Discussion Manual for Convergence of Inter-disciplinary Technology by Technology Roadmapping

（Version 2.0）

C-Plan
(Convergence –Plan)

[Unofficial and Tentative Translation]

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Research & Development Division

The Ministry of Economy, Trade and Industry

CONTENTS

Discussion Manual for Convergence of Inter-disciplinary Technology by Technology Roadmapping (Version 2.0)

1. Introduction

They say often "inter-disciplinary-involved technology convergence is the key to creation of brand-new innovation." Amid such arguments, however, few have been published which discuss, by specifying a viable approach in a readily comprehensible way, how to advance inter-disciplinary-involved technology convergence and what sorts of new values should be created through such efforts. To advocate the single phrase of inter-disciplinary technology convergence just reminds us of the proverb, "It is easier said than done," while today's situation unveils various entities all continuing strenuous efforts to find some answers through trial and error. More importantly, making a convergence itself a goal should be heeded because it can blur essential qualities. The main grounds for making inter-disciplinary technology convergence difficult are that different technologies dwell in different research domains where speeches (technical terms) and cultures (research methods) are completely different from each other, with some even repulsing sometimes.

To advance technology convergence among heterogeneous sectors requires removal of a long-standing frame in each research community. To this end, instead of unfolding a cumulative discussion from technical perspectives, required first is to set a theme of common interest, for which different technology solutions can be proposed by different participants based on their expertise, who simultaneously clarify the limits of their solution paths. Then, the key is the subsequent process, where all participants, different in specialties, constructively discuss if the limits of different technology solutions could be overcome by mobilizing their wisdom and technology to get them fused with the technology solutions in question.

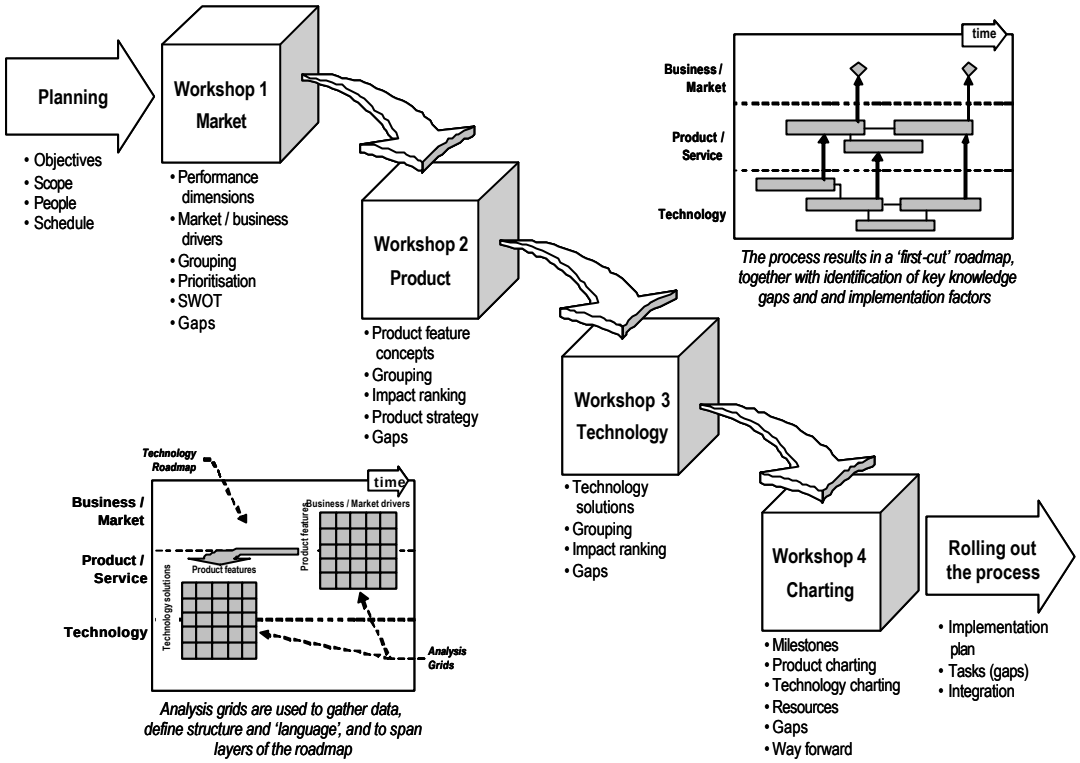
What is a discovery/creation of new needs or a product/service which can satisfy such needs? What on earth is a function which can actualize a new product/service? What is a technology which can realize such a function? These questions are endlessly repeated many times within a manufacturing firm. Technology roadmapping (TRM) is available as an approach to draw out rational answers to these questions. TRM can also serve as a communication tool among different organizations and the like. If utilized well, TRM could prove that it enshrines great potentials for advancing technology convergence, typically by smoothening communications among different engineers from different sectors.

It was with this in mind that the Ministry of Economy, Trade and Industry and the New Energy and Industrial Technology Development Organization (NEDO) embarked upon an effort to create new value through the convergence of inter-disciplinary technologies using the methodology of "technology roadmapping." The experiences gained from this process were used as the basis for the creation of a "Discussion Manual for Convergence of Inter-disciplinary Technology by Technology Roadmapping" ("C-Plan Ver. 1.0") in June 2006. This document takes its cue from the standard process management technique for roadmapping known as "T-PLAN" developed by Cambridge University (UK), and uses case studies to illustrate how specific discussions can move forward, the kinds of organizations that can be used and how roadmapping can be managed.

We should underscore, however, that this manual is not fixed in stone; it will be revised and made need easier to use as it is applied in real-life situations . With this in mind, we established to themes for FY 2006 and made several attempts at technology roadmapping, using them to improve C-Plan Ver. 1.0. This text represents those results, and we are pleased to present a revised C-Plan Ver. 2.0 for your consideration and comments.

These findings are shared with you in the hopes that you may obtain some hints from this text. This manual envisioned standard cases, and one must expect that the situation will change depending upon the domains involved, the specific participants and how secretariat functions are administered. We encourage you to customize this manual to your own circumstances as you use it.

A Flow of Discussion Recommended by T-PLAN



Source: Dr. Robert Phaal , T-Plan The fast start to technology roadmapping Planning your route to success, University of Cambridge

Points of concern

? This manual is meant for researchers at universities and public research institutions, for people in the planning, R&D and new business development units of private sector companies, and for the managers of small and medium-sized companies that are trying to develop new areas. Others may also find its discussion of roadmapping methodology to be useful in different situations.

? As a reference for activities under the C-Plan, the Ministry of Economy, Trade and Industry and the New Energy and Industrial Technology Development Organization (NEDO) have created a "Strategic Technology Roadmap." The organizations began formulating and publishing the Map in 2005; the 2007 edition covers 25 technology areas. An understanding of technology trends in these areas will be useful for the process of discussion advocated in this manual.

? To facilitate the activities described in the C-Plan, it is necessary to have "secretariat functions" that support activities from the preparation stage through completion. The role of the secretariat functions and thee people providing them will differ depending on who (which units) are the drivers of the road mapping process and what kind of implementation organization the implementing body has. This manual talks about "secretariat functions," but readers should feel free to experiment with organizations, administration and implementation depending on their circumstances.

2. The flow of roadmapping

What is a discovery/creation of new needs and a product/service which can satisfy such needs? What on earth is a function which can actualize a new product/service? What is a technology which can realize such a function?

Discussion is to be made on these questions one by one.

Below in broad strokes is the flow from preparations through completion of the roadmap, which we have divided into the preparation stage plus 4 workshops. If workshops are scheduled for different times, it is of particular importance that preparations for Workshop 3 begin after Workshop 2 ends. It is also effective to provide follow-up.

[Planning]

Themes are preset, based on which objective, scope, system and schedule are fixed.

[Workshop 1]

Given the preset themes, participants cite "wants," followed by grouping of "wants," concept-making and prioritization through discussion.

[Workshop 2]

Each concept adopted is converted into a definite theme, from which relevant functions are evolved.

[Workshop 3]

Element technologies required for theme-solving are extracted, and an overall theme-solving system is charted in such forms as diagrams and image drawings.

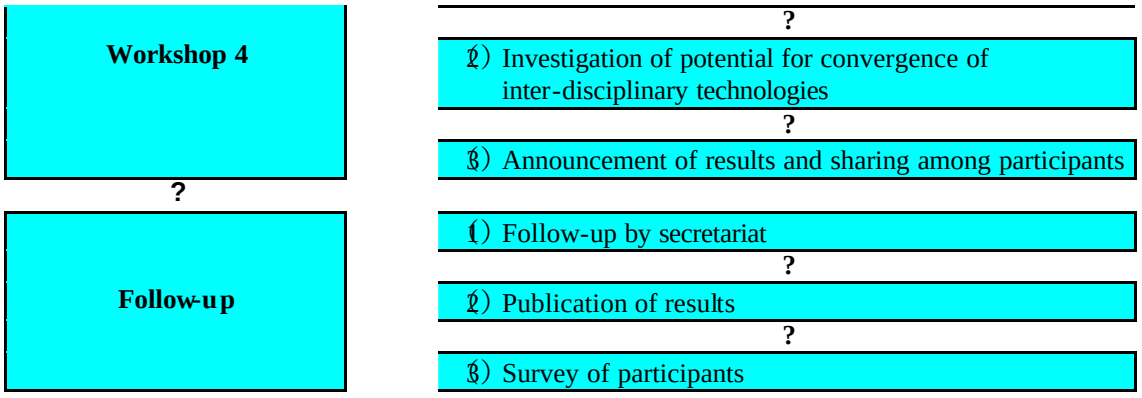
[Workshop 4]

Given discussion results of Workshops 1~3 and taking concepts and functions into consideration, element technologies and their casual relations are organized in reference to an axis of time. ? "Completed TRM"

[Follow-up]

Surveys and similar techniques are used to identify the secondary outputs of the workshop and create lists of people suited to different themes.

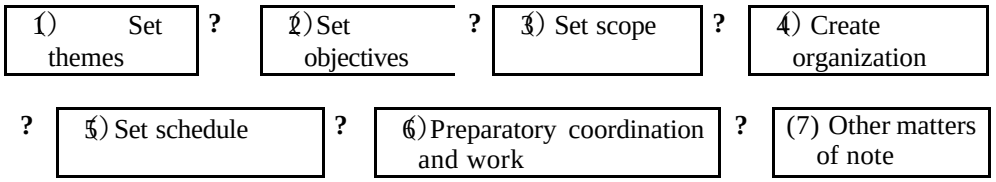
Step	Action item
Planning	(1) Set themes
	?
	(2) Set objectives
	?
	(3) Set scope
	?
	(4) Create organization
	?
	(5) Set schedule
	?
	(6) Preparatory coordination among core members and preparatory work by participants
	?
	(7) Other matters of note (agreement on whether content will be made public etc.)
?	?
Workshop 1	(1) Preparations by secretariat
	?
	(2) Listing up of "wants"
	?
	(3) Conceptualization
	?
	(4) Prioritization and selection of concepts
?	
Workshop 2	(1) Preparations by secretariat
	?
	(2) Identification of required functions
	?
	(3) Imaging of services to achieve functions
?	
Workshop 3	(1) Preparations by secretariat
	?
	(2) Listing of element technologies
	?
	(3) Creation of diagrams to illustrate the overall system
	?
	(4) Investigation of the status and limits of element technologies
?	
	(1) Preparations by secretariat



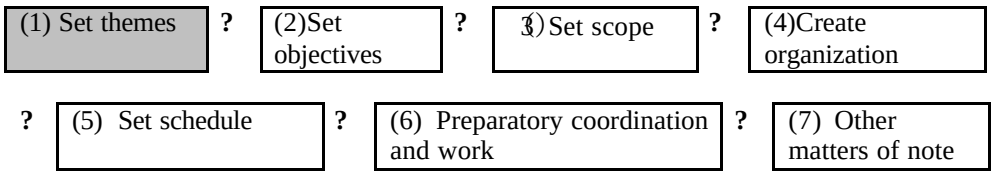
3. Planning

The preparatory stage involves setting themes, objectives and scopes, and then creating the organizations and schedules under which targets will be pursued. Once the broad framework has been set, preparatory consultations and work can begin on the workshops.

Action items at the preparatory stage



(1) Set themes



The first step is for the drivers of inter-disciplinary technology convergence roadmapping activities to present issues in the form of central tasks to be addressed.

(Point)

Plenty of time, if available, could afford a start completely with a free hand without any specific theme preset, though diffusion of discussion seems inevitable. Without themes narrowed down to some extent prior to talks, rambling discussion would be likely. Though strict theme-setting is not needed at all, roughly selected themes (placed as main agenda), if notified beforehand, could help participants prepare their arguments so that they could unfold more effective discussion than otherwise.

Case study: Setting themes

Three areas were focused on to perform case studies. Below are the themes that were set for each.

i) Use of optical molecular imaging technology to "fuse optical measurement technology and fluorescent probe technology with medical diagnostic technology"

We studied the scientific areas and technology domains that could be involved in

inter-disciplinary conversion and identified a conversion domain in optical measurement technology and fluorescent probe technology on the one hand and medical diagnostic technology on the other. However, as described below, at the workshop stage the decision was made to focus on other themes.

ii) Use of nano/bio technology to create "general clinical doc based on nano/bio integration"

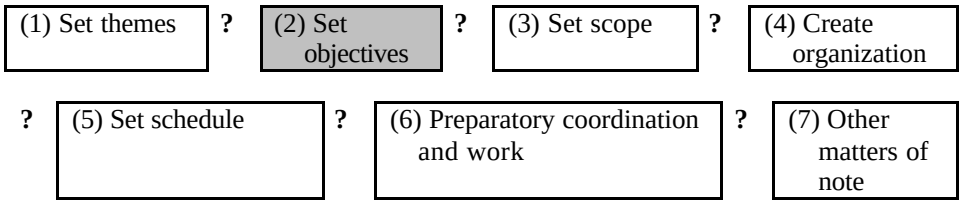
As a preparatory task, we advanced creating a "general clinical doc based on nano/bio integration." Our perspectives were that as society ages, people should not merely live longer but should continue to be active as a part of society, but we also envisioned that participating members would be free to set their own themes.

iii) "Prevention and treatment of lifestyle-related disease" fusing medical, cognitive and information technologies etc.

In trial runs of the C-Plan, we set a theme of prevention, early detection and treatment of lifestyle-related disease from the insurance, medical and welfare domains as a theme that would broadly acceptable to participants.

As can be seen from the above, when work goes forward on the basis of fairly fixed themes, there are often cases in which it is necessary to revise them to take account of creative ideas that emerge in the discussion process. It is therefore necessary to move forward flexibly according to the objectives.

(2) Set objectives



This is where the orientation and destination of the study are set. In other words, this is where you identify the "target" that serves as a guideline for the investigation. In doing this, it is desirable to create diagrams that can be presented to participants in advance.

(Point)

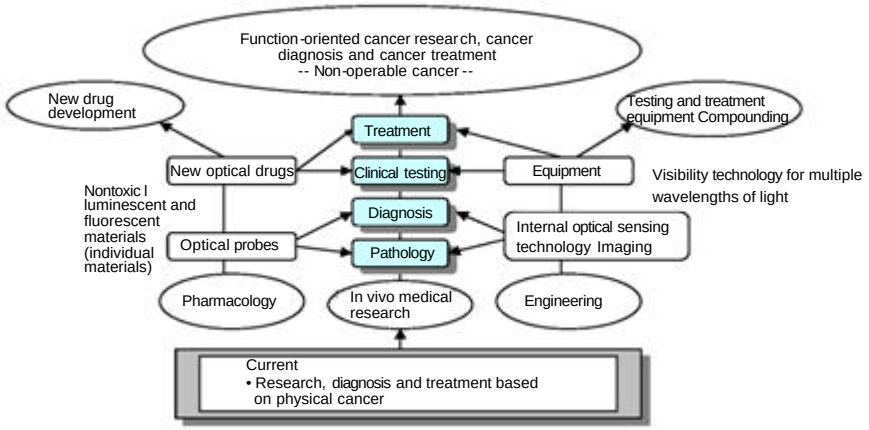
It is recommended to collect beforehand as much information as possible about on-going actions which can be related to a given theme (e.g. basic data found in relevant government systems and reports). Particularly in case the participants in talks are not experts straightly in a given theme, a roughly-cut target needs to be figured out, as part of information gathering efforts to set assumptions, as to when the theme is counted as solved with what's done.

Case study: Diagram of theme and objective setting

The themes set in (1) can be schematized in advance like the drawing below to serve as a guideline illustrating the objectives of the study.

