Third anniversary of *Synthesiology*

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A roundtable discussion of the authors was held for the third year anniversary of *Synthesiology*. We asked the authors what they gained from writing for *Synthesiology*, and their thoughts on the "Discussion with Reviewers" that is the distinguishing characteristic of this journal.

***Synthesiology* Editorial Board**

Participants of the Roundtable Session

Hiroyuki Yoshikawa	Editor,Center for Research and Development Strategy of Japan Science and Technology Agency, AIST
Motoyuki Akamatsu	Executive Editor, *Synthesiology*
Takeshi Komai	Institute of Geo-Resources and Environment, AIST
Makiko Suwa	Computational Biology Research Center, AIST
Yoshiki Kinoshita	Collaborative Research Team for Verification and Specification, AIST
Koji Watari	Planning Division, Research and Innovation Promotion Headquarters, AIST
Yasuhiro Nakamura	Planning Headquarters, AIST
Koji Wakita	Geoinformation Center, AIST

Akamatsu

Unlike the conventional academic journals that publish the scientific findings or the results of basic research, *Synthesiology* asks the authors "to write the scenario of the research". In writing papers with a viewpoint quite different from the conventional way, I imagined that the authors might have encountered new findings or gains. Therefore, to commemorate the third year anniversary of *Synthesiology*, the authors got together with Dr. Yoshikawa to discuss their writing experiences.

First, please describe your paper and what went through your minds while you were writing.

What did you want to express in your paper?

Komai

My paper was "Development of a risk assessment system for soil contamination and the application to the social system: processes in synthesiology for practicing an advanced environmental risk management". This research spanned two fields: environment/energy and geology. Unlike the risk assessment for air and surface water, the methodology of the risk assessment for soil and ground water was not established anywhere in the world, and we developed a technology to assess how such contamination may affect human health.

To tell you the truth, I wasn't really sure what the difference between a *Synthesiology* paper and a conventional paper exactly was. I described my research in chronological order, and I was sure I organized it cleverly in terms of synthesis. It was reviewed by Vice-President Ono and Dr. Togashi, and the result was terrible: "We have no idea what you are talking about." So, I abandoned the chronological order. What I wanted to express was just one point: "if we have such and such members and such and such composition, it can be realized as a product". In the conventional journals, we must remove such elements and concentrate on the logic only, so I don't think such papers can be readily understood by general readers. While academic papers are important, I think the writing style emphasizing synthesis will become increasingly important in the future.

Suwa

My research topic is "A bioinformatics strategy to produce a project structure of spiral development: comprehensive functional analysis of the drug design target genes", and it is a story of the database creation started in 2001 and the joint research using this database. There was an epic event in 2001 where the entire human genome was decoded. Among that genome sequence, we created a calculation pipeline which comprehensively searches for and conducts functional analysis of GPCR gene that transmits information received from the exterior to the interior of the human cell membrane

and is a crucial target gene in drug discovery. The applied result was formed into the functional analysis database SEVENS. It took two years from the start of the research to the publication of the database, or the so-called product realization. I wrote in the paper that this product became the elemental technology for the next study, and major joint researches happened cyclically. In the field of bioinformatics, the time required to produce a result is relatively short. Moreover, we can choose practically any subject which allows us to move forward quickly, and we are able to expand the research plan with several joint researchers.

In writing the paper, the part I had most trouble with was to "show the research scenario". In this research, I can't remember ever making a scenario. If I had one it was for the first few years. From then on, the research developed spontaneously, and I just rode along. However, I do believe that as a consequence I was able to take the shortest route.

In a conventional paper, you write up the optimal data after everything is finished to make it look neat. Dr. Komai said, "I quit the chronological order and reorganized things". In my case, the chronology itself bred new developments, so, in my case, I thought the chronological order was important. Another point is, in a conventional paper, I don't think I can ever write failure stories. If I write, "I failed", I won't be allowed to continue. I find it interesting that this journal allows us to argue that the failures help the next step forward.

