Guid Book for Civil Information

2005.8

Introduction

This book has been compiled to broaden the knowledge of the latest information related to the technology of information usage in civil engineering field among young technicians and students. In other words, this is a guidebook on "Civil Engineering Information". "Utilization of computer in civil engineering" or "Information systems technology in civil engineering" is the conception that has been representing the field called "Civil Engineering Information". Committees in Japan Society of Civil Engineers have changed the name from "電算機利用委員会 " (Used from November 1976 to September 1989), to "Committee of Civil Engineering Information Processing System" (Used from October 1989 to June 2002), and to "情報利用技術委員会" (Used from July 2002 to the present). It can be said that name alteration was means to correspond to the changes in expectation and demand in "Civil Engineering Information" that took place in each era.

We have written this book understanding that it is our duty to reconfirm the details of research activities demanded by "Civil Engineering Information", by redefining the present version of "Civil Engineering Information", gathering its information from a wide area, and compiling it into a guidebook to be presented to the world.

The present society is undergoing bigger than ever metamorphosis with the development of telecommunication technology, turning into a ubiquitous society after experiencing IT revolution. Construction industry is no exception to this change, and telecommunication technology in various fields such as CAD/CAM, intelligent construction system, CALS/EC, electronic bidding and delivery, ITS, and Cyber Japan, is becoming an essential technology. Importance of information exchange, sharing, and cooperation is big, and it can be said that the effect brought about when these are planned out effectively is enormous especially for civil engineering project where many interested parties are involved in one project. From this, necessity of standardizing information concerned with CALS/EC have been strongly recognized, and consequently, research and development has been made on standardized technology in civil engineering information by many technicians who make up each related organizations such as "Ministry of Land, Infrastructure and Transport", "Japan Construction Information Center (JACIC)", and Japan Society of Civil Engineers.

In chapters 1, 2, and 3, definition of "Civil engineering information" and research trend concerned with each type of project and standardization are introduced as contents based on the subtitle, "The Bare Essentials of Standardization in Civil Engineering Information". In chapter 4, many advanced "Application examples of

civil engineering information" are introduced based on the trend of standardization.

Each and every one of us involved in compiling this book strongly wishes all the young technicians and students interested in the ever more increase in quality and efficiency, and decrease in cost of civil engineering project by usage promotion of telecommunication technology, to utilize this book and take the next step towards the future.

A Day in August, 2005

Japan Society of Civil Engineers: 情報利用技術委員会

Special Small Committee on Civil Engineering Information Guidebook Compilation

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Chapter 1　With Civil Engineering Information

The arrival of an information society is said and passes for a long time, but we mention much information routinely and live by using it.

A purpose of civil engineering business is to offer a comfortable social infrastructure by security for society. On the other hand, by the present age, there is a social tide to demand with low cost and civil engineering structures of high quality.
It becomes effective means to utilize information technology to meet such needs.

In this chapter, I comment on a definition and a role of civil engineering information and survey various actions to relate to a method of the information acquisition / profit practical use and standardization of civil engineering information

1.1　A design of civil engineering information

Civil engineering business takes at least two roles for society. One makes civil engineering structures or a social infrastructure institution by civil engineering business literally, and it is the role that it maintains. Through having you use a social infrastructure institution, another one makes me secure people and social security / relief and help smooth activity, and it is a role to restrain environment influence to be caused by institution itself and activity of a human being / society at the same time.

I may call a role of the latter contribution to society through use of an institution and the local management. I think that It is easy to understand that I think about a river levee. I make a dike, and it is big objective one of the civil engineering businesses not to mention maintaining it, but it is for an original purpose of a dike to reduce a risk by floods. Therefore I control development of a basin using city planning and land use regulation, development regulatory systems. For example, I let you make the institution which pools temporarily before flowing into a river by rainwater flowing out from a town area I help rainwater infiltrate a basement, and to reduce load to a river.

In addition, tell inhabitants about a risk by a flood in form such as risk maps and help with urgent correspondence at the time of a disaster. It is a possible to be low and be able to control the menace that a flood gives human life by putting such a close individual measures together.