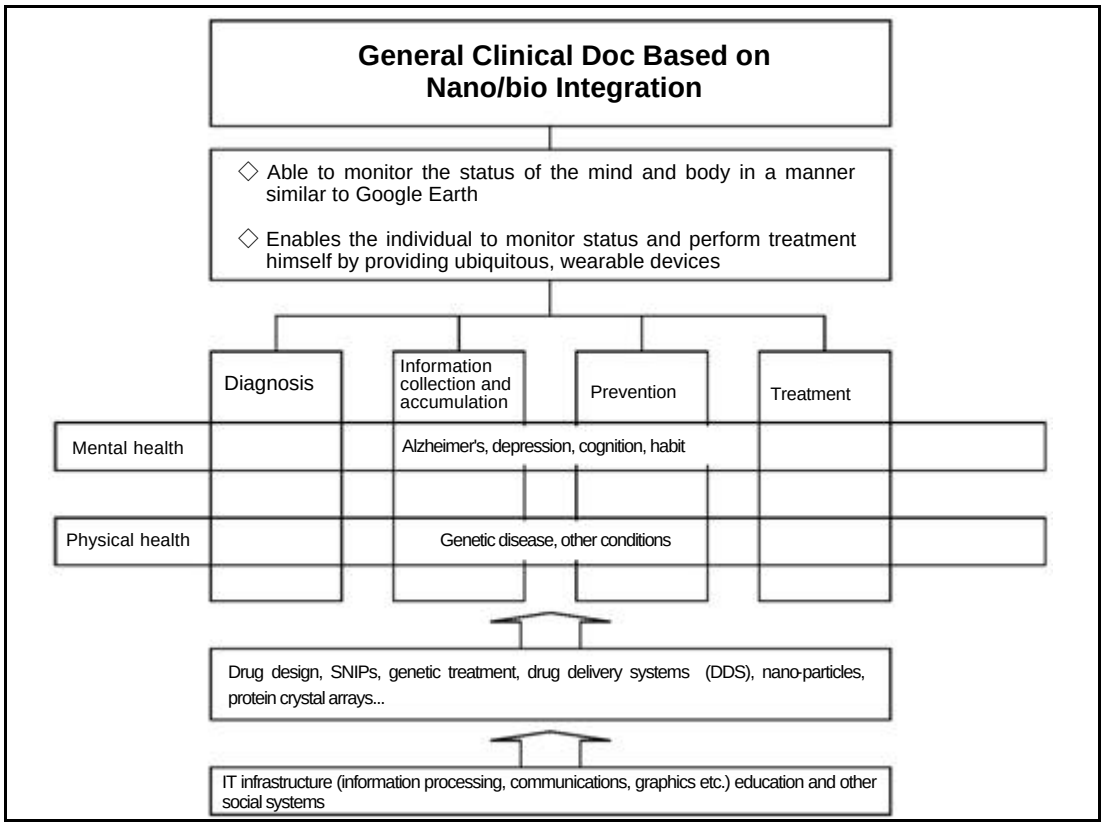
i) Optical molecular imaging

In the optical molecular imaging case, the theme was "to apply optical molecular imaging technology in the process from diagnosis to treatment in ways that would simplify diagnosis and provide for treatment of non-operable cancer." Participants were presented with the following schematic:



ii) Nano/bio case

In the nano/bio case, the objective was the creation of a "general clinical doc based on nano/bio integration" that will use integrated nano/bio technologies supported by social systems and IT infrastructure to achieve medical and health-management services which allow people in our increasingly aging society to not only live long lives but continue to be active as members of society." Participants were presented with the following schematic:



(3) Set scope

(1) Set themes **?** (2) Set objectives **?** (3) Set scope **?** (4) Create organization

? (5) Set schedule **?** (6) Preparatory coordination and work **?** (7) Other matters of note

When setting themes and scopes for inter-disciplinary convergence ((1) and (2) above), it is best to begin the discussion somewhat abstractly and elicit a wide range of comments and ideas. Then at this stage, one begins to narrow the scope of the study so as to enable the discussion to progress.

(Point)

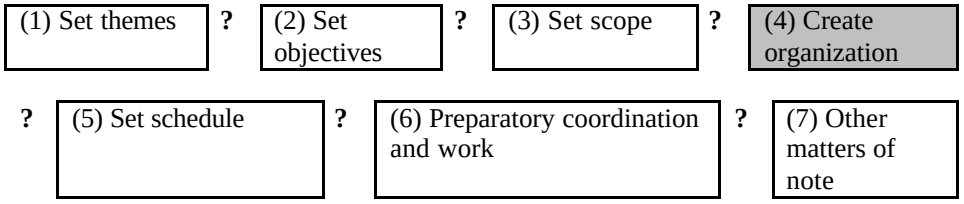
There will be a wide variety of official and personal comments and ideas that come out in the course of discussions, and it is important to narrow the scope of investigation in order for discussion to progress. One effective technique for doing this is to provide representative keywords for the theme and objectives.

Case study: Presentation of keywords to help set the scope

In the nano/bio case, we provided a framework for the discussion of scope that had on one axis words like diagnosis, information collection, prevention and treatment, and on the other mental health and physical health. We also included several other keywords like "drug design."

In the "prevention and treatment of lifestyle-related disease" case which attempted to fuse medicine, cognition, and information technologies, the keywords were genetics, lifestyles, aging, cognition and mental health.

(4) Create organization



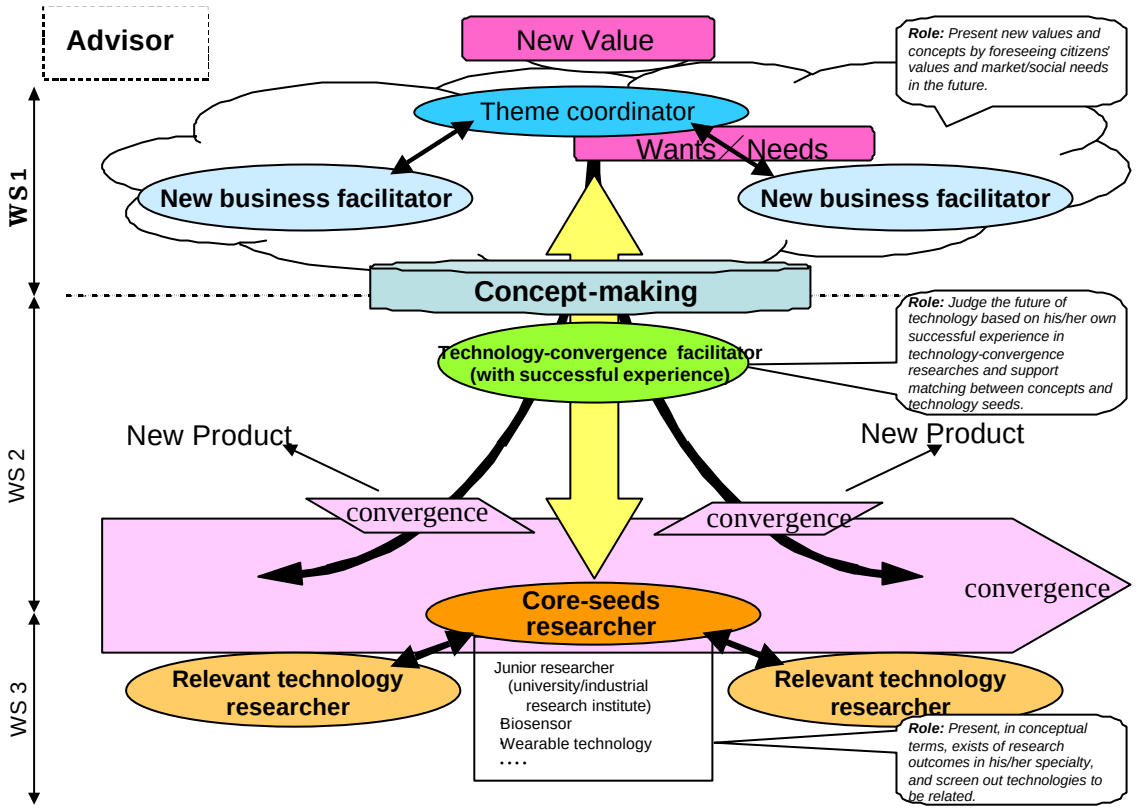
The convergence of inter-disciplinary technologies requires the participation of a number of experts in inter-disciplinary technologies (core seeds researchers). They are also need to be coordinators and facilitators who give direction to roadmapping discussions and provide organization and leadership. Another important group is advisors who are experienced in roadmapping. Given the important role that the secretariat will play in supporting roadmapping, the organization-creation stage should determine who (what unit) will provide secretariat functions.

Below is an outline of the roles and requirements of people involved in the roadmapping process. (See Point 1.)

When selecting personnel, it is recommended that candidates be evaluated in terms of their expertise in the domains under discussion and their experience with commercialization. (See Point 2.)

Note that the roles of members are not necessarily fixed in stone. In moving forward with inter-disciplinary technology convergence, members will have their basic roles, but should not be limited to that framework. Rather, it is important that they be able to participate in discussions freely. (See Point 3.)

Framework of discussion to R&D in fusing areas（Roadmapping）



Types and Roles of Participants

（Point1）

It is no exaggeration to say that the key to an ever-better outcome depends on nothing but member selection. Because to be advanced is inter-disciplinary technology convergence, naturally participation, in plural numbers, of core-seeds specialist researchers from heterogeneous sectors is imperative. Yet, convergence could hardly advance if discussion was made by inviting such specialist researchers alone. It is because different technologies dwell in different research domains where not only speeches (technical terms) but also cultures (research methods) vary completely, with some even repulsing sometimes. To move inter-disciplinary technology convergence requires the repeal of the frame which governs individual research communities. To this end, instead of unrolling a cumulative discussion from technical perspectives, it is required first to set a theme of common interest, for which technology solutions can be proposed by different participants having different expertise, who concurrently point out the limits of their solution paths. Subsequently, all participants, different in specialties, constructively discuss if the limits could be overcome by mobilizing their wisdom and technology, or by virtue of technology convergence. It is believed the key is this sort of constructive discussion. To lead discussion that way crucially requires participation of a theme coordinator with broad perspectives. Also, viable discussion results could be expected if participated by anyone who advocates a new project based on his/her successful experience of inter-disciplinary technology convergence.

(Point 2)

It is important to choose a diverse range of members in order for debates and studies to be effective. To move the discussion forward, thought should be given to the similarity of domains as well as their diversity. This will require a bit of creativity. For example, one could identify a "key man" based on the themes etc. that have been set and then ask the key man to propose researchers and experts in heterogeneous sectors he would like to discuss. The proposed researchers and experts could also be asked to propose researchers etc. in heterogeneous sectors with whom they would like to hold discussions. Repeating this process will enable organizers to select the proper member candidates.

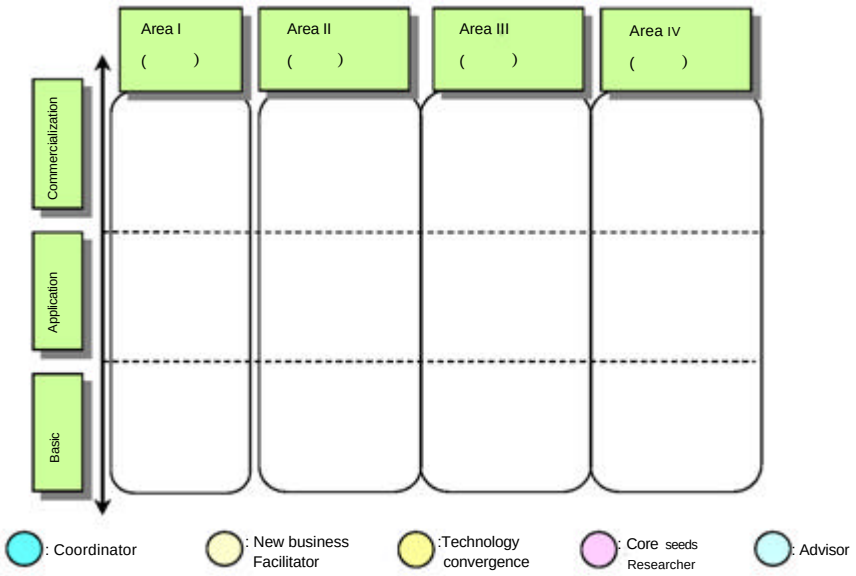
Additionally, to arrive at a membership that appropriately balances diversity and similarity in the themes to be studied and to assign roles to these numbers, it will be effective to use an evaluation framework such as the one described below both to nominate candidates and to narrow down the nominated candidates. We recommend that studies proceed by placing candidates on the matrix according to the specific axes of evaluation that are employed. See the case study below.

Example of using evaluation matrix to select members

1. **Evaluation axis 1: Mapping by research and technology domain**
   Create a list of the required technology domains and identify candidates based on it. Investigate the research domains of the nominated candidates, divide them into areas of specialty and create the map.
2. **Evaluation axis 2: Mapping by stage of R&D and commercialization**
   Identify the insights required candidates according to stage (basic research, applied research, commercialization etc.) and map the qualities of the nominated candidates.
3. **Analysis in terms of comprehensive coverage of the theme and individual expertise and cross-disciplinary skills**
   - Check that all required areas of specialty are covered and that there is no bias along Evaluation Axis 1.
   - Check that the team is able to cover the entire process from technology development through commercialization of results and that there is no bias along Evaluation Axis 2.
   - Use the results from mapping candidates along the 2 axes to characterize candidates in terms of both "expertise (degree of specialty)" and "breadth" of domains, and use this as reference material in establishing roles.

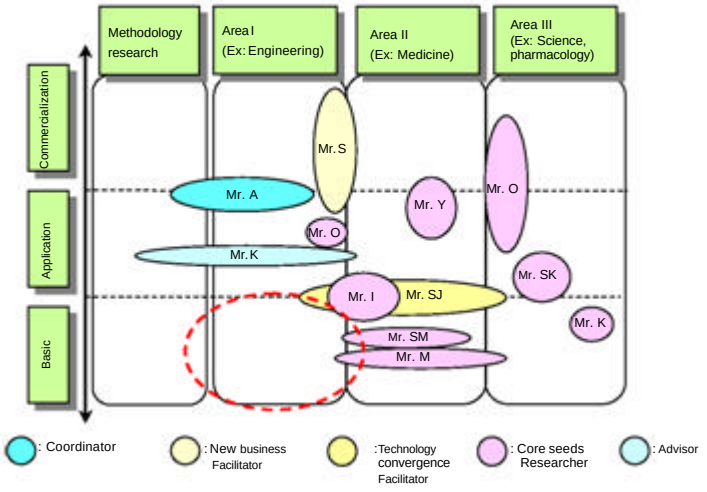
Sample mapping sheet using evaluation axes to select members

Mapping sheet for the selection of members and assignment of roles



Case study: Use of mapping to select participants and assign roles

For the optical molecular imaging case, we created the following matrix and used it to select workshop participants and assign them roles.



(See Annex 2 for sample formats)

(Point 3)

Circumstances will dictate the assignment of the coordinator, facilitator and core seeds researcher roles to members, the structure of the organization and the procedures used to recruit members. In some cases, it may be necessary to assign roles after members have been assembled and candidates' backgrounds are known. Below is a description of how roles were assigned to participants in the case study.

Again, it should be emphasized that participants' roles are not fixed in stone; all participants must be free to participate in discussions aimed at inter-disciplinary technology convergence.

Case study: Backgrounds of candidate members

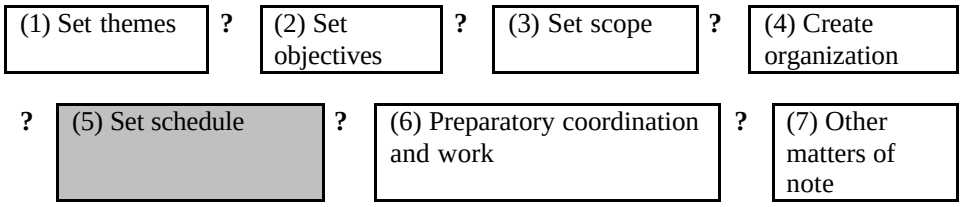
There are different conditions that must be satisfied by theme coordinators, facilitators and advisers and different backgrounds that support these roles. In the case study research we established the criteria as shown above, nominated candidates and requested their participation. The following may serve as reference examples.

- **Theme coordinator**
  - Research executive in charge of developing new areas at a manufacturer of electrical and electronic equipment
  - Professor at a graduate school of technology management with experience in the development of new areas at a manufacturer
- **New business facilitator**
  - Chief researcher who actively publishes opinion pieces on industry and economics
  - Executive in the business strategy office of a manufacturer of electrical and electronic equipment
  - Specially-appointed professor for industry-academic relations with specialties in multiple fields of bioscience and engineering and active in both the business and academic communities
- **Technology convergence facilitator**
  - Head of research at a medical school with degrees in medicine, engineering and other fields
  - Young researcher with a foundation in engineering and a track record of coordination with heterogeneous sectors like medicine who successfully launched a university-originated venture business
- **Core seeds researcher**
  - University researcher, private sector researcher, manager of university-originated venture business etc. with track record in industry-academic collaboration
- **Advisor**
  - Vice president of technology-oriented graduate school, professor in technology management department at university

(Point 4)

You may encounter conflicts of interest among the participants when they are drawn from more than one company or institution. One technique for overcoming this and enabling workshop discussions to go beyond parochial interests and be productive is to sign nondisclosure agreements. (See (7).) Another technique is to seek the participation of researchers at public institutions who are in neutral positions and ask them to lead the discussions from long-term perspectives.

(5) Set schedule



Time is assigned to Workshops 1~4.