Another point that I found difficult was that I had to explain things, so people of other fields could understand. Dr. Akamatsu reviewed my paper and said, "This is totally incomprehensible". To use terminologies that can be understood by people in any field, that was very difficult.

Kinoshita

With my colleague, Dr. Toshinori Takai, I wrote a paper entitled "A field-scientific approach to clinico-informatics: towards general models of technology transfers". about the technical transfers conducted in the Research Center for Verification and Semantics, over six years, until March 2010. System verification is a technology to find and fix bugs or the faults in information systems. At the Electrotechnical Laboratory, before it was incorporated into AIST, we conducted research in semantics of programming. When AIST started, I thought that a person, like me, engaging in semantics research could contribute to society through research in system verification. If one follows a waterfall style model, however, taking steps from basics to application, the day will be over before making any contribution to society. Therefore, I decided to try concurrent engagement in both the academic research and the technological transfer. It did not seem impossible, as the people in universities engage in both education and research, and while not all their research link directly to education, they realize both. Moreover, some interesting things happen because of theinteraction between research and education. So, we decided to try doing research and technological transfer concurrently with industry-academia collaboration. The word "clinical" was borrowed from medicine as a way of drawing an analogy between system verification and a doctor's diagnosis. Finally, "field science" is a term coined by the cultural anthropologist Dr. Jiro Kawakita, who wrote a book about abduction which also introduces the famous KJ method. In spite of the importance of abduction, it had not been discussed very much in the context of Full Research. So, we wanted to emphasize it in our paper.

Watari

I submitted a paper with a simple title "A strategy to reduce energy usage in ceramic fabrication: novel binders and related processing technology". It is a write-up of an R&D for the ceramics manufacturing process in industrial operation. The point of the research is to understand the relationship between the binder and the energy consumption in ceramics manufacturing, and we implemented energy savings in manufacturing through this new binder technology.

In writing the paper, I had a personal battle of whether I should write about the results obtained with private companies. However, as I wrote, I understood that there was a story of how we created the scenario under what thinking and what were extracted among which elemental technologies, and I was finally able to finish the paper.

Dr. Yoshiki Kinoshita

Dr. Koji Watari

I also realized that difficult research topics and social demands could be solved by clarifying the topics and synthetic elements. I am extremely honored that I was able to publish in *Synthesiology* through the joint research with corporations. Thank you very much for the opportunity.

Nakamura

My paper is "National electrical standards supporting international competition of Japanese manufacturing industries: realization of a new capacitance standard and its traceability system". For example, the company that makes the scales is responsible for assuring the precision of the "size of an object". The company regularly checks that their standard is accurate, by bringing the company standard to the calibration laboratory. The calibration lab has its standard calibrated by an authoritative institute, and finally it is traceable to the national standard. As you can see, there is a "national metrology standard" for all physical quantities, and currently, almost all metrology standards are set by AIST, which maintains, manages, and provides them to industry. Therefore, our mission is to set the national metrology standard, to guarantee the correct values for measurements in industry, and thereby supporting the activities of the Japanese manufacturing industries in the international market. The capacitor is one of the major Japanese products, and recently large capacity capacitors are in demand for batteries. The precision level demanded for capacitance standard is increasing. I wrote about how we developed the new capacitance standard that matches the current demand although the national standard for capacitance existed before, and how the new standard was provided to society through the calibration labs.

When I am told to "write a scenario",I must look back on how I arrived here. Since the national standard is a standard of the highest order, it must have the highest precision possible. We always aimed for the world's best. Yet, by writing this paper and looking at the industrial demands and comparing the standards of other countries, I was able to think in terms of what would be the satisfactory specification that could be achieved in the shortest time and at the most reasonable cost. Another point is whether the provided standard is being delivered to the sites of production. At the production sites, the pressure of time and cost is extremely high, and many people say, "We don't need the national standard level precision at the production sites. Give us something that is easy to use, costs less, and can be used quickly, even though the precision is slightly poor". Therefore, I reviewed my scenario and conducted the desired R&D. The paper was written as a story that followed an actual case.