In the times when the flood damage was frequent because a dike is not got ready it was a central purpose to build a dick and to maintain it of civil engineering business. I still really build a social infrastructure institution, and a role improving is very big, and it is the important means that civil engineering engineer can pressure society to

work on directly. However, when a maintenance standard of dike in itself rises and I cannot find enough security only by dike maintenance, it is demanded that I cooperate with an administrative organization and a private enterprise, inhabitants group to be related to and carry out various measures to reduce a flood risk. A role of civil engineering business changes into "improvement of service by the local management" how you improve a service to an area and inhabitants that in the first place an institution was aimed for from "only an institution" in cooperation with various organizations.

1.1.1 Strategic importance of information

In a change of such a role, importance of information in civil engineering business becomes bigger and bigger.

(1) I improve effectiveness of a business

Increase of social insurance payment of savings occurs with social aging and the fund which I can pass to public works spending as Great Society decrease greatly.
It is important point that whether you make a good thing effectively in that, you maintain it. When I think about a large quantity of social infrastructure institutions built in the 20th century in particular will become obsolete steadily in future, it is important how I reduce expense while keeping a maintenance standard. The profit inflection of information not only reduces expense to need for a plan and management of a business but also is indispensable so that minimum maintenance repairs it in the time when I do not help it and particularly judge structure specifications or the deterioration situation of an existing structure preciously. The cooperation of precise information and knowledge is very important for civil engineering business not to do waste in this way, to perform only that should do it effectively.

(2) It supports a difficult condition than environmental problems surround civil engineering business.

Environment surrounding construction work while I do not trouble a large quantity of construction remaining soil and disposal of scrap wood, reduction of a carbon dioxide discharge in cement production, repair work while I offer an existing makeup in the town area where I crowded open, activity of people at the outskirts to occur by civil engineering business itself becomes severe at all.
What kind of construction work is performed I watch it because waste is not dumped

illegally, and to perform a business while controlling environment influence such as subsidence of neighboring districts at the same time and monitors neighboring what kind of influence give consistently, and a sharp "sensory nerve" and agile "motor nerves" to take correspondence promptly when I turned worse are necessary. Information technology becomes convincing technology of that purpose.

(3) I level up management of the whole not only improvement of institution use but also all of the country

It is necessary to keep a social infrastructure institution a healthy state physically, but it in itself is not an original purpose It is necessary to think how to use an institution effectively, as a result of having had you use it, what to do to improve security and convenience of a user still more. Therefore not only an institution but also information to relate to what kind of people how to use it is necessary. Appropriate use is not possible without it.

Furthermore, it is indispensability to put institution construction and use and other policies together effectively it is more effective, and to achieve original purposes such as security, relief effectively. Therefore information about activity of an area and other organizations is necessary. When I make a dike an example as had already explained, it is effective to put various policies such as development regulation or land use regulation together besides dike maintenance to carry out reduction of the disaster risk that is an original purpose of dike construction. It is valuable open space, and river in itself becomes natural environments and a place touching at the same time in cities. Therefore a device to keep a role of a river alive from a viewpoint except such security, relief on maintenance and maintenance of a dike to the maximum is necessary.

In this way I grasp various information consistently what kind of creature lives in where of a river from information whether the old man who is refuge difficulty where lives in where a flood may arrive at where of a dike destroys what kind of thing is biotope to need and must be able to take the correspondence that you are quick when it is necessary, and is appropriate.

In addition, I arrest an earthquake wave to arrive at it before full-scale rolling when an earthquake really occurred as a working system and intercept gas and let the Sinkansen stop, and there is the system which few, is going to reduce the damage. This is a fine example of the trial that is going to find a user and security of local inhabitants and Great Society ahead of a frame of disaster prevention to protect an institution. And it is coming true in Intelligent Transport System, To let detour around

the road which became high-risk by a landslide by a heavy rain, freeze of a road surface; service giving information to the people who are going to use it beforehand, I show a freeze point for a person using such a route by all means and rouse attention, and emergency stops a rolling stock at the place that there was, and service to evacuate can contribute to a user directly, and falling rocks are service to need various information except an institution at the same time.