（Point）

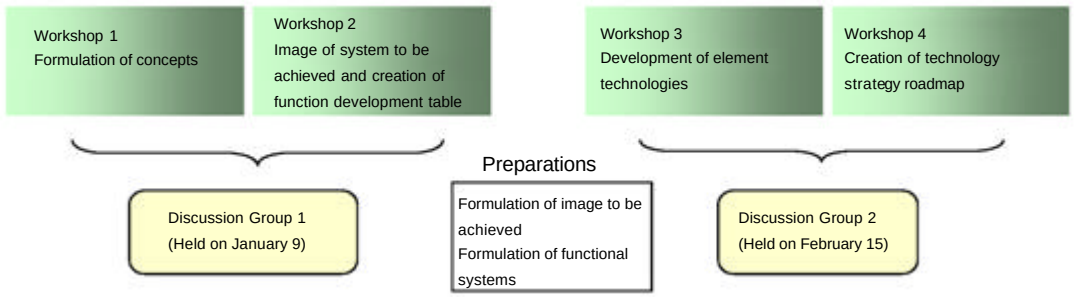
Prior to starting Workshops, to provide guidance on, among others, the significance and values of technology roadmapping is important. Also, it becomes an important step to gain cooperation and understanding of the participants by explaining them at the beginning an overall flow of discussion, the scope of discussion to be covered by each workshop and so on.

There are two ways to hold Workshops 1~4; hold them separately on different days or intensively on a single day. Those who challenge for the first time are recommended to learn a flow of discussion and a methodology by taking the intensive approach. Once experienced, they become able to foresee what should be prepared at which workshop and how. Originally it is believed Workshops held by taking certain intervals are apt to produce better outcomes than those intensively organized in a short period, because the former affords more time for planning.

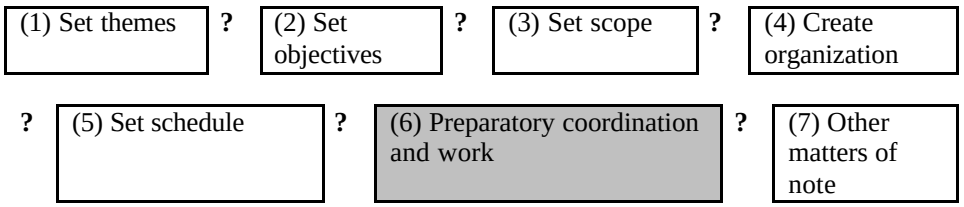
Case study: Scheduling

As will be seen below, for the optical molecular imaging case, we held Workshops 1 and 2 on 1 day and then held Workshops 3 and 4 roughly 1 month later.

Both days were full-day events beginning at 9:30 a.m. and ending at 6:00 p.m.



(6) Preparatory coordination among core members and preparatory work by participants



An effective way to bring all workshop participants onto the same page and conduct effective discussions is for the secretariat to gather the theme coordinators, new business facilitators, technology convergence facilitators and other core members in advance to establish: (1) themes, (2) objectives and (3) scope. Having done this, it is possible to decide on the preparatory work to be requested of all participants in the workshop and ask them to complete the work by the time of the workshop. Examples from the case studies of how to use the preparatory stage to create more effective workshops have been summarized below as "points."

(Point 1)

Many of the participants in the workshop will be meeting each other for the first time, so it is desirable to prepare documents that briefly outline participants' backgrounds and recent activities. Request that participants provide this information in advance so that it is available in time for Workshop 1. A sample format is provided below. As a first step in creating a "common language," it will probably be more effective to use magazine and newspaper articles rather than stiff, formal lists of results.

- **Envisioned role in workshop**
- **Name**
- **Affiliation and position**
- **Academic history (may have multiple degrees)**
- **Description of research results**
- **Research history/development and commercialization history**
- **Other information (words etc.)**

(See Annex 2 for sample formats)

(Point 2)

The secretariat should already have made preliminary decisions on "themes," "objectives" and scope" prior to the workshop, should discuss them in the coordination sessions and attempt to arrive at a common consensus. For workshops to proceed effectively and efficiently, participants need to be informed of themes, objectives and scope in advance. An effective technique for doing this is to request participants to prepare their statements for the workshop in advance so that the secretariat can summarize them as documentation. Create a form that can be filled in, send it to participants by e-mail etc. and request that they return it. An important point in this is to create a schematic that illustrates themes, objectives and scope.

Sample Format for Preparatory Documentation for Workshop 1

Name	
Theme/topic	
Wants	Description of values, phenomena, activities, services, products and technological requirements etc. assuming the social conditions envisioned for circa 2030
Concept	Description using keywords of the "values" and "services" embodied in wants

Technologies and social systems that are currently lacking for the achievement of the above	Technologies that are lacking and research and development themes etc. on which breakthroughs are required for the achievement of the above wants	
	Non-technical requirements (institutions, social systems etc.)	

Case study: Sample preparatory documents for participants

In the nano/bio case, we mailed a form for participants to fill in and return, from which we created documentation in advance, which was distributed and presented at Workshop 1.

Name	
1. Based on secretariat-formulated theme: "General Clinical Doc Based on Nano/bio Integration"	
Wants	• Consecutive, remote monitoring of individual physical conditions etc.; bidirectional communications networks • Treatments, measures and prevention optimize to individuals at a genetic, proteins and cell levels (taster chips, anaphylactic -free treatment) • Nanomachines for search and treatment in organs and blood vessels • Individualized, real-time diagnosis at the genetic and cell levels • Identification of full-body diagnosis techniques (☆-CT metrics) ☆. (To follow x-rays, MRI, PET) • Quantified, numerical observation of mental health
Concept	1) "Anytime, anywhere" ubiquitous, tailor-made medicine that uses a convergence of nano/bio technology and IT to enhance safety and peace of mind 2) Drexler's nanomachine concept (micro suicide squad project)
Technologies and social systems that are currently lacking for the achievement of the above	• Highly reliable processing technologies (T4 fuzzy) • Efficient energy conversion technology • Learning from living organisms how to control "wobbling" and development of applying technology
	Non-technical requirements (for example, education and training systems, institutions to conduct cohort studies)
2. Based on free themes (domains outside of medicine and healthcare)	
Wants	Food • Genetically modified crops and foods • Countermeasures for bird flu, koi herpes etc.

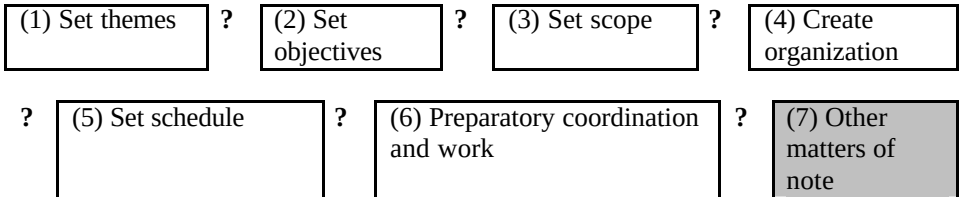
	Housing • Artificial light synthesis (highly efficient energy conversion) • Artificial molecular motors (highly efficient machines): Molecular motors, insects • Learning from living organisms (smooth information processing): Frogs... Human beings
Concept	Scientific and technological base to support food safety, peace of mind and sustainable social development (rather than "food, shelter and clothing" the concept should be "food, shelter and health," with particular emphasis on food (processed foods and materials) and housing (environment and energy))
Lacking for achievement of the above...	• Ultra-high precision machine tools and assembly technologies • Ultra-efficient energy conversion (light-mechanical, combustion-mechanical)

(See Annex 2 for sample formats)

(Point 3)

The core members and secretariat should discuss in advance the roles to be played by coordinators and facilitators in moving the workshop agenda forward and summarizing the points of discussion, and the nature of the support to be provided by the secretariat. This should include consideration of methods and assignments when group work is envisioned, use of tags in the KJ technique, and other techniques for summarizing points of discussion.

(7) Other matters of note (agreement on whether content will be made public etc.)



It is expected that the process of discussion will elucidate many new, innovative ideas. However, there is also the potential for discussion to be muted unless the preconditions are put in place for free discussions.

For instance, there should be rules determined in advance for the handling of intellectual property (to publicize or not, ownership of results), including the new ideas and concepts that emerge from the discussion. This is usually not a matter of concern when discussions occur within a single organization, but it must be addressed when members come from different industrial, academic and government etc. organizations. Below are some examples of points on which confirmation will be required.

◇ Should be content of discussions at the meeting be published? Who owns the results?

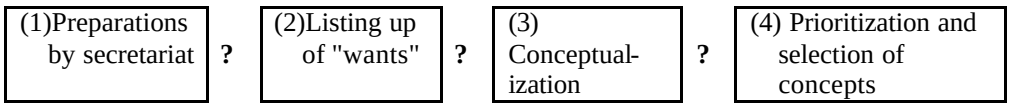
◇ Nondisclosure agreements (NDAs) covering new ideas and detailed technologies etc. that emerge in the course of discussion.

(See Annex 3: "Nondisclosure agreement template")

4. Workshop 1

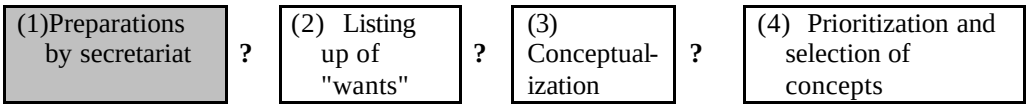
Workshop 1 plays the most important a part in the roadmapping process. It will ultimately establish the concepts (*) that will be used. It is during this workshop that you create lists of wants from the perspective of consumers, focusing on the themes that were established in the preparatory stage. These wants are categorized according to values and services etc., conceptualized in terms of creating value , and organized and prioritized.

Workshop 1 actions



* Concept use keywords to describe the social "values" and "services" desired for the future.

(1) Preparations by secretariat



When opening the workshop, it is important that all participants understand the general flow from Workshop 1 through Workshop 4 as well as the content, destinations and discussion methods to be used in the current Workshops 1 and 2. It is also necessary to explain the terminology that will be used in the workshop ("wants," "concepts" and "functions" etc.) so that a common understanding is formed. To do this, the secretariat should create explanatory documentation and mail it to participants in advance, or an explanation can be provided at the start of the workshop itself.

Case study: Documentation explaining the content of Workshop 1

Below is the format that was created for the case study, and explanations were provided in the form of guidance at the beginning of the workshop.

Diagram illustrating procedures for Workshop 1

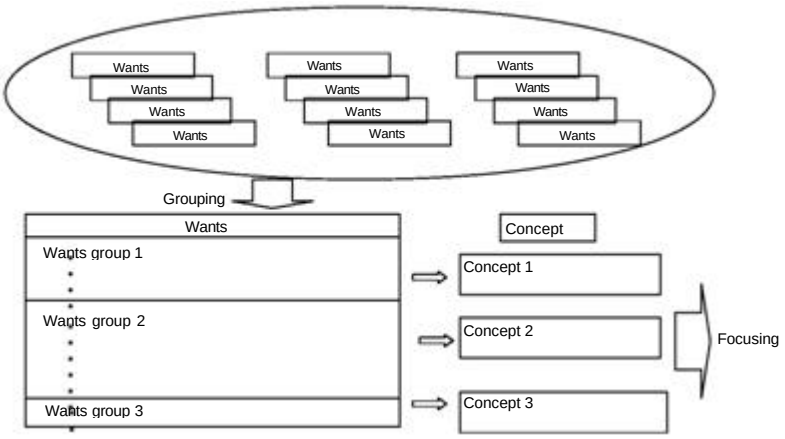


Diagram illustrating procedures for summarizing Workshop 1

Image of Workshop 1 summary

Wants	Concept

(See Annex 2 for sample formats)

(2) Listing up of "wants"

(1)Preparations by secretariat **?** (2)Listing up of "wants" **?** (3)Conceptualization **?** (4)Prioritization and selection of concepts

All participants (including observers) are asked to submit "wants." "Wants" are formulated in terms of wishes and desires: "I want to do this." "Needs" are desires that have emerged, while "wants" are values (phenomena, activities, new services and products etc.) to be achieved in the future.

(Point)

"Wants" are formulated as lists for the "themes" established in the preparatory phase. When formulating "wants," do not attach any preconditions; allow participants to express their ideas freely and fully. It is desirable that participants make an effort to provide mutual stimulus in the submission of their wants, for example, by making use of projectors.

Case study: Presentation of wants

In beginning Workshop 1, it will be effective to have the participants do the kind of advance work described in 1. "Advance preparations." For example, in the optical molecular imaging case, projectors were provided and participants were asked to make presentations on their wants. In the nano/bio case, the secretariat had edited documents created during the preparatory work and used them to present wants. In both cases, after the initial presentations, participants were invited to write wants on tags, and whiteboards and schematic paper were used to organize them.

Writing wants on tags and presenting them (optical molecular imaging case)

(3) Conceptualization

(1) Preparations by secretariat	?	(2) Listing up of "wants"	?	(3) Conceptual-ization	?	(4) Prioritization and selection of concepts

Next, "wants" are categorized according to the perspectives of value and services etc. and concepts are formulated for the creation of new values. In this case, "concept" refers to a description of a "want" using key words to express the social "values" and "services" to be achieved .

(Point)

The "wants" submitted by participants during Part (1) should be categorized and collected from general perspectives. These large categories and collections are "concepts." There can be any number of categories and collections, but it is generally best to create between 3 and 5 large groups.

Case study: Examples of conceptualization (optical molecular imaging: food, agriculture, microorganisms)

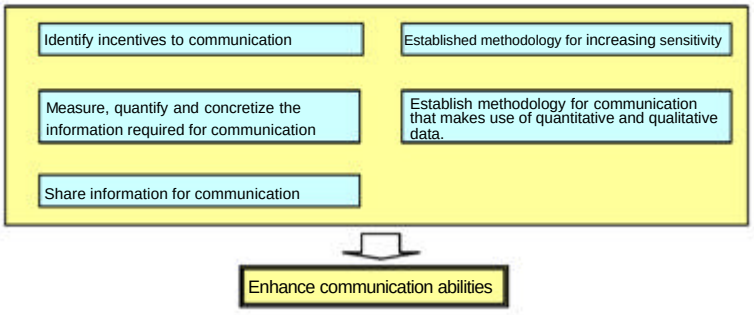
Wants	Concept
I want an effective, precision way to know the status of any health abnormalities in the body.	Being able to measure and visualize in a real time, continuous and noninvasive manner at the level of functions, cells, tissues and genetic materials that are important for monitoring the status of mental and physical health (phenomena), and being able to monitor life functions and status, including the organs and other aspects that have not been monitored to this point will achieve social systems that provide for prevention (early discovery of abnormalities), diagnosis, treatment and follow-up care so as to maintain mental and physical health from day to day.
I want to be able to discover a wide range of health conditions, including lifestyle-related diseases, at an early stage.	
I want to be able to discover a wide range of health conditions, including lifestyle-related diseases, at an early stage.	
I want an integrated system from identification to treatment.	
I want to be able to quickly transmit and store large volumes of biodata.	
I need to quantify and process large volumes of data in a short period of time.	
I want to achieve safe good environments and dietary habits for the general public.	The use of optics to accurately measure the qualitative status of food, its safety, quality (freshness, flavor) and degree of activity, and use of optics to analyze the status of food at the production, processing, distribution and home levels will make it possible to present information that will ensure that people eat safely and with peace of mind, enriching the dietary environment and improving the quality of life.
I want to use optical technology to quickly detect the degree of risk from food and microorganisms that could damage health.	
I want to be able to quickly and accurately measure and evaluate the safety and security of food materials at the supply points.	
I want traceability mechanisms that cover the entire range of food production, processing and distribution and retailing etc.	
I want a nondestructive way to measure the flavor, freshness and time to eat food so that food tastes better.	
I want people with allergies to be able to know the influence of food materials in advance.	

Case study: Sample conceptualization (nano/bio case)

It is essential for "human beings" to achieve smooth communication with themselves, with others and with the outside world (phenomena, environment) so as to behave in an appropriate manner and maintain and increase physical and mental health as a social animal.

To do this, it is necessary to establish methods to recognize oneself, others in the external world, improve sensitivity and enhance communication based on both quantitative and qualitative data.

Basic concepts



Words in boxes came from the list of wants developed in the 1st study group .

(4) Prioritization and selection of concepts

(1) Preparations by secretariat ? (2) Listing up of "wants" ? (3) Conceptual-ization ? **(4)Prioritization and selection of concepts**

There will likely be many concepts brought forward. While it may be possible to discuss all of the concepts, it will probably be more effective to focus on important concepts, which requires that concepts be prioritized in some manner.

(Point)

Below are two strategies for prioritizing concepts. The first is to "vote" so as to understand the general will of the participants. Another is to establish criteria like "degree of innovation" or "degree of novelty," and to study individual concept proposals using an evaluation matrix like the one shown below. Obviously, there could also be other matrixes use to evaluate concepts, for example urgency or size of envisioned market. Matrixes should be chosen according to the themes and purposes of inter-disciplinary technology convergence.