Wakita

The title of my paper is "Creation of seamless geological map of Japan at the scale of 1:200000 and its distribution on the web: for maximum accessibility and utilization of geological information". Seamless means that there are no joins. The Geological Survey of Japan, AIST created the geological maps for the wealth and military power of the nation in the Meiji period and for the exploration and development of the mineral resources for recovery after the World War II. After that, the objective for geological information research became vague, and geology started to concentrate on, for example, how the Japanese Archipelago was formed or how certain rocks and minerals were created, or the *Type 1 Basic Research* as stated by AIST. When I joined the institute, I seriously studied how the Japanese Archipelago was formed, and for a long time, I produced the geological maps as a result of that study. As a result, the geological maps of Japan became diverse according to the interests of the researchers in charge. Therefore, after the establishment of AIST, we set up the seamless geological map project where we reconsidered the geological map in terms of being useful to the users, recreated the maps using the latest information under a uniform standard, and the boundaries were joined digitally according to the latest findings. Several years have passed since the maps were completed and utilized, and I wrote in my paper describing the basic principles, the process of creation, and the ripple effects and responses. There is no place to publish a paper on how the database was created or how it was useful to society, and I thought it was an excellent opportunity. A long time ago, this field was a practical science that became pure science, and now it is returning to practical science. I am grateful that I am working in such a time, to be able to publish my work.

Dr. Yasuhiro Nakamura

Dr. Koji Wakita

What was gained from writing the paper?

Akamatsu
I think the common experience is that the authors look back on their studies and realize that they were actually following some story or scenario. I am interested to know whether this realization has been useful in conducting your other studies.

Nakamura
In case of standards, the focus tends to fall on the development and provision. Now, I can say to other people in the lab, "You must think of the scenario for how the standard will be diffused after it is provided".

Akamatsu
That means that the process of actually diffusing the product was not shared among the researchers. I get a similar impression for geology.

Wakita
After writing the paper, for Phase 3, the project called the next-generation seamless was created, and collaboration with JIS and national standardization led to expanding utilization in the GEO Grid system. I feel the ripple effect in that, in collaboration with the information technology field, the user-orientation of how geoinformation can be utilized became clear among researchers including many young researchers.

Komai
The starting line is the desire to develop a methodology that will ultimately become a national standard, and that this is incorporated into the legal and social systems. How to diffuse it in society, while appealing to the ministries and agencies, solving the contamination problem without spending much money; these are the hard-and-fast rules of risk management.

However, I am having a lot of trouble now. The product realization was done and the social system started spinning, but things stagnated due to the "cost and risk" relationship. We plan to develop an economic model in Phase 3, but I feel that we're hitting the second "valley of death".

Kinoshita
We tried to conduct academic research and technology transfer concurrently. It seems this brought about cases where a great burden was imposed on the researchers involved. We did not want to be narrow minded, i.e., we did not want to think only about academic research nor to seek only for industrial values. Because of that, there were some cases where some researchers felt overloaded.

Akamatsu
I think the scientists may be thinking that the sociological methodologies that Dr. Kinoshita used to solve the on-site issues may not be that valuable. By understanding that there is a theory different than that in natural sciences and that it is part of how the discipline is done, the researcher may be relieved or may feel a bit more comfortable.

Kinoshita
Comparison of social and natural science is interesting. I, however, wish to compare quality and quantity. Where quantitative discussions are possible, those are preferable to qualitative discussions because they enable much more precise arguments. However, there often are many kinds of quantity to measure and it is not necessarily clear which is to be chosen. If that is determined injudiciously, the whole argument would be like a castle built on sand even if rigorous and detailed quantitative considerations are made on it. We are faced with systems with many kinds of quantities in computer science, probably many more than in physics and chemistry. So, analysis which justifies the selection of quantity to be measured is necessary before we start a quantitative theory. Such discussion will naturally be qualitative. Some people tend to say that qualitative argument is less precise than a quantitative one. It may be true, but a qualitative argument would be much more precise than a quantitative argument based on careless choice of the quantity. I wish to emphasize this point.

