort to make sure that the accumulated results may someday become valuable in the ever-changing society. On mismatch with society, coincidence or trend of the time may be influential, and the mismatch in this situation must be tolerated because it is a world where originality and fantasy are separated by a thin line.

How to link research to society

Akamatsu
What do you think about the extent to which the researcher should be involved in the process where a research result which is successful is accepted into society? I feel that there are many researchers who take the stance, "I did good research and produced good results, and the rest should be done by others."

Ishikawa
I work on high-speed image processing, and I create systems that can be understood by society, not just the device and theory. In addition to nurturing the elemental technology, for example, I make a batting robot using this high-speed image processing. The majority of the researchers think that once a paper is written, someone will pick it up, and once the patent application is filed, someone will understand it and buy it. As long as the researchers think so, no new field will emerge.

The reason is simple. It is because the person who has the most knowledge of the result is the person who produced that result. There is no other person who understands the results better and who is capable of linking the results to social value than the researcher. Since there is no infrastructure that allows the research results to be linked to social value, to simply present the research result and say, "The rest is up to you," is like throwing your own efforts in a trash can. At the present state, the choices are to wait until the infrastructure is built or to do it yourself, and in the absence of the infrastructure, the researcher must do things on his own to some extent.

In fact, the researchers should raise their voices against the lack of infrastructure. Some things need not be done by a researcher, and if the infrastructure becomes available, the researcher may offer ideas only. However, such infrastructure is very difficult with the current lack of understanding by organizations, and even at the University of Tokyo, it took five years to organize the supporting organization for intellectual property, collaborative research, and start up ventures. There are still lots left to be done, and time is also required to shift consciousness. In the current situation, the researchers must do a lot. I think this is a sad thing about Japan for the development of science and technology.

Ono
It's the valley of death indeed.

For the researcher to write the scenario

Akamatsu
You need a refined sense or intuition in the process by which the researcher presents the results to the world. Although it is not known whether it will be a good seller, one needs a degree of refined intuition to specifically show society that something is valuable. I think the researcher must cultivate this refined intuition in the future. If one becomes dependent on other people, I feel there is less opportunity to cultivate this refined intuition.

Ishikawa
There are variations. For this kind of "sense" or refined intuition, I think the word "art" fits well. Referring to Donald Knuth's "The Art of Computer Programming," art, originality, and intuition (or sense) are needed in science and technology. Since my field is sensing, I use this word and say "The Art of Sensing." I want to say I dig deep, I do synthetic research, and I draw the whole picture. Perhaps this is a bit exaggerated.

Dr. Akira Ono

Akamatsu
I'd like to say that *Synthesiology* is the art of research. Drawing from what you said, I hope people with refined artistic sense will present their research, and people without it would experience it through some sort of education. I hope the percentage of such refined people will increase.

Ono
Talking very optimistically, I want to think that people who produced socially valuable research results had some sort of scenario. I don't think social value can be generated without a scenario. I feel that there are many researchers who realize that they had a scenario on retrospect but were never aware of it during the research processes. We've been surprised to find there were many cases where the authors became aware of scenarios when writing up the *Synthesiology* papers. If that is the case, it would be much better that those researchers create their scenarios from the beginning of the project and engage in the research as they mature the scenario.

Ishikawa
In this age, it is reckless to do research without a scenario. To have an original "scenario" that leads to social value is an absolute requirement, but there are many ways of writing this scenario, and the variations should be allowed. For example, one method is to do a thought experiment, where one assumes that a venture is built based on a research result, or a technological transfer is done to some company, and then write a scenario on how one's technology will be returned to society and how it will be evaluated. I think the things that are lacking or points that the researchers are unaware of will become visible.

Akamatsu
By trying to write the scenario, the scenario that existed in the mind becomes clear. By repeating this exercise, one becomes capable of writing a scenario for the future. I think one can develop such skills.

Ono
Making scenarios is the first step, and then there must be the process of showing it to someone else, being criticized, revising it, and prioritizing it. Currently, however, it seems to me that the quality of scenario writing is poor at the beginning.