Sample concept evaluation table

	Convergence potential	Novelty	Consistency with theme	Priority
Concept 1	?	-	◎	2
Concept 2	?	-	?	3
Concept 3	?	◎	?	1
Concept 4	?	-	-	4

Key: ◎⇒ Best, ?⇒ Good, -⇒ Ordinary

(See Annex 2 for sample formats)

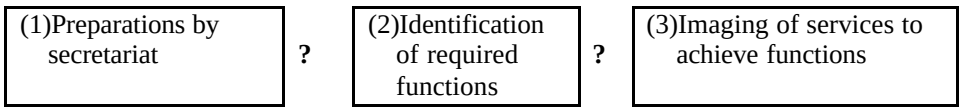
To evaluate innovation and novelty, we used the future market etc. documentation in the "Strategic Technology Roadmap" created by the Ministry of Economy, Trade and Industry and New Energy and Industrial Technology Development Organization (NEDO). This information can be found on the website. The website of the New Energy and Industrial Technology Development Organization also contains a search system for the "Strategic Technology Roadmap," and during the workshop it was possible to use Internet connections so that studies proceeded more flexibly.

http://www.meti.go.jp/press/20,070,423,006/20,070,423,006.html
http://www.nedo.go.jp/roadmap/index.html
http://www.aist.go.jp/aist_j/press_release/pr2007/pr20,070,315/pr20,070,315.html

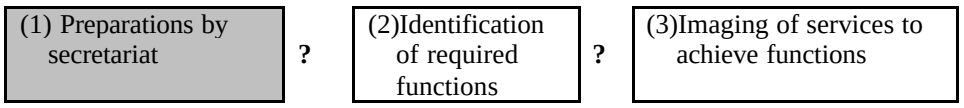
5. Workshop 2

The objective for Workshop 2 is to identify the "functions" that will achieve concepts and create an overall vision of the services to be achieved. Workshop 2 works from the "concepts" created in Workshop 1 to organize the tasks necessary for their realization. It also identifies and organizes the functions that will achieve wants and concepts. Finally, based on this, it presents an image of the overall system of services that will realize the goal, encompassing all of the functions that are required.

Workshop 2 actions



(1) Preparations by secretariat



1) Summation of Workshop 1

Workshop 2 begins with a confirmation of the results from Workshop 1. This requires that the secretariat accurately summarize the course of discussions in Workshop 1 and present them in advance to participants.

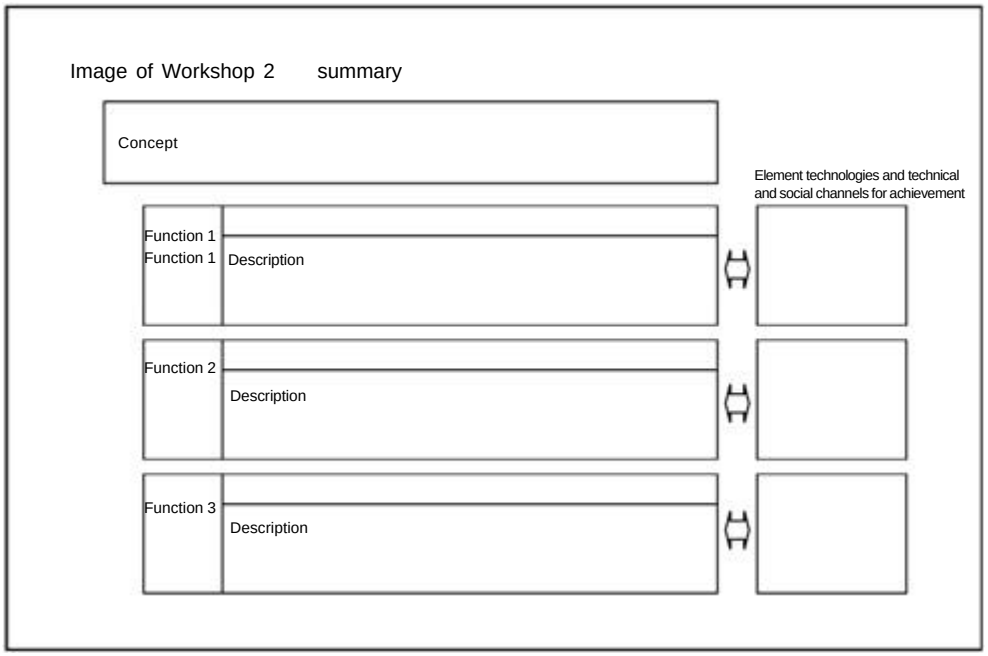
2) Format to identify correspondences between concepts and functions

The most important task for Workshop 2 is to clarify the relationship between concepts and the functions that support them. An effective way to do this is to present participants with a "Concept/Function Correspondence Sheet" (see format below) that lays out a framework for discussion in advance. Use of this format can help not only to clarify the relationship between functions and element technologies, but in many cases will assist in sorting out confused concepts.

When preparing the format, it is important to allow organization of the element technologies to achieve concepts, the technology tasks to be addressed and the social channels by which this will take place. Having this in place will facilitate progress in the next step. See the following case study for a specific example. There is also a collection of sample formats at the end of this document.

If possible, participants should be furnished with this format prior to Workshop 2 and asked to fill it in. This will help discussions to proceed more efficiently. The final decision on how much preparatory work to ask for will depend upon the scheduling.

Format providing framework for discussions in Workshop 2
-- Concept/Function Correspondence Sheet --



(See Annex 2 for sample formats)

(2) Identification of required functions

(1)Preparations by secretariat **?** (2)Identification of required functions **?** (3)Imaging of services to achieve functions

The first step is to identify the functions required to achieve the "concepts" that organized the "wants" brought out in Workshop 1. This requires identifying, from a functional perspective, what is required to achieve the items in the list. Directions for future development will become clearer if, in the process of doing this, participants also write down any other points they become aware of with respect to functions, for example, social mechanisms or technical issues that will be bottlenecks in their achievement.

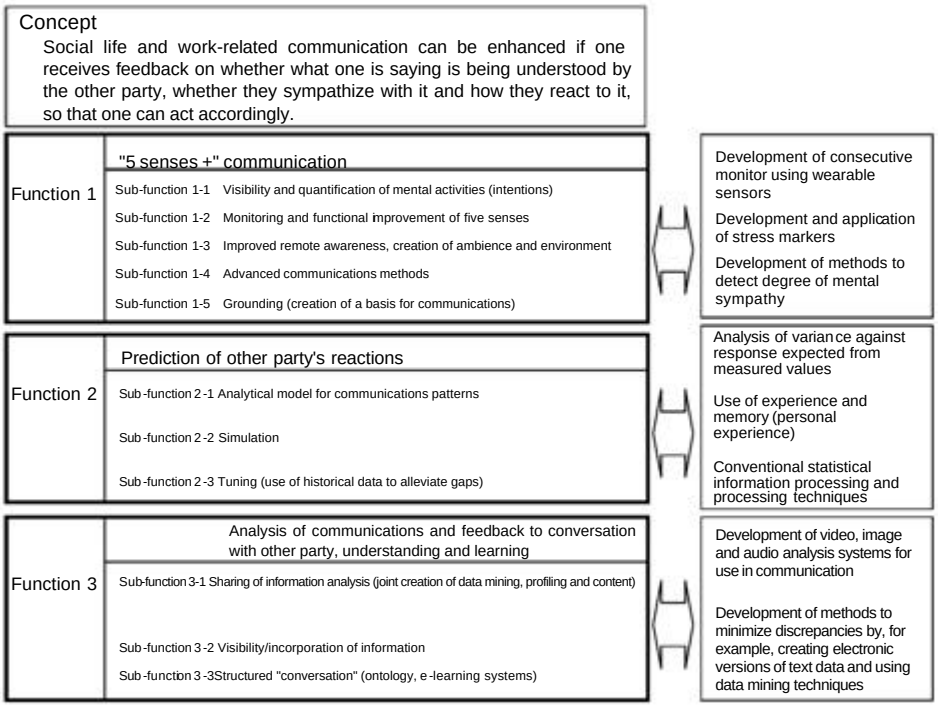
Case study: Identification of functions
Optical molecular imaging case

Concept

The use of optics to accurately measure the qualitative status of food, its safety, quality (freshness, flavor) and degree of activity, and use of optics to easily analyze the status of food in the home will make it possible to present information that will ensure that people eat safely and with peace of mind, enriching the dietary environment and improving the quality of life.

		Element technologies and technical and social channels for achievement
Function 1	**Sensing functions** Function to use light reflection or absorption to identify the presence of specific materials or microorganisms and detect their volume and number etc. according to the relevant date and while not modifying the food materials in any way	・Food Sanitation stipulates public testing and evaluation methods ・Elucidate with sensing principles
Function 2	**Analysis and quantification functions** Function to analyze and quantify the content of substances measured with sensing functions	・Elucidation of the principles related to the cause-and-effect relationship with the materials subject to sensing
Function 3	**Judgment and information-provision functions** Functions able to use quantified substance content to quickly and accurately capture, judge and evaluate the status of food safety according to specific purposes, make judgments and furnish results in an easily understood manner	・Elucidation of the principles behind human senses of taste and flavor ・Creation of traceability mechanisms
Function 4	**Control functions** Effective control functions for safety (for example, disinfection when warranted by the status of materials), functions to maintain the freshness and flavor of food	Japan does not allow irradiation of fresh foods ⇒Institutional issues

Nano/bio case



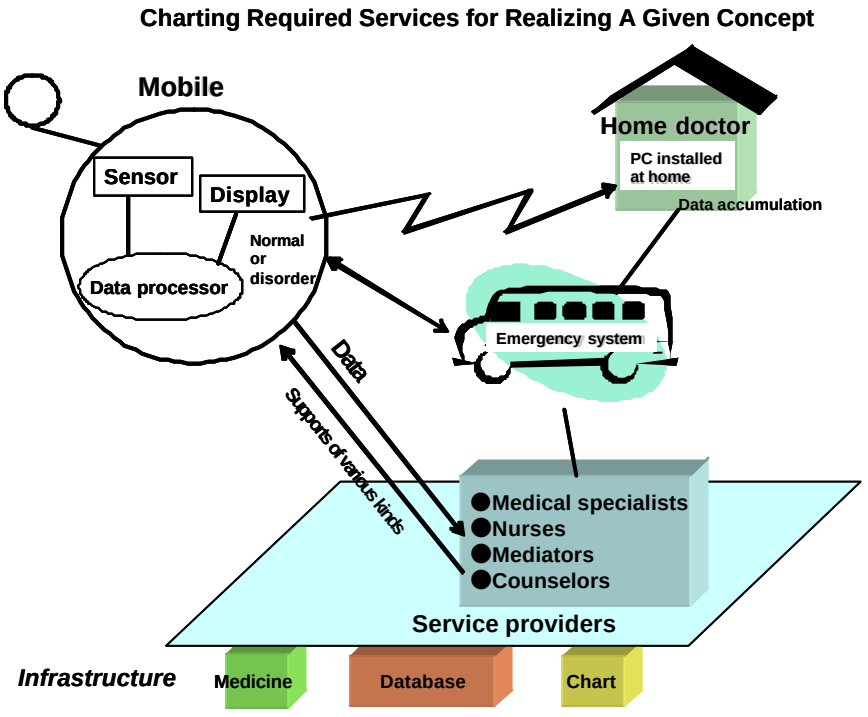
(3) Imaging of services to achieve functions (Schematic)

(1)Preparations by secretariat	?	(2)Identification of required functions	?	(3)Imaging of services to achieve functions

Schematics are created to aid understanding of the interrelationships among the functions that will achieve concepts. In some cases, it may be beneficial to list up the services that will achieve concepts and schematize an overall structure of services. Participants will develop more solid awarenesses and discussion will be more vigorous if the image diagram is as concrete as possible.

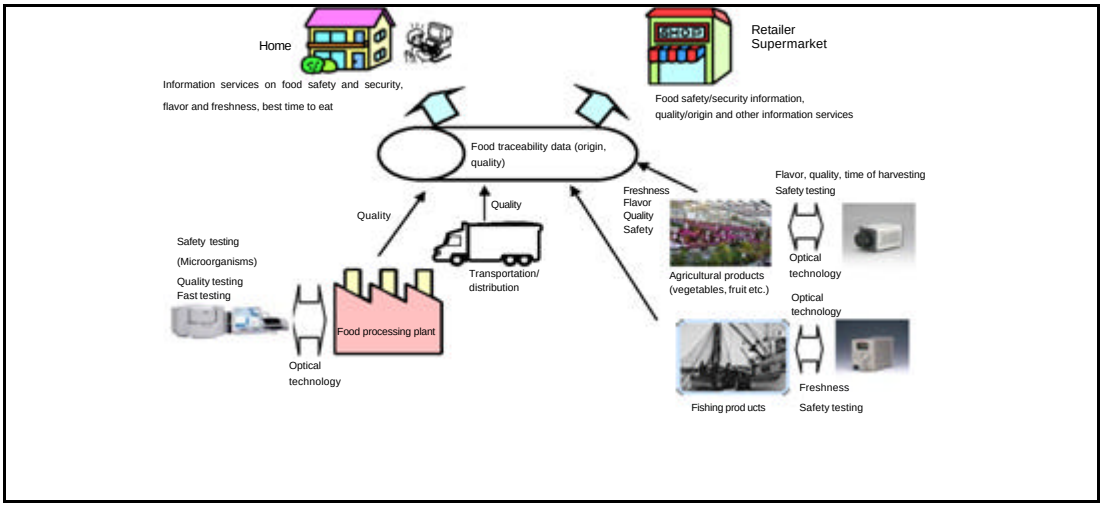
Case study: Sample schematic of services to achieve concepts ("prevention and treatment of lifestyle related diseases")

The study began by categorizing the elements required to achieve concepts the perspective of "services." Services thought necessary were listed up and placed into broad categories in order to schematized the overall structure of services.



Case study: Study of system schematic for achievement of functions (optical molecular imaging)

The study group organized the functions required to achieve the concept (application to food analysis) from the perspective of services and developed a general system schematic.


Home
Retailer
Supermarket
Information services on food safety and security, flavor and freshness, best time to eat
Food safety/security information, quality/origin and other information services
Food traceability data (origin, quality)
Flavor, quality, time of harvesting
Safety testing
Freshness
Flavor
Quality
Safety
Quality
Quality
Safety testing
(Microorganisms)
Quality testing
Fast testing
Transportation/ distribution
Optical technology
Agricultural products (vegetables, fruit etc.)
Optical technology
Optical technology
Food processing plant
Optical technology
Fishing prod ucts
Freshness
Safety testing

6. Workshop 3

The objective for Workshop 3 is to identify the element technologies that correspond to functions and discuss their current status and limitations. The first step is to list up the element technologies required to achieve the functions identified in Workshop 2. At the same time the image of systems to achieve concepts discussed in Workshop 1 and 2 are expressed in the form of a diagram using the element technologies. This provides the basis for a discussion of the current levels of required element technologies and their limitations.

Workshop 3 actions

(1) Preparations by secretariat **?** (2) Listing of element technologies **?** (3)Creation of diagrams to illustrate the overall system **?** (4)Investigation of the status and limits of element technologies

(1) Preparations by secretariat

(1)Preparations by secretariat → (2)Listing of element technologies → (3)Creation of diagrams to illustrate the overall system → (4)Investigation of the status and limits of element technologies

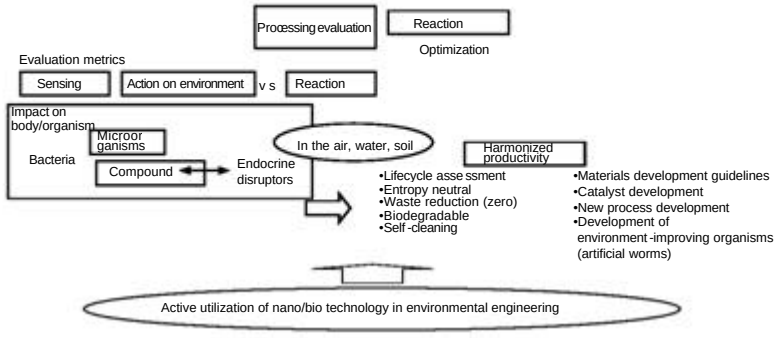
1) Summarize the results of Workshop 1 and 2 and send them to participants

It will be effective if the secretariat provides the following kinds of support for Workshop 3.

① Summarize the proceedings and conclusions of Workshop 1 and 2 and send them to participants in advance of Workshop 3. You should include matters that were not fully discussed in Workshop 2, for example, the creation of system diagrams.

Case study: Diagram of results summary from 1st day distributed to participants (nano/bio)

In the nano/bio case, the secretariat prepared the following diagram and sent it to participants after the conclusion of the 1st day.