Komai
Currently, what troubles me the most is the "social approach". Although risk assessment is a scientific approach, there is a

Dr. Takeshi Komai

Dr. Motoyuki Akamatsu

matter of whether the general public will accept the result of risk assessment. When I talk to the local government or company, it is about social acceptance, and I think AIST should step into that field. Well, there's a problem of how many people with sociology background can be employed here.

Yoshikawa

I've been thinking about the same thing for a long time, and that was why I set up "design science". I've been told that "design is not a discipline", and the individual designers just made things in solitude. There was no accumulation, and there were no advancements like in physics, and it's been viewed with some degree of discrimination because it cannot be expressed quantitatively, and therefore it's not a science. In a wide sense, there's a structure where the science department is important but the engineering department isn't. I am trying to think of the method for "making science out of qualitative issues". The fact that many issues can only be handled qualitatively means that it can be a major issue as the subject of science, and the researcher involved deserves respect.

Kinoshita

While I am not a physicist, I have a science background. In my field, many people who studied in faculties of science seek for qualitative discussions, and many people from faculties of engineering tend to seek for quantitative arguments, such as computer performance, etc. I think it's the people from faculties of science where the qualitative discussions are sought that are discriminated.

Akamatsu

In the case of Dr. Suwa, the goal is not set with quantitativeness alone, but qualitative element enters to form a cycle. I felt that the next step couldn't be taken unless some sort of spiral is set off.

Suwa

It's exactly as you say. While the qualitative factor cannot be explained clearly, it is there for sure, and the quality changes throughout the research process. If there is an academic demand at some point and the daily trendiness mixes in, a certain vector is formed. We must decide what we should do about the vector as we come across it. As a cycle, I think we return to the basics again and again.

Akamatsu

Dr. Watari emphasizes that the story is important.

Watari

I've been in charge of various projects in the Research and Innovation Promotion Headquarters, and the way of thinking of synthesiology was extremely instructive for understanding the start-up of a project and its topic. Recently, we're promoting another activity, the promotion of joint research with companies. As a recent trend, we find that it's difficult to determine the topic of joint research between the AIST and the company people. That is because they do not have the synthesiology to breakdown the subject based on the topics they are studying. To get the blooming results, we must think about which elemental technologies to select or which technologies should be developed as the target of basic research. I think synthesiology is necessary to send the technology into society, such as understanding the other's demand or creating a scenario through close communication. I feel that the study of building synthesiology may be the most important activity for AIST right now.

Kinoshita

Joint work with industry sometimes brings about a language barrier. In some cases, I found that there was some fundamental misunderstanding half a year after we started talking.

Watari

I think narrowing down the subject is a preliminary preparation stage, but the vocabulary is difficult even within AIST.

Akamatsu

I think it is good training to write for *Synthesiology* so people of other fields can understand.

Dr. Hiroyuki Yoshikawa

Dr. Makiko Suwa

Watari
Normally, I have no idea what the research papers of other fields are saying, but I can get the flow when I read *Synthesiology*. When I read the questions first, I can understand what other people consider as the main issue and what the point is. I think the good thing about *Synthesiology* is that a reader can understand a paper of any discipline if he/she has a basic knowledge of science.

Through the discussion with reviewers

Akamatsu
One of the characteristics is the discussion with reviewers. How do you feel about the quality of the discussion with the reviewers?

Komai
It was vey educational. I had about two exchanges, and when I wrote the scenario, everything became clear, and I am grateful for this experience. I have abundant dealings with companies, and the people of the companies are dead serious about manufacturing and product realization. I feel that the R&Ds at AIST do not have a scenario all the way to the final product realization. I feel that by writing the whole scenario, you can propose the research project with the fastest route to product realization.

Suwa
First, I was thinking I had to explain my research within the framework of AIST's Full Research. When I tried to fit it in, there were some kinks that I found rather uncomfortable. I was advised to "freely present what you designed", and I felt better about writing. It was very educational because I was able to look back on my research. I think the paper turned out excellently. However, I think this kind of discussion can be directed only to the employees of AIST. I assume you will be seeking submission from people outside of AIST. In conventional papers and journals, there isn't much exchange of opinions for the reviews, and I am worried that there aren't any people outside of AIST who will spend time on this.