Ishikawa
I think AIST carries the mission. Since the companies aim to maximize profit, they do not present the scenario. There are probably few people at the universities who have got a scenario. I want AIST to actively make presentations to society in the form of scenarios, as well as to do R&Ds.

Ono
Yes. I think that is the industry-academia-government collaboration.

Ishikawa
AIST should present several major scenarios. There should be a variety of patterns of scenarios such as ones that include the research results, market, or technological prediction. There should also be scenarios that will be rejected, or ones agreed by 80 % but rejected by 20 % of the people. Such scenarios are much more original than the ones that receive unanimous approval.

Evaluation of human resource for value creation

Akamatsu
Now we shift to evaluation. It is, of course, difficult to do evaluation where one has to accept failure. Don't you think evaluation itself is impossible in some cases?

Ishikawa
This is a matter of "do or don't." It is necessary for both the evaluator and the evaluated to accept that randomness functions in adopting a socially accepted value. At times, the evaluation may not be technologically correct, but the evaluation is about whether it generates value. Going a bit further, there are many technologies that generated new markets and values in the world today because "they had well-crafted scenarios." In this way of thinking, evaluation is a matter of do or not do rather than possible and impossible.

Ono
You mean, to evaluate is to take risks?

Ishikawa
Yes. As an assumption, it is necessary to lower the evaluation of the person with "unjustifiable failure." The person with justifiable failure should be evaluated as zero or something extra, and the person with success should be rewarded, for example, by increasing his salary. Since the Japanese culture tends to emphasize equality and merit of accumulation, this may raise opposition. However, if there is a common understanding or that if everyone understands that some degree of randomness exists, there will be an acceptance that "someone wins the lottery." By raising the evaluation of the person who generated value, the whole may start moving in that direction.

Dr. Motoyuki Akamatsu

Akamatsu
In an evaluation, the evaluators tend to get into negative evaluation. I think it is a major issue of how to cultivate the habit of rewarding.

Ishikawa
Things should shift to a point-addition system. This is the attitude of saying, "Hey, this is great." The rest should follow. The point-addition system can be in the form of salary or awards.

Ono
Awards have the effect of clearly indicating what society and organizations demand now. I believe that the awards exist not only for the persons who receive them, but also for the persons who do not receive them.

Akamatsu
Since evaluation is a culture, it is necessary to build the culture. To do so, one must continue raising one's voice.

Ishikawa
If the culture is set, it will be easier to evaluate. It's a matter of solving the problem of chicken or the egg.

Akamatsu
It also affects the organizational management.

Ishikawa
In terms of research organizations, I think there are pull type and push type organizations. The push type is a management style that starts from the groundwork such as organizational design and consciousness building, the momentum for the entire organization is then generated, and the researchers are told, "Let's all go there," from behind. The pull type is a management style where outstanding activities are accepted and people are told, "Follow me." Both have their good and bad points. Since with the push type, the groundwork is done and then the research takes off, the force is great but the movement is slow because everyone moves in unison. In contrast, the pull type is fast, but only few sharp ones do well, and the movement does not involve the whole. In reality, both types are necessary in the management of

the research organization depending on time and content. Therefore, push-pull management is necessary. In nurturing the culture and developing the policy-driven evaluation, the organizational management style that alternates between push and pull is necessary.

Companies, universities, and AIST must team up for human resource training

Ono
The human resource training is one of the missions of AIST. However, I hear that few students continue on to the doctorate course.

Ishikawa
It may be helpful if the universities and AIST form a team and set a certain career path. We'll be scolded if we say there is a highway directly from the University of Tokyo to AIST, but perhaps a country road will be okay.

The reason the excellent master's course students of the University of Tokyo do not go on to the doctorate course is because there are many places that provide high salaries and good jobs to people with masters only, like foreign companies, for example. The activities of the foreign countries are extremely aggressive and they are quick to evaluate. When our research result appears in the newspaper, the first to contact us are the foreign companies. Before, the calls came from Koreans, but the other day, a Japanese who transferred from a Japanese company showed up. I think the outflow of excellent, experienced engineers and researchers who have supported Japan, as well as young people, is a serious problem. We must see that here also lies a problem of evaluation. Even the large Japanese companies started as ventures. I think we are at a stage where we should not regard Apple, Google, and Facebook as the rich on the other shore. I hope there will be more people who will think hard about how to create values that can face up to such companies.