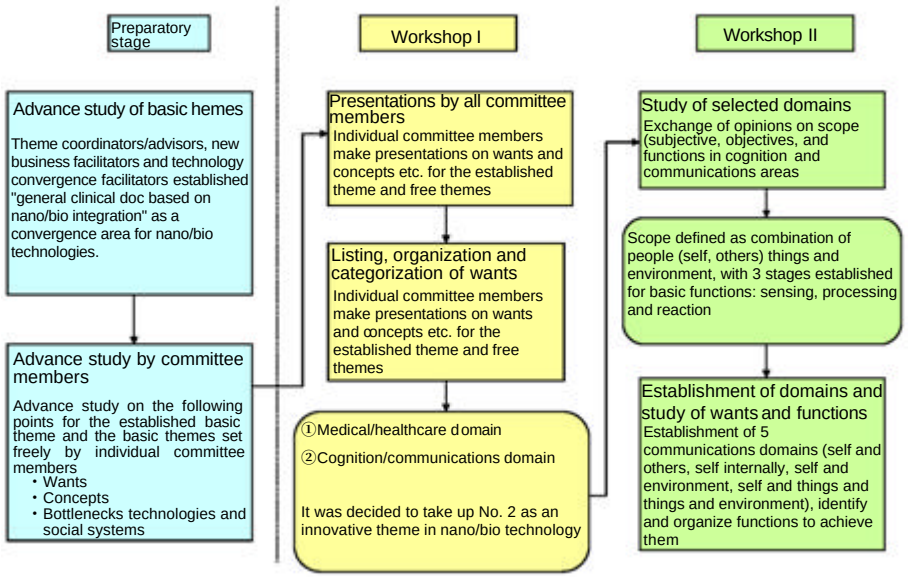
② By confirming the course of discussions in Workshop 1 and 2 and the results so far, it is possible to

establish a starting point for Workshop 3 and develop a shared understanding among participants. This will be effective in sustaining participants' motivation.

Case study: Workshop 1 and 2 interim documents distributed to participants (nano/bio)

In the nano/bio case, after the 1st day finished, the secretariat created a diagram of the proceedings (see below) and sent it to participants in advance.

Flow of studies in the 1st study group (February 13)

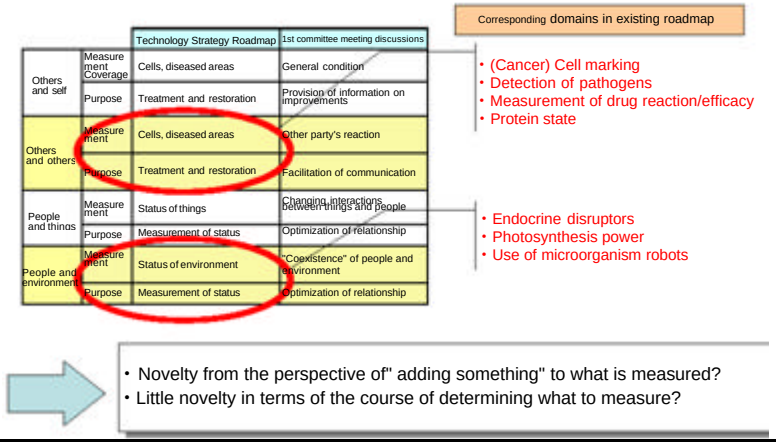


2) Discussion and verification of novelty

Workshops 3 is based on the findings from Workshop 1 and 2, but there is little to be gained by proceeding with discussions beyond this point if the concepts and functions lack novelty. If innovation and novelty or not fully discussed in the previous workshops, the 'Strategic Technology Roadmap" should be used by the secretariat to confirm innovation and novelty as part of its support services. If similar projects are identified, it will be necessary to guide the organization in new directions.

Case study: Documents used by the secretariat to verify the novelty of concepts

In the nano/bio case, the secretariat studied the novelty of concepts etc. and summarized its findings in documents such as that shown below.



3) Securing enough participants for discussion

It is conceivable that, depending upon the concepts and functions that are arrived at in Workshop 1 and 2, it may be difficult to discuss roadmapping only with the members who have participated so far. In such cases, it will be important to identify researchers and experts who are well-versed in the domains and solicit their participation as core seeds researchers etc.

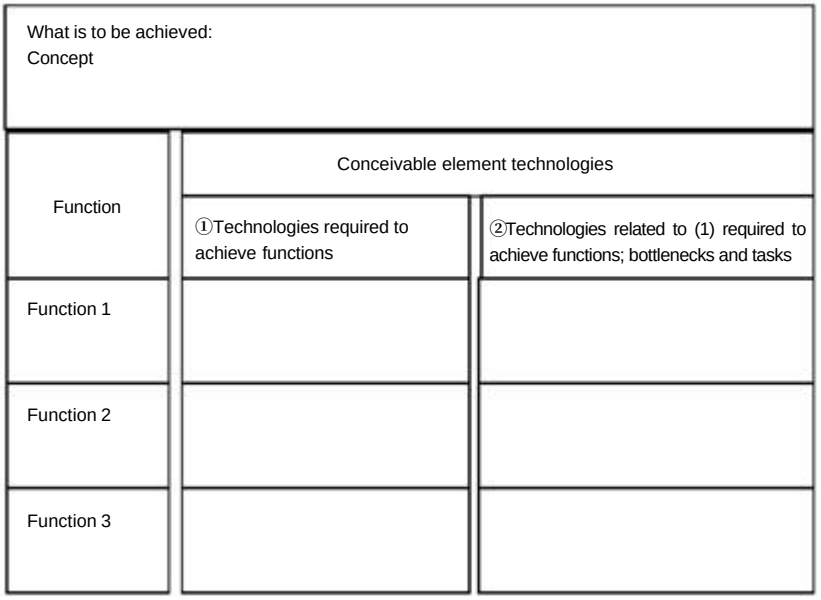
4) Briefing documents on discussion procedures in the workshop

For Workshop 3 to proceed effectively, it is important that all participants have a good understanding of the workshop's content, objectives and procedures for organizing discussion points. This will require preparations on the part of the secretariat by meeting with coordinators and facilitators and preparing forms to be used in the identification and organization development technologies.

5) Arrangement for preparations by workshop participants

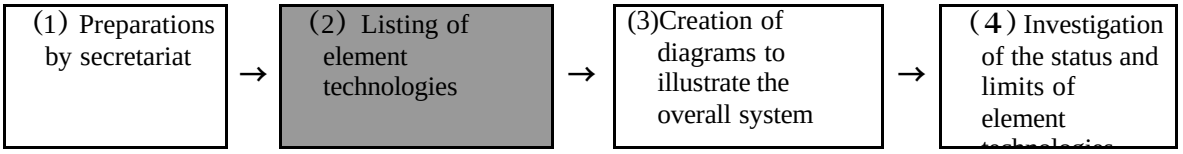
It is important that the coordinators and facilitators first need to determine the content of presentations and discussions in Workshop 3. Having done so, it will be effective to ask all participants to do preparatory work along the lines determined and to arrange for them to make individual presentations at the beginning of the workshop.

Sample preparatory work form for the identification of element technologies



(See Annex 2 for sample formats)

(2) Listing of element technologies



Create a list of element technologies to achieve concepts based on the functions identified in Workshop 2. There may be some element technologies already in existence and some that will need to be created in the future. It is necessary to accurately identify both groups.

(Point 1)

Beginning with Workshop 3 there will be opportunities for full participation by core seeds researchers. In creating in this development technologies, is necessary to identify future technologies for issues that cannot be resolved with current technology. In doing this, an effort should be made to avoid expressions like "technology able to achieve _____" or "technology that makes _____ possible." Descriptions such as these merely create technology "black boxes" and do not show how issues can be technically resolved. Instead, descriptions should contain as detailed a breakdown is possible of the specific element technologies that will be key to the solution. Indeed, success hinges upon how much insight can be brought to bear at this point and what sorts of new ideas are identified.

(Point 2)

In listing up element technologies, thought should be given to the relationship to the ones that form the foundation of concepts, which will enable a systematic consideration of how to proceed while reorganizing functions and wants. This will also identify areas where technology convergence is required. One effective way to do this is for the discussion to create a matrix showing the

correspondence between wants and functions.

Case study: Sample documentation prepared by committee members to facilitate the creation of an element technology last

In the nano/bio case, we studied element technologies corresponding to concepts and functions by following a prepared format. By giving consideration to the technology bottlenecks and and issues to be overcome in order to achieve element technologies, we were able to enter the next that smoothly.

Examples of specific questions studied (presentations by participants in the nano/bio case)

Concept:
Social life and work-related communication can be enhanced if one receives feedback on whether what one is saying is being understood by the other party, whether they sympathize with it and how they react to it, so that one can act accordingly.

	Function	Conceivable element technologies
Sensing	①Technology to sense and quantify phenomenon necessary for the achievement of functions: temperature, humidity, audio (background music, noise), smell (offensive odors, aromas), physical condition, stress etc.	②Technologies related to (1) required to achieve functions; bottlenecks and tasks: Example 1: Constant monitoring using wearable sensors to monitor ordinary physical conditions. Example 2: Stress markers・Lipid peroxidation and 8-OHdG value・D-ßaspartic acid etc.・Difficulty quantifying active oxygen in brats (see attached documents). How to detect? Detection of mental sympathy
Processing	Use of data on personal experiences etc. to analyze variances between responses expected from measurements and actual responses, so as to evaluate degree of understanding and reaction and offer appropriate responses.	New processing in addition to conventional statistical information processing; Example: data mining; oncology; how to incorporate past experiences and memories?
Reaction	Immediate determination of methods to minimize variances based on computerized text data and data mining, and change communications methods according to the responses indicated.	

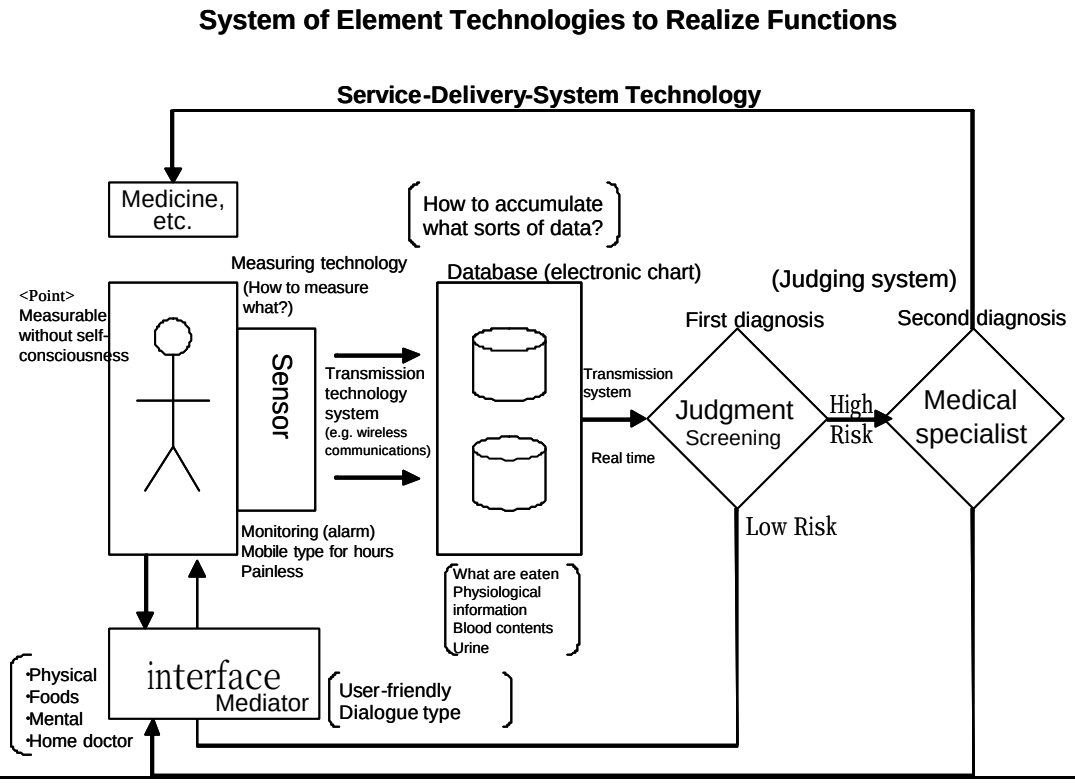
(3) Creation of diagrams to illustrate the overall system

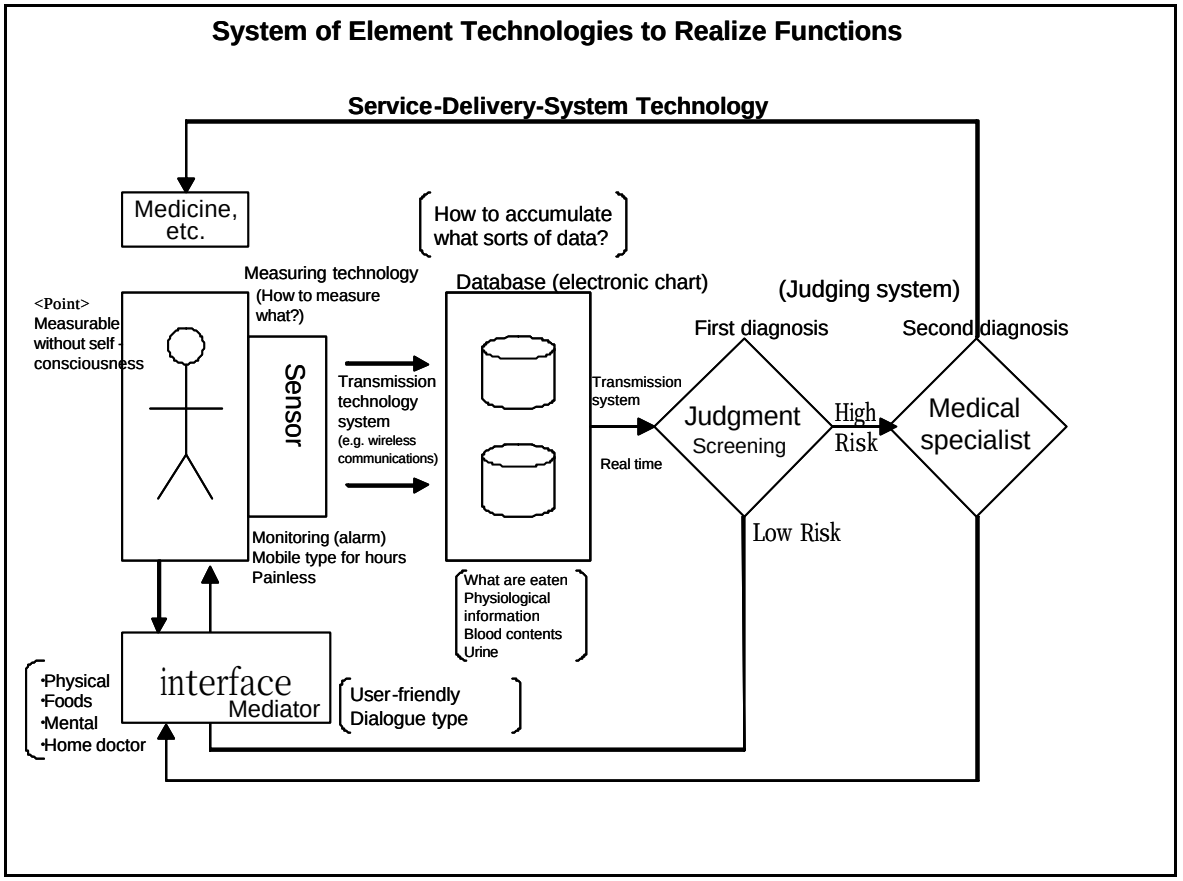
(1) Preparations by secretariat → (2) Listing of element technologies → (3) Creation of diagrams to illustrate the overall system → (4) Investigation of the status and limits of element technologies

The ultimate objective is to realize concepts, and to do this it is necessary to create an image of the system with a diagram of how element technologies will be integrated. The diagram should systematically show the element technologies that will achieve functions. Creation of the diagram will enable confirmation that no necessary element technologies have been left out. This is also an important preparation for the mapping process and Workshop 4.

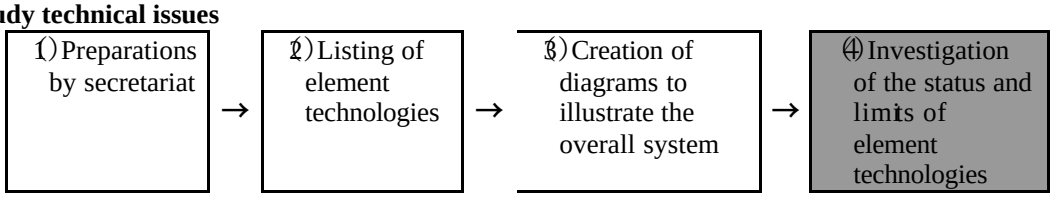
Case study: Sample diagram of element technology ("prevention and treatment of lifestyle-related diseases")

At Workshop 3, METI imaged a system to realize the concept and prepared its diagram as follows:





(4) Study technical issues



Discovering new ways to achieve concepts requires that he necessary element technologies be organized and specific, concrete discussions the hell of current technology levels and limitations or each individual element technology.