Akamatsu
Dr. Yoshikawa, what do you think after hearing other people's comments?

Yoshikawa
Dr. Komai extends into the field of science and technology policy and system design, not just the new risk assessment technology for soil and ground water contamination. Dr. Watari covers various fields to realize the great objective of energy-saving process for ceramics manufacturing. I call this the "design of super-discipline", and the "synthesis" is possible when the individual researches are integrated. Dr. Suwa integrates wide-ranging researches in bioinformatics that is the combination of life science, information and communication, and ICT. Dr. Kinoshita's clinico-informatics discusses, in some sense, the design of synthesiology or the essence of synthesis. Dr. Nakamura engages in a wide range of research with the increasing importance of standard and globalization in the background. In Dr. Wakita's seamless geological map of Japan, accumulated knowledge was not written up as a research paper until now, but with this paper, the larger issue in the background was extracted.

I think that the science handled in *Synthesiology* has a universal structure, though rather abstract, in the background of diverse issues. From the accumulated papers, it may be possible for us to extract something that is different from the methodology of *Type 1 Basic Research*, but just as important; something that we can say "this is *Type 2 Basic Research*". That is something which I look forward to.

Expectation for *Synthesiology*

Akamatsu
Finally, please express your expectations for the journal *Synthesiology*.

Kinoshita
I've worked on the scenario based on the thought that whenever you discuss safety and reliability there is always risk assessment, and that dependable and reliable software should be constructed in a certain way. I've never thought of generalizing this to other fields of technology. So, Dr. Yoshikawa's comment was an eye-opener for me, and to pursue a common structure in these kinds of scenarios is interesting. Hopefully, there will also be other authors who will take part in the pursuit of this direction.

Suwa
If it is called science, it must be reproducible. I think it would be interesting to categorize the structure of researches in linkage with the results, to study how many percentages of researches succeeded or failed when some method was taken. Also, considering the trend in the world and the interaction with the exterior environment, I think it will be helpful to see the results of the research group in a certain era and the changes in reproducibility over time.

Akamatsu
That means that one may fail using the same method depending on the changes in the social situation. I hear suggestions that people would like to read stories of failures, but you'd have to be brave to publish that.

Wakita
In my field, recently we are discussing "geodiversity", and we hope to propose a new discipline as synthesiology of the fused disciplines. I hope you open roads for publishing cases of failures and successes of attempting such fusions.

Nakamura
I think that standard is a common infrastructure even in synthesiology, and I am impressed myself. I think the collaboration and fusion with other fields can be done through the keyword "standard".

Watari
Recently, there's talk within AIST that "fusion of fields is important", but the major issues in society are all already fused. Since this is a good opportunity, I want people who wrote for *Synthesiology* to get their hands in practical science. I think the next step is to get down to practice, like when you break down a topic, you see there are such research elements, and you can actually do such projects.

Akamatsu
So, you mean don't just write and feel important, but get down and do it !

Komai
I wish the young researchers would have this attitude. I speak to sociology students in collaborative lectures, and last year, I started talking about synthesiology, and they are showing great interest. To have an overview of the whole and to engage in solid synthesis are important for people studying social sciences as well as for those seeking employment in companies, and it is important that this thinking diffuses among the young people. Also, this year, I was a moderator at the Innovation School, and the post-doctorate level people of system science and bio fields were particularly interested.

Yoshikawa
I think the strategic projects are created based on the thoughts of *Synthesiology*, but I hope it becomes a bit more analytic so it can be appealing to people outside AIST. In the Fourth Science and Technology Basic Plan, we have the problem-solving innovation, but we have no methodology. I would like you to make a presentation, "Here is the methodology."

Akamatsu
I would like to aim for not just writing papers based solely on what I practiced, but for providing verification as I re-practice making use of what I gained through writing the paper. Thank you very much for your participation today.