Government's organization design for value creation

Akamatsu
Is the national policy changing?

Ishikawa
The Project for Creating Start-ups from Advanced Research and Technology (START) started from FY2012 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). This is a project where the government offers a place to bring in risk money and allow active challenges, so the research results of the universities can be linked to social values. As a policy, success is the goal, but as it can be seen from bringing in risk money, the risk of "justifiable failure" will be absorbed within the mechanism. The MEXT personnel says, "This is a challenge for MEXT." It is very fresh to hear the MEXT personnel use these words, and I think it is innovative.

Considering the interface with industry, I think we are taking in too much demand of industry. The demand of industry is the demand of now. As soon as the demands of industry are gathered and declaration is made that the important policy for Japan is to incorporate such demands, Japan will be trying to catch up, and we will dive right into researches that merely improve the current situation. Of course, improvements are necessary, but for policies to create the future, the government must take risks. How the government can manage the risks is in question. Here, you can replace the word "government" with METI or AIST. I think building the structure that allows the government to take risks is a matter of ideas. It is a matter of design as stated by Dr. Yoshikawa. Unless this structure is included, the research organization in the future will be working only on improvement research.

Ono
Certainly, a new technology may be the technology that may crush the current companies. The difference is whether such a technology emerges from one's own company or somebody else's. Ideally, the technology must come out of your own company, but because self-destruction is scary, one falls into the way of thinking that there is no demand. When the company loses its vitality, it starts accepting the current situation, and the power to change weakens.

Changing the subject a little I work in the field of standardization. There I am often asked "to develop international standards that back up the current Japanese technology." That is not quite right. We should develop standards needed by the world in the future, and Japanese industries must quickly adapt to that. However, there are still many people with attitudes that accept the status quo, and I think this is a problem to be addressed.

Ishikawa
For standard, I think you need the courage "to change." Occasionally, the organization must also have the courage "not to change." Various forms of courage are necessary to change a culture. In the atmosphere of no change, one needs the courage to change, and in the atmosphere of change, one needs the courage not to change. I think the point is to appropriately select and develop what are necessary and unnecessary for the creative culture, by capturing the social demand.

Akamatsu
I wish our journal will contribute to building this culture. By combining the system building, I hope we can build something for Japan as a whole.

Ishikawa

This kind of activity should be done actively in the spirit of challenge, and I am for it. I am also for the synthetic approach that considers the total system, and I think we need the schemes for the direction of organizations and the ideas about how to realize the policies. From my experience in designing the organizations and systems at the University of Tokyo and MEXT, I think AIST has an important role to create new social values, and it is expected to take on new challenges to generate such values. I pray for your future successes.

Akamatsu

Since there are differences in organizational format between the universities and research institutes, I hope we can work as a team by practicing the ways suitable for each of us. Thank you very much.

This roundtable talk was held at AIST in Tsukuba, Ibaraki on February 24, 2012.

Profile

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Graduated from the Department of Mathematical Engineering and Information Physics, School of Engineering, the University of Tokyo in 1977. Completed the courses at the Department of Mathematical Engineering and Information Physics, Graduate School of Engineering, the University of Tokyo in 1979. Joined the Industrial Products Research Institute, Agency of Industrial Science and Technology, Ministry of International Trade and Industry in 1979. Assistant Professor, Department of Mathematical Engineering and Information Physics, School of Engineering, the University of Tokyo in 1989, and Professor in 1999. Appointed as Special Adviser to the President, the University of Tokyo in FY2002 and FY2003; Vice President in 2004; Executive Vice President in 2005. Worked on the design and management of the organization of the industry-academia collaboration for the University of Tokyo. Doctor of Engineering. Received the Medal with Purple Ribbon in 2011. Currently, Professor, Department of Creative Informatics, Graduate School of Information Science and Technology, the University of Tokyo; and Research Advisor, AIST.