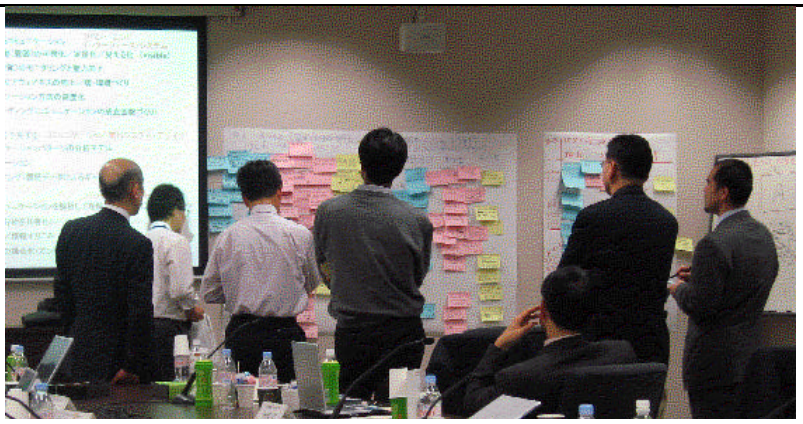
Case Example:

In the "prevention and treatment of lifestyle-related diseases" case, we discussed the following technology levels and limitations.

Themes/functions, etc.

Present technology levels and limits

Themes/functions, etc.		Present technology levels and limits
Mediator	Dialogue type	Wearable type not available yet.
		All responses cannot be automated.
		Battery, communications
		Not receivable with mobile phone
		Sensors to be made wearable
		Voice recognition, voice response
	Mobile for hours	Continuous accumulation of sensing data
		Automated judgment
		Communications
	Non-invasion	Sensing
		Physical sensor (Optical-system sensor)
		Spectrometer
		Biochemical sensor
		MRI
		Electric physiological measurement Built-in type (energy source: decomposed glucose within a body)
		Behavior analysis
		Voice/behavior records
		Image analysis



7. Workshop 4

Workshop 4 is the final stage of roadmapping. This workshop uses the findings from Workshops 1-3 to review the concepts and functions/property cause-effect relationships before organizing element technologies along a time axis to create a roadmap. The key questions are how to break through the current status and challenges identified for element technologies in Workshop 3 and what the potential is for technology convergence from the perspective of what is required to achieve future technologies. The results of roadmapping are announced and are shared by all participants.

Workshop 4 actions

(1)Preparations by secretariat	?	(2)Investigation of potential for convergence of inter-disciplinary technologies	?	(3)Announcement of results and sharing among participants

(1) Preparations by secretariat

(1)Preparations by secretariat	?	(2)Investigation of potential for convergence of inter-disciplinary technologies	?	(3)Announcement of results and sharing among participants

1) Development of shared output image

Workshop 4 begins by confirming the results of Workshop 3. It is necessary at this point to ensure that participants share a common starting point. Workshop 4 is also the time for producing final results. Thus, it is important that participants understand in advance the content of Workshop 4 and the output image. To facilitate this, the secretariat summarizes results in advance and creates and distributes documents explaining the output image.

Summary of element technology and relationships along a time axis (optical molecular imaging)

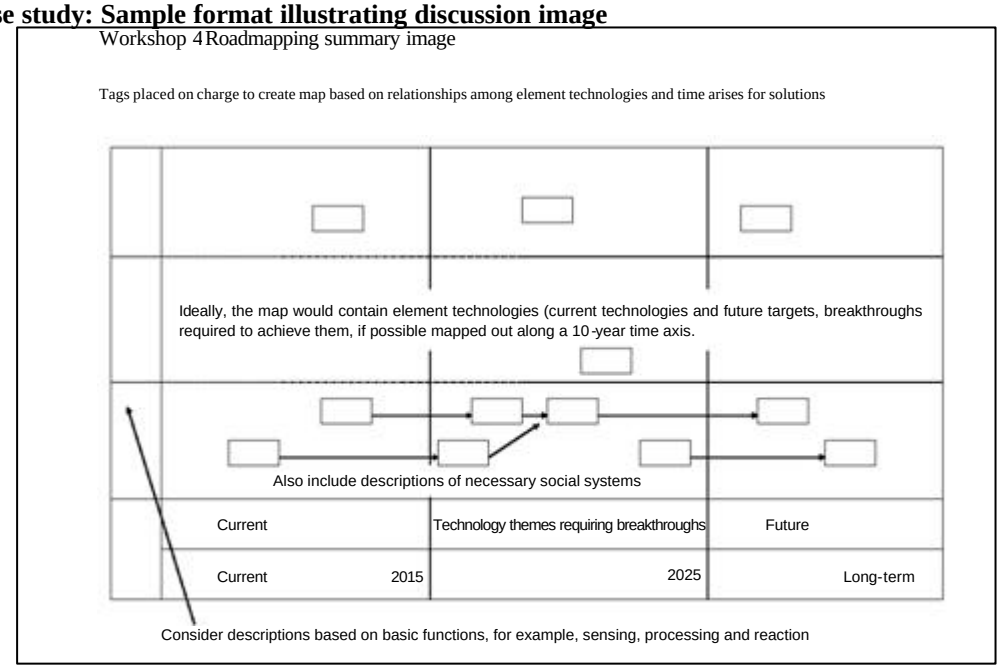
(Point)

A good way to ensure that participants have the proper image of a road map is to provide them with an existing roadmap as reference. The 'Strategic Technology Roadmap" will be helpful in this

context.

Another effective strategy is for the secretariat to create a template. In the case study, we created a summary image as a roadmap (see below) and presented it at the beginning of Workshop 4.

Case study: Sample format illustrating discussion image



2) Preparing for tag-based roadmapping

In identifying and summarizing element technologies, it is important to investigate the use of tags and other techniques. We recommend using 2 or 3 different colors of tags to differentiate between current technologies, a future technology targets and impediments to be overcome and breakthroughs to be made in order to achieve them. If possible, the secretariat, coordinator and facilitator should, with the guidance of the adviser, rehearse their use.

Case study: Image out how tags are used to identify element technologies and their relationships

(Nano/bio case)

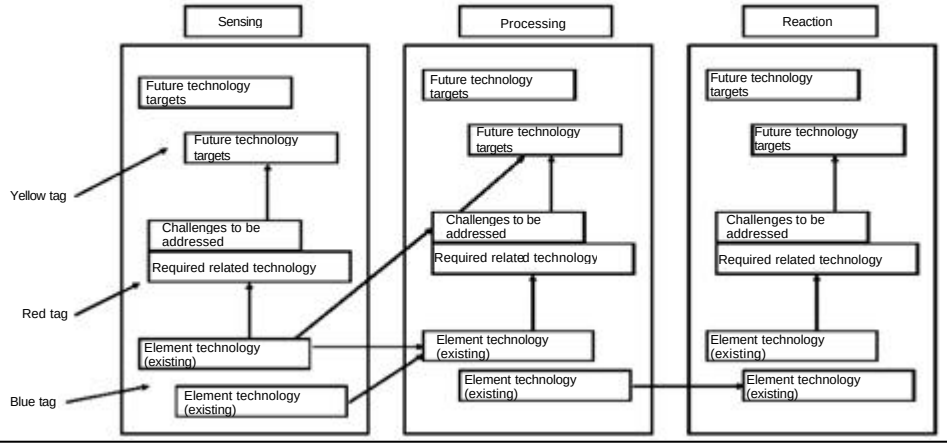
For the study group, we created the following documentation and used 3 different colors of tag to move the discussion forward.

Identify and list up the element technologies comprising the individual functions that have already been broken down. Determine the overall position of each technology and its relationship with other technologies.

Avoid descriptions like "technology to achieve _____." Rather, write the names of specific element technologies.

1) Currently available technology --> Blue tag 2) Future target --> Yellow tag 3) Required breakthroughs and related technologies? Red tag

Writing out the element technologies in this manner clarifies the domains for inter-disciplinary technology convergence.



(2) Investigation of potential for convergence of inter-disciplinary technologies

(1)Preparations by secretariat	?	(2)Investigation of potential for convergence of inter-disciplinary technologies	?	(3)Announcement of results and sharing among participants

Discussion of how to achieve the integrated systems created in Workshop 3 will generate new ideas about the convergence of inter-disciplinary technologies. More specifically, this workshop takes the element technologies, relationships among element technologies and challenges to be addressed in the creation of future technologies that were identified in Workshop 3, considers when they will be achievable, deepens the discussion and organizes them along a time axis.

In particular, the consideration of technologies required in the future must examine how they relate to existing technologies, what the issues are at the current point in time and whether they can be resolved by applying technologies from other sectors. These discussions will provide the stimulus that generates new ideas.

In terms of specific methods for proceeding with the discussion, element technologies are written on

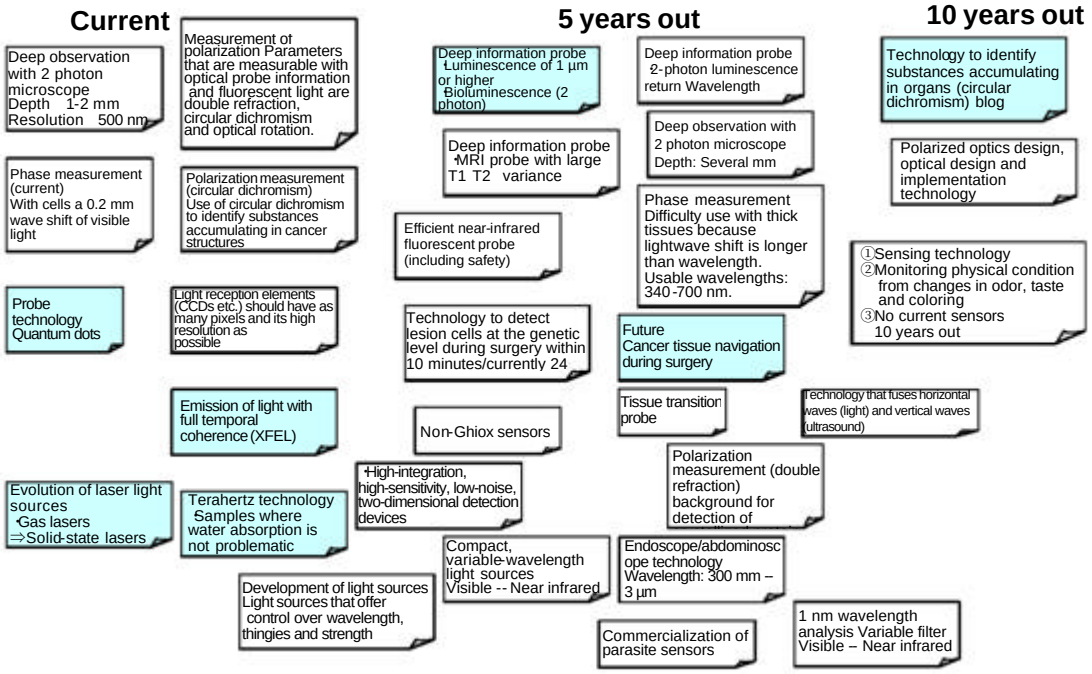
tags (post-its) and placed on a white board etc. At this time multiple tags (post-its) are used to color code currently available element technologies, element technologies that will be required in the future, challenges to be resolved and required relevant technologies etc. During this process, participants may also become aware of new element technologies other than those discussed to that point. When that happens, write the technology on a new post-it and add it to the board. The point is to organize element technologies and the cause-and-effect relationships among element technologies along a time axis.

In doing this, it will be more efficient to use the search system of the "Strategic Technology Roadmap" (see above) to refer to technology trends and relevant domains.

(Point)

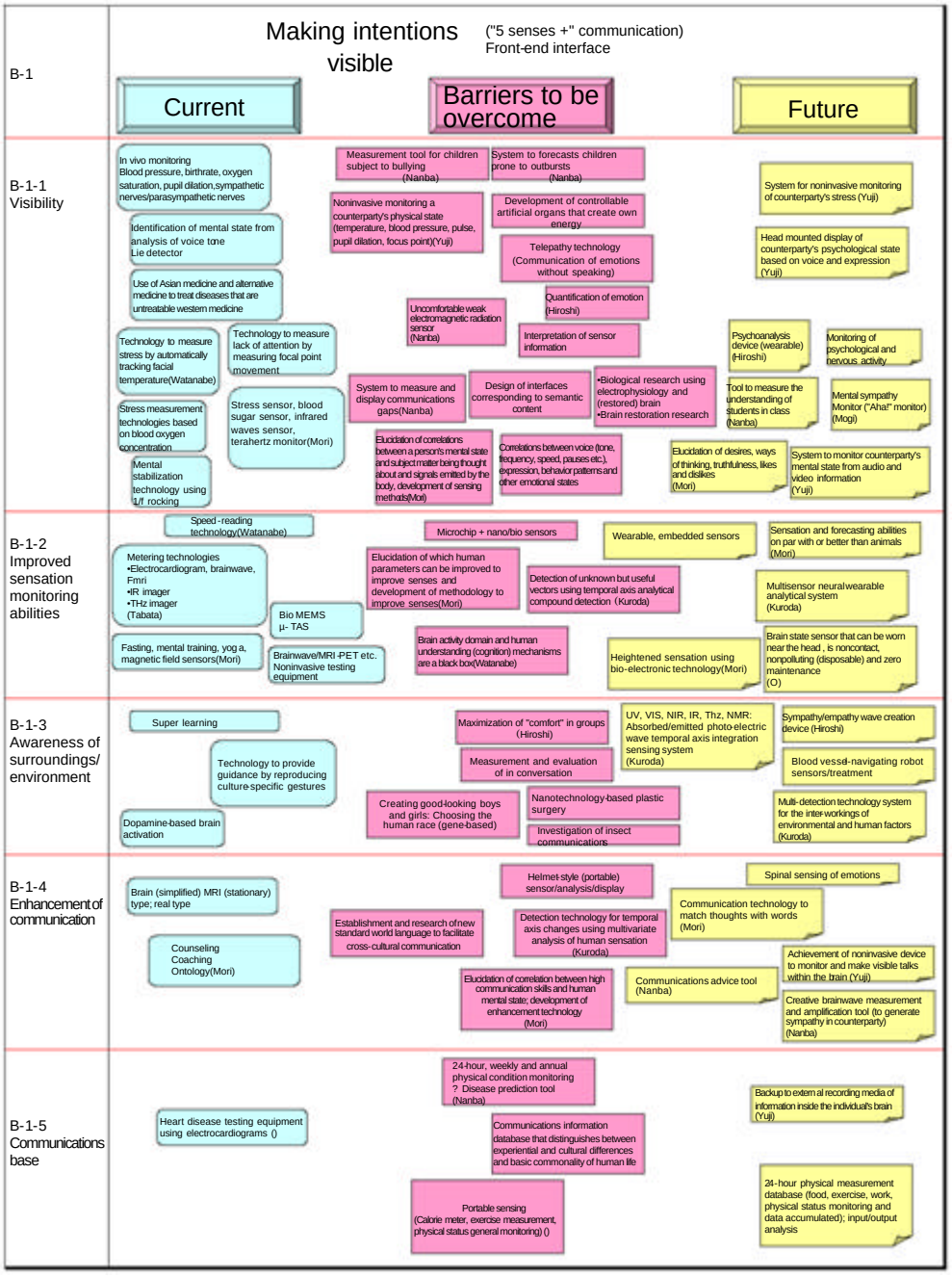
Core seeds researchers with different areas of expertise should be asked to discuss how technologies in their areas of expertise can be used or how they can be combined with technologies from other areas to create the technologies required for the future. What is important here is that core seeds researchers in individual areas use their knowledge of their area of expertise as a basis from which to explain to participants what can and cannot be done. It can often be difficult to explain to someone else why something cannot be done. However, doing this will clarify the points on which technology breakthroughs are required. It may also generate breakthrough ideas from experts in other areas. One effective way to study orientations for technology convergence is to create a matrix that lists element technologies on the horizontal and vertical axes.

Case study: Example of identifying and organizing element technologies (optical molecular imaging)



Case study: Sample results from study of element technologies corresponding to functions

Nano/bio: "5 senses +" communication



(3) Announcement of results and sharing among participants

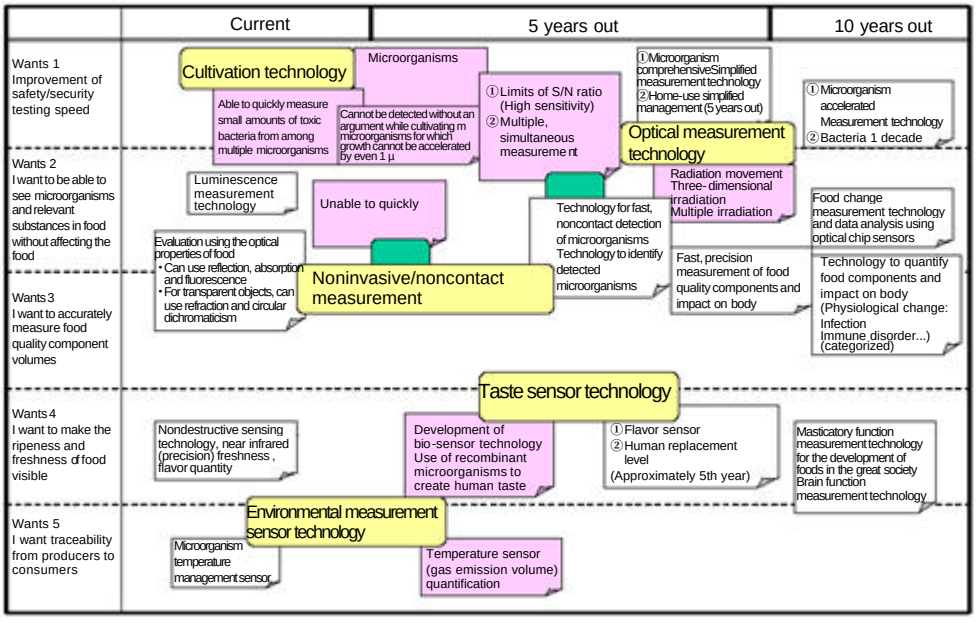
(1)Preparations by secretariat	?	(2)Investigation of potential for convergence of inter-disciplinary technologies	?	(3)Announcement of results and sharing among participants

The results of the roadmapping exercise are summarized and announced, verified by all participants and then shared as collaborative findings.

Announcement of roadmapping results (optical molecular imaging case)

Case study: Roadmapping results

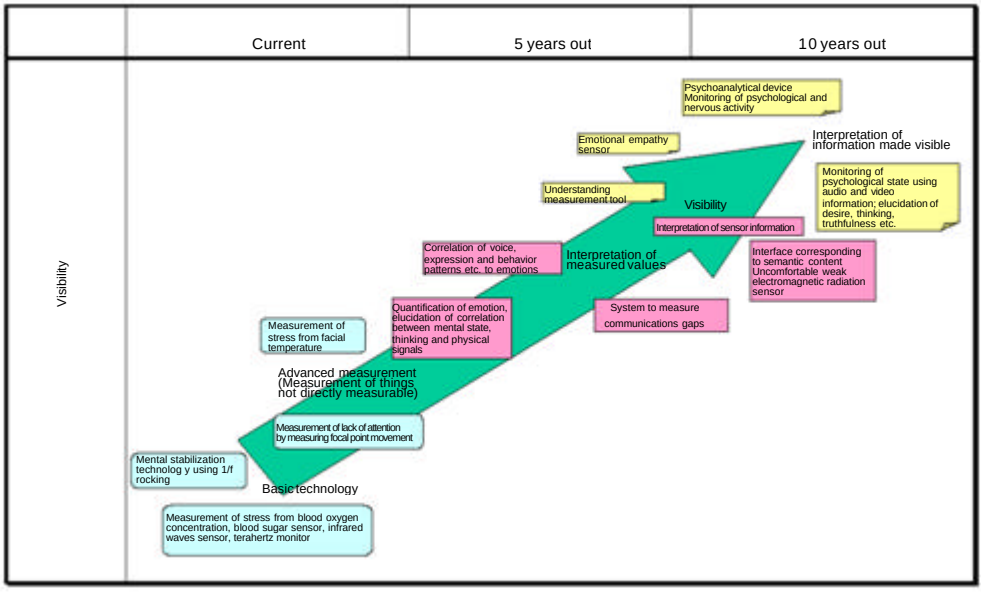
[Sensing functions in optical molecular imaging]



Announcement of roadmapping results (nano/bio case)

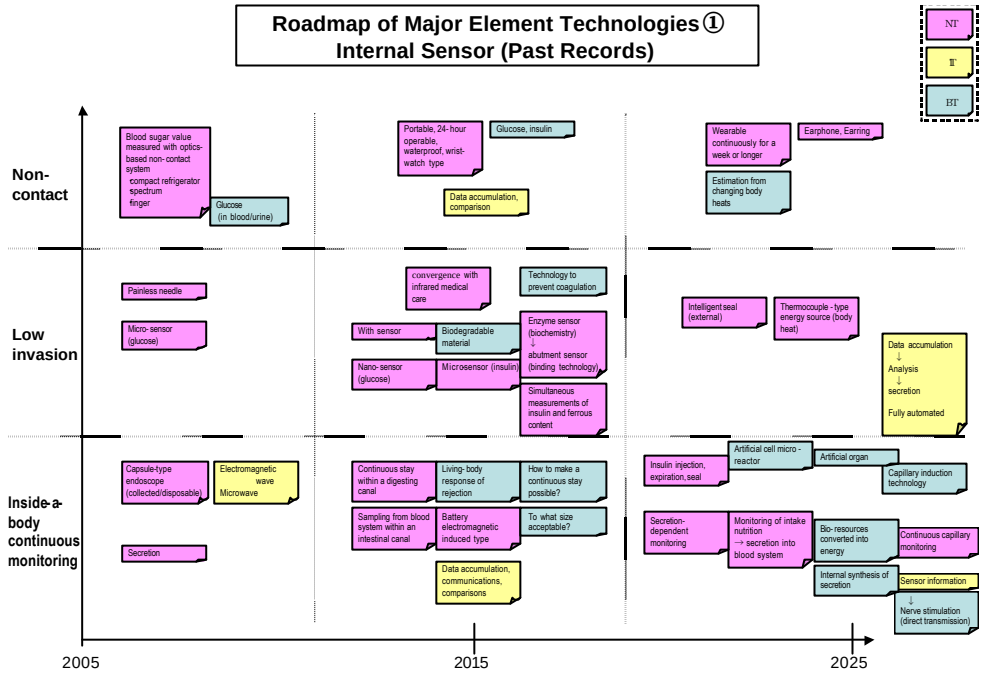
Case study: Roadmapping results

[Developing "visibility" in nano/bio cognition and communications]

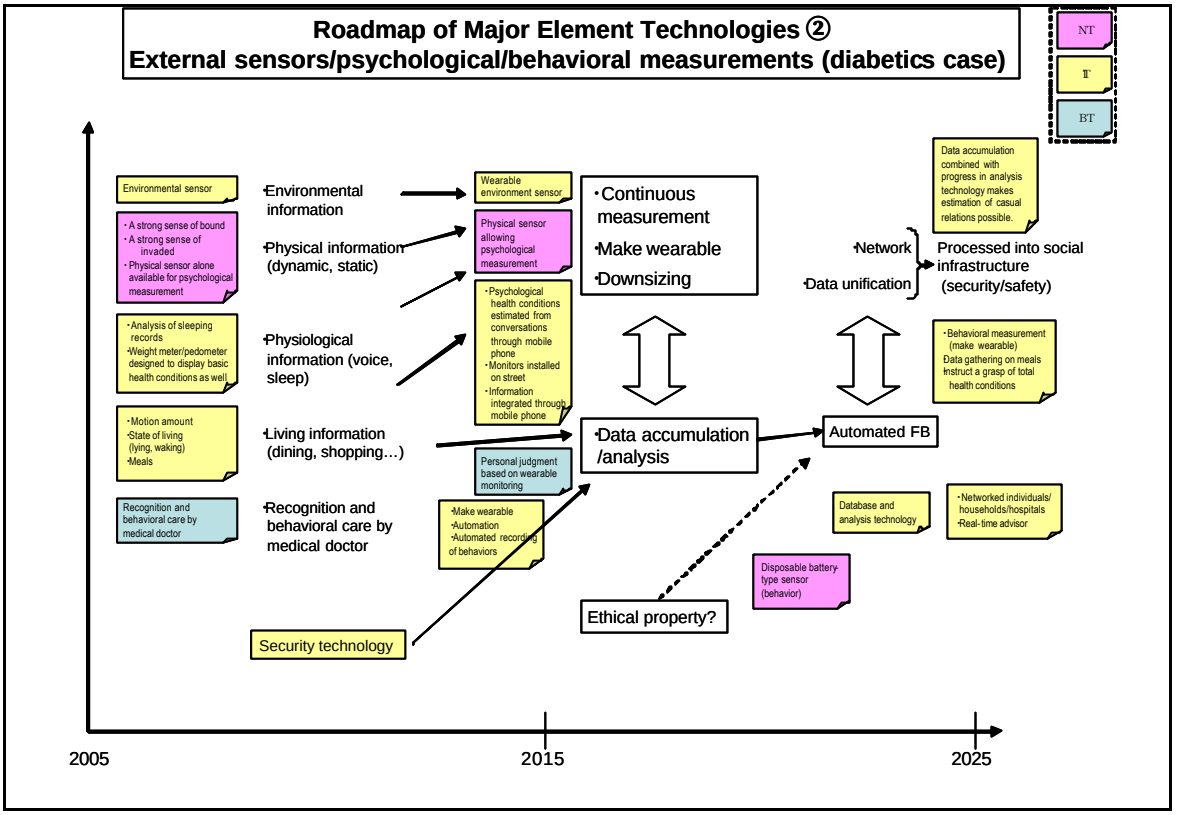


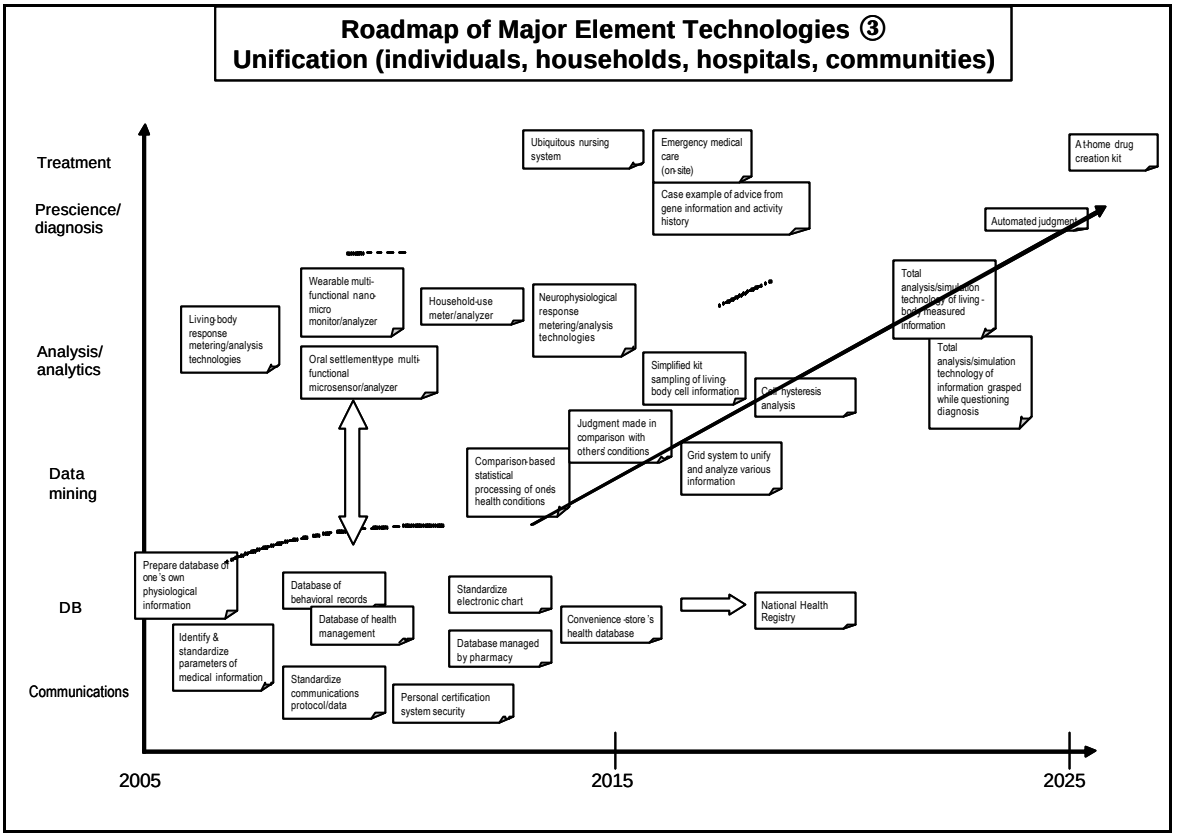
Case study: Roadmapping results [Prevention and treatment of lifestyle-related disease]

Among the element technologies organized at the preceding step, the three of "internal sensor, external sensor and unification" were counted as particularly important and, on each of them, roadmapping was in practice with a rough axis of time introduced from the standpoints of concept-functions/others-element technologies.



12


Roadmap of Major Element Technologies ②
External sensors/psychological/behavioral measurements (diabetics case)
NT
IT
BT
Environmental sensor
・A strong sense of bound
・A strong sense of invaded
・Physical sensor alone available for psychological measurement
・Analysis of sleeping records
・Weight meter/pedometer designed to display basic health conditions as well
・Motion amount
・State of living (lying, waking)
・Meals
Recognition and behavioral care by medical doctor
・Environmental information
・Physical information (dynamic, static)
・Physiological information (voice, sleep)
・Living information (dining, shopping…)
・Recognition and behavioral care by medical doctor
Wearable environment sensor
Physical sensor allowing psychological measurement
・Psychological health conditions estimated from conversations through mobile phone
・Monitors installed on street
・Information integrated through mobile phone
Personal judgment based on wearable monitoring
・Make wearable
・Automation
・Automated recording of behaviors
Security technology
・Continuous measurement
・Make wearable
・Downsizing
・Data accumulation /analysis
Ethical property?
Disposable battery-type sensor (behavior)
Data accumulation combined with progress in analysis technology makes estimation of casual relations possible.
・Network
・Data unification
Processed into social infrastructure (security/safety)
・Behavioral measurement (make wearable)
Data gathering on meals
Instruct a grasp of total health conditions
Automated FB
Database and analysis technology
・Networked individuals/ households/hospitals
・Real-time advisor
2005
2015
2025



Announcement of roadmapping results (prevention and treatment of lifestyle-related disease)

8.Follow-up

After the workshops conclude, the secretariat completes whatever work is necessary, provides feedback to participants and announces the roadmapping results. Participants are surveyed to identify tasks for achieving technology convergence, themes that are considered important for the future, and people wishing to collaborate in heterogeneous sectors. The findings are used to provide follow-up that will facilitate innovation and new business creation in inter-disciplinary convergence.

Action item

(1)Follow-up by secretariat ? (2)Publication of results ? (3)Survey of participants

(1) Follow-up by secretariat

(1)Follow-up by secretariat ? (2)Publication of results ? (3)Survey of participants

There will conceivably be cases when an adequate roadmap could not be created even though the discussions of the Workshop 4 roadmapping session were summarized. In these situations, the secretariat works with the coordinators and facilitators to complete the map, finish the report and feed them back to participants .

(2) Publication of results

(1)Follow-up by secretariat ? (2)Publication of results ? (3)Survey of participants

If the circumstances and time permit, the roadmapping results can also be published to a wider range of interested people to encourage the exchange of information.

(Point)

The roadmapping process is merely the starting point. It must be used as a base from which to assemble a wide range of people, technology seeds, market information and collaborators in order to achieve inter-disciplinary technology convergence. A number of different activities follow on, including creating organizations and raising funds for research, development and commercialization. This requires that results be published to the extent possible so that two-way exchange information can be pursued. If research institutes and companies take the lead in roadmapping, publication of the results within the organization can help to reinvigorate it.

(3) Survey of participants

(1)Follow-up by secretariat ? (2)Publication of results ? (3)Survey of participants

After the workshop concludes, surveyed the participants to get their opinions and impressions. Below are some of the items that could be included.

(See Annex 3)

1. **Opinion/impression of workshops**
   - ? Did it provide an opportunity for technology convergence?

? Which workshops and discussions for the most effective?

2. Issues in achieving the roadmap

? Technology domains in which you would like further discussions aimed at breakthroughs

? Social systems and other conditions to be satisfied in order to achieve technologies

3. Desire to participate in the future

4. Inter-disciplinary technology convergence and themes you would like to see taken up in the future, recommended experts

? Inter-disciplinary technology domains that should be converged

? Proposed themes for discussion

? Recommended expert candidates

(Point)

This manual is meant to be customized as you use it, and it is important to use survey findings to improve workshops.

A key point is to use survey findings to generate new roadmap for inter-disciplinary technology convergence and to accumulate information about human resources.

9. Conclusions

Technology roadmaps are a MOT technique commonly used in companies. The Ministry of Economy, Trade and Industry began to use it as a government research and development management tool in FY 2005 and has created a rolling cycle for the annual "Strategic Technology Roadmap." The FY 2006 version of the Strategic Technology Roadmap covers 24 areas; further expansions are planned for the FY 2007 version. This map identifies important element technologies in heterogeneous technology fields and charts their development from medium and long-term perspectives. Rather than just specific technology areas, the objective is to experiment with the creation of new values by using the accumulation of maps for different technology areas to discover the potential for mutual combinations and convergence.

The Ministry of Economy, Trade and Industry and NEDO created this manual in order to share what they have learned through this process with as many people as possible and to encourage the use of technology roadmapping to achieve inter-disciplinary technology convergence. GPlan Ver. 2.0 is a revision of the original version.

It is expected that these findings will be used by local small and medium enterprises and universities to pool technology resources and create and plan new collaborative ventures and local R&D based development consortia. We look forward to seeing groups experiment with the techniques outlined in this manual. While we are certain that there will be wide variety in the themes that are undertaken, the participants that become involved and the degree to which objectives are achieved, we have made every effort to ensure that this manual can be customized according to individual conditions and circumstances. We will continue to perform case studies and evolve more effective methods, and we look forward to your advice in these efforts.

In conclusion, we would like to express our gratitude to the committee members who participated in the case studies and the staff of NEDO for all of their help and assistance in the creation of this manual.

Editor	Ministry of Economy, Trade and Industry, Industrial Science and Technology Policy and Environment Bureau Planning Officer (Industrial Technology Research and Development Strategy) Masayoshi Watanabe
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Annexes

Annex 1. **C-Plan Overall Progress Management Checklist**

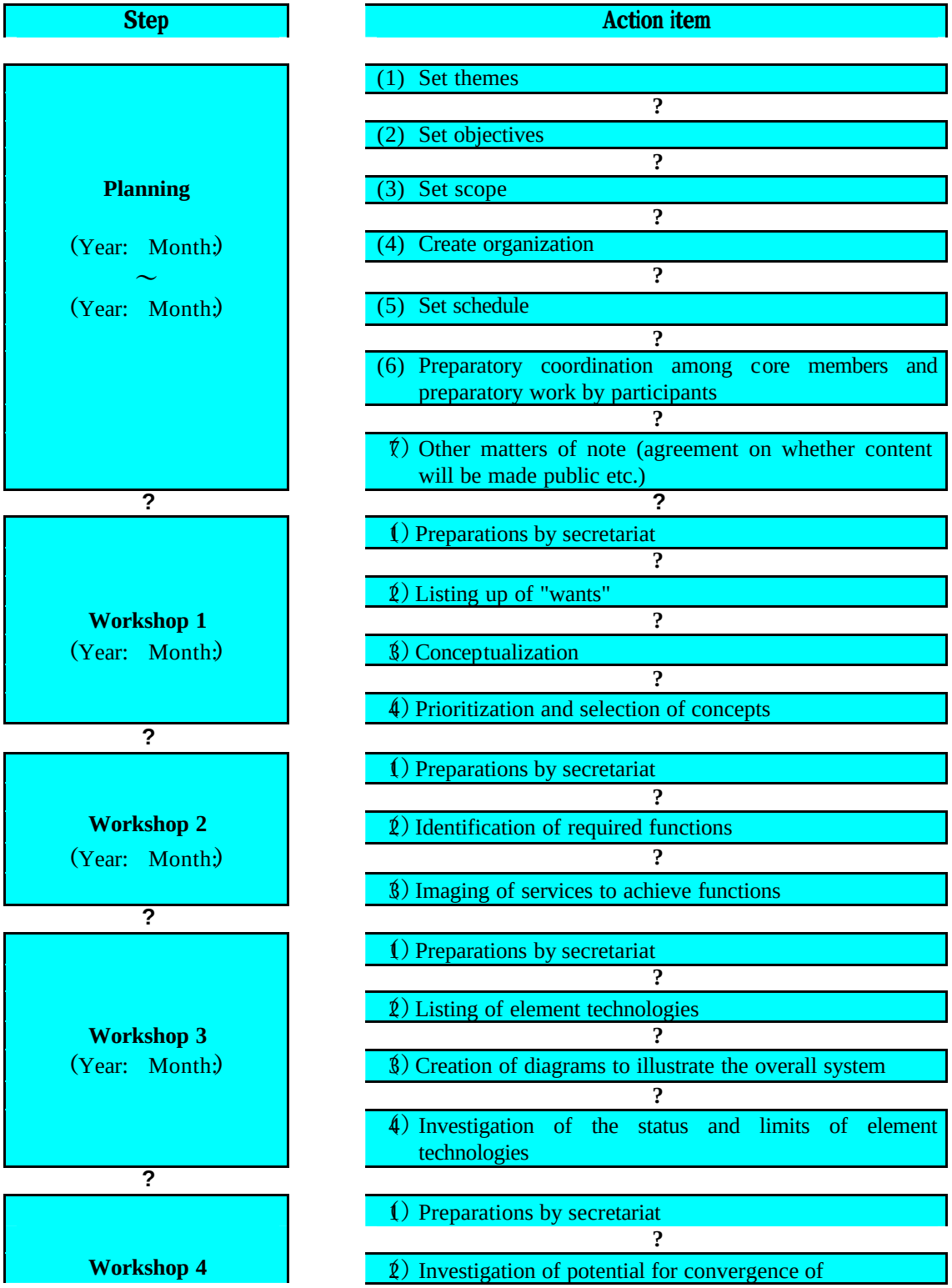
Annex 2. **Reference Formats**

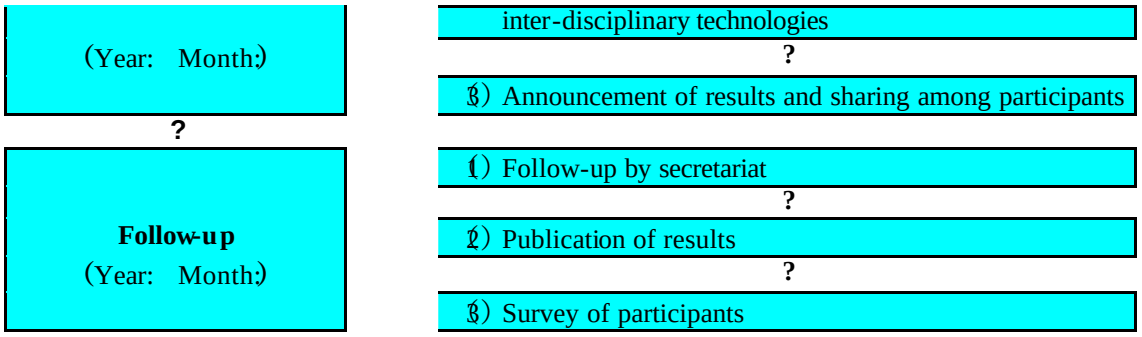
Annex 3. **Nondisclosure Agreement Template**

Annex 4. **Sample Survey Questionnaire**

Annex 1. C-Plan Overall Progress Management Checklist

This checklist is for the management of overall progress from the preparatory stage through the 4 workshops and follow-up. It is meant to be adjusted to your purposes and circumstances.


Step
Action item
Planning
(Year: Month:)
～
(Year: Month:)
(1) Set themes
(2) Set objectives
(3) Set scope
(4) Create organization
(5) Set schedule
(6) Preparatory coordination among core members and preparatory work by participants
(7) Other matters of note (agreement on whether content will be made public etc.)
Workshop 1
(Year: Month:)
(1) Preparations by secretariat
(2) Listing up of "wants"
(3) Conceptualization
(4) Prioritization and selection of concepts
Workshop 2
(Year: Month:)
(1) Preparations by secretariat
(2) Identification of required functions
(3) Imaging of services to achieve functions
Workshop 3
(Year: Month:)
(1) Preparations by secretariat
(2) Listing of element technologies
(3) Creation of diagrams to illustrate the overall system
(4) Investigation of the status and limits of element technologies
Workshop 4
(1) Preparations by secretariat
(2) Investigation of potential for convergence of

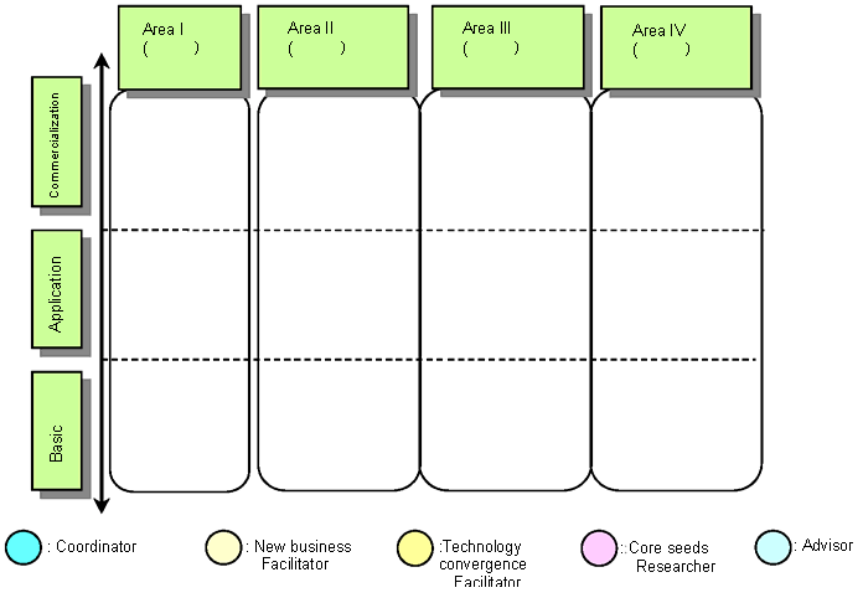

(Year: Month:)
?
Follow-up
(Year: Month:)
inter-disciplinary technologies
?
3) Announcement of results and sharing among participants
1) Follow-up by secretariat
?
2) Publication of results
?
3) Survey of participants

Annex 2. Reference Formats

This section contains samples of the forms used for the secretariat preparations, summaries and advance work in the preparatory stage and 4 workshops.

1. Advance Preparations

Mapping sheet for the selection of members and assignment of roles



Committee member profile

Name	
Role in workshop	
Affiliation	
Academic history	
Recent research Results	
Recent research Results	

* Please attach any recent newspaper, magazine or professional journal etc. articles about your work.

Participant presentations in Workshop 1

Name	
Theme/topic	
Wants	Description of values, phenomena, activities, services, products and technological requirements etc. assuming the social conditions envisioned

	for circa 2030
Concept	Description using keywords of the "values" and "services" embodied in wants
Technologies and social systems that are currently lacking for the achievement of the above	Technologies that are lacking and research and development themes etc. on which breakthroughs are required for the achievement of the above wants
	Non-technical requirements (institutions, social systems etc.)

2. Workshop 1 and 2

Wants and concepts summary sheet

Image of Workshop 1 summary

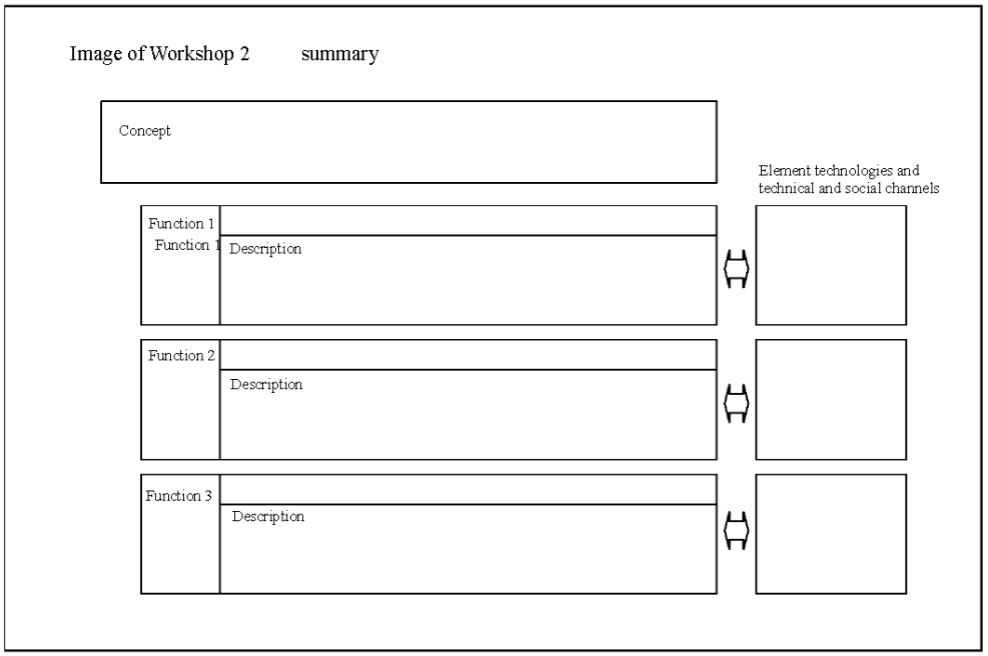
Wants	Concept

Evaluation sheet for concept prioritization

	Convergence potential	Novelty	Consistency with theme	Priority
Concept 1	?	-	◎	2
Concept 2	?	-	?	3
Concept 3	?	◎	?	1
Concept 4	?	-	-	4

Key: ◎⇒ Best, ?⇒ Good, -⇒ Ordinary

Sheet for summarizing concepts and functions required for their achievement



3. Workshop 3 and 4

Sheet for identification of element technologies and Workshop 3

What is to be achieved: Concept		
Function	Conceivable element technologies	
	①Technologies required to achieve functions	②Technologies related to (1) required to achieve functions; bottlenecks and tasks
Function 1		
Function 2		
Function 3		

Annex 3. Nondisclosure Agreement Template

(Template)

Nondisclosure Agreement (Draft)

All participants in the inter-disciplinary technology convergence study group ("the Meeting" hereinafter) do, in conjunction with the meeting and in order to facilitate the discussion of creative ideas, hereby agree to adhere to the following terms and conditions regarding respect for and nondisclosure of the rights and interests in technology information disclosed by members.

Article 1 Confidential information

With respect to the Meeting, "confidential information" shall be construed as confidential technology information disclosed during the Meeting by rights-holders and technology information arising from collaborative work in the workshop(s), including any ideas voiced. However, information corresponding to any of the following shall not constitute confidential information.

(1) Information that was public knowledge at the time of disclosure

(2) Information obtained legitimately from third parties without incurring a confidentiality obligation

(3) Information in the possession of the participant without incurring confidentiality obligations

(4) Information that became public knowledge after disclosure for reasons not attributable to the participant

Article 2 Nondisclosure

All participants shall hold in confidence all confidential information learned in the course of the workshop(s) and shall not disclose or reveal said confidential information to third parties without the approval of the rights-holder disclosing confidential information at the Meeting. Confidential information shall be identified after the conclusion of the series of workshops, and until that point all technical information in the Meeting shall in principle be treated as confidential information.

Article 3 Identification of confidential information

At the conclusion of a series of workshops held in conjunction with the Meeting, the secretariat shall consult with all participating members regarding disclosure of information, identify rights-holders who disclosed confidential information that they wish to refrain from making public, identify confidential information created in the course of collaborative work, make confirmations and endeavor to secure approvals and consents.

Article 4 Publication of technical information

The technical information studied by the Meeting, other than confidential information identified pursuant to Article 3 above, shall be published in the form of a findings report and its use shall be broadly encouraged.

Article 5 Handling of confidential information created during collaborative work

All participants shall jointly hold rights to confidential information created during collaborative work by the Meeting, and the treatment of said information shall be as unanimously agreed to by all participants after said confidential information has been identified.

Article 6 Term of force

This agreement shall remain in force for a period of 5 years counting from the commencement of studies by the Meeting after the identification of confidential information and the determination of the

handling of confidential information created as a result of collaborative work.

Date: _____

Agreement confirmed by

	Organization	Name	Seal
1			
2			
3			
4			
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Annex 4. Sample Survey Questionnaire

Ⅰ. Workshop content

[Q 1]Did the discussions provide an opportunity to move forward on technology convergence?

1. Yes. ⇒ To [Q 2]
2. No. ⇒ To [Q 4]

[Q 2]Choose 1 of the 4 workshops that you thought was the most effective step in inter-disciplinary technology convergence.

1 Workshop 1 (Step 1: Concept creation)
2. Workshop 2 (Step 2: Functions/achievement image creation)
3. Workshop 3 (Step 3: Identification of element technologies and consideration of timing of achievement)
4. Workshop 4 (Step 4: Explanation and study of element technologies and challenges)
5. Others(Your opinion:)

[Q 3] In the step that you chose in Q 2 above, what was be specific point at which you felt it to be effective? Describe the specific point as clearly as possible.

[Q 4] This discussion manual will be revised in the future. Are there any points for improvement that you became aware of in the administration of the meeting? Select items that you observed and provide specific descriptions of your observations. Multiple responses are welcome.

1. Methodology workshop steps and content
2. Number of workshops
3. Grouping during workshops
4. Spacing of workshops
5. Preparations during the time between workshops
6. Number of participants in study group, number of participants in group work
7. Workshop structure and roles
8. Themes, researchers, experts
9. Changes of, greater numbers of researchers and experts in workshops
10. Others（ ）

Observation No.	Description

Ⅱ. New themes in which you would like to participate

[Q 5] If we were to hold another expert-level, cross-disciplinary discussion for the purpose of inter-disciplinary technology convergence, would you like to participate?

1. Yes, very much so.
2. It depends on the theme.
3. No.
4. Other (Your opinion:)

[Q 6] Are there themes you would like to see taken up by expert-level, cross disciplinary discussions aimed at inter-disciplinary technology convergence? If there are, please describe the themes and the expertise required of discussion members.

Theme No.	Theme name	Required R&D/technology expertise

[Q 7] Please recommend researchers and experts you think would be suited to expert-level, cross-disciplinary discussions aimed at inter-disciplinary technology convergence, including on the themes above. Please check off any roles in the meeting that you think this person would be suitable for. Please color in the role you think they would be most suited for.

Corresponding Theme No.	Recommended researcher/expert Name and affiliation	Suitable role at meeting
		?2 Coordinator ?3 New business facilitator ?4 Technology convergence facilitator ?5 Core seeds researcher ?6 Advisor
		?7 Coordinator ?8 New business facilitator ?9 Technology convergence facilitator ?10 Core seeds researcher

		? Advisor
		?11 Coordinator ?12 New business facilitator ?13 Technology convergence facilitator ?14 Core seeds researcher ?15 Advisor
		?16 Coordinator ?17 New business facilitator ?18 Technology convergence facilitator ?19 Core seeds researcher ?20 Advisor

Thank you for taking time to fill out this survey!