In this way therefore I live when I think that people use the whole country space in various form by managing the whole country and can elaborate a plan by service to help activity such as active people or various organizations / companies, "country space use support service". The role that civil engineer realizes country space use support service while putting a pivot leg in a social infrastructure institution is expected.

1.1.2 Civil engineering information challenge

The information use in civil engineering business and technical development include two challenges. One is a challenge for inside the civil engineering business. Many parts of civil engineering business have been performed with a frame of a public works project. In that, it did not keep an eye on the side of offer of running new "Service" easily the operation of an efficiency improvement and the structure though securing fair of the procedure and quality of the structure was recited. A big effect is exactly expected of the use of the information technology on such a side, and how is the information technology used well in civil engineering business while distributing eyes to the viewpoint of public in that sense, and whether the use of the information technology infiltrates becomes a problem.

Another is a challenge for outside the civil engineering business. Besides, a purpose of civil engineering business can be said to be contribution to "country space use support service" not an unemployment policy, an anti-economy floating measure as well as building an institution. The social infrastructure institution which is a direct object of civil engineering business is a frame of country space, and information about it is the basic important information for organizations such as other organizations participating in realization of "country space use support service", an administrative organization, a private enterprise, the NPO which, for example, is in charge of firefighting / the police, medical care / health, environmental safeguard, farmland maintenance, forest management. Therefore I share information accumulated by civil engineering business with such an outside organization, and it is a big challenge how you build such a base which you cooperate while changing information each other, and

realize country space use support service technically systematically.

1.1.3 Expectation and the prospects

Various catch phrase （a multi media society, a high information-oriented society, ubiquitous networked society） floats, and disappears till now, but, as for the tendency that it becomes important to bring about new value in what I change information computerized as Great Society abundantly and process, it is it in the direction that is reliable as an undercurrent. For civil engineering business, a social infrastructure business, that I take the core of country space use support service while being based important on construction and maintenance of a structure is expected in that by a role to think about only a structure. Country space use support includes very wide contents from a prediction of a typhoon course to cleaning of a road, guidance, and it is not pushed forward without various organizations and cooperation of people. I offer information to relate to the present conditions of information to become the basics of cooperation there, a social infrastructure institution and a country, and it is right a prospective role to engineering engineer to help such a cooperation. This is one of the important elements of a social infrastructure (figure 1-1-1) in an information-oriented society. I gather flexible action , ③ information from a point of view how can improve information management , ② service to be based on the scope that , ① is long-term to meet such an expectation and accumulate, and the examination that was able to enter a field of vision to an organization and design and plan theory using of the system / mechanism is necessary.

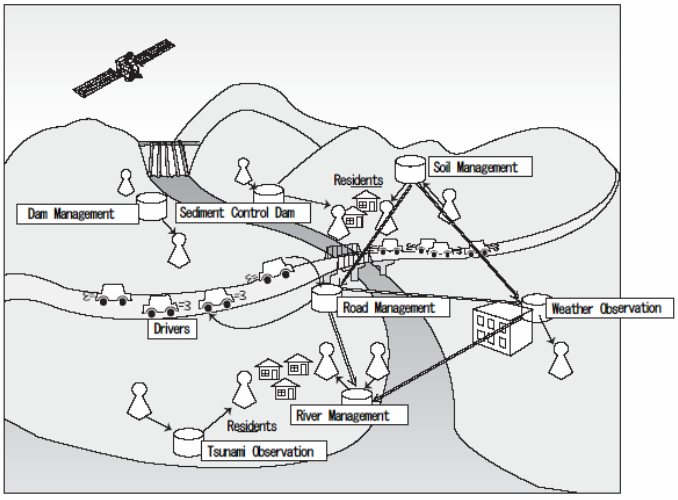

Figure 1-1-1 An inflection image of civil engineering information

The new civil engineering business challenge, the civil engineering information challenge began. There is this book to introduce a new trial and the background and intention, the future directionality that I did so. Give me this book as an opportunity producing a new idea, ideas by all means.

1.2 A component of civil engineering information

I introduce concrete technology and information use project after having explained a total frame and constituent supporting the use / inflection of civil engineering information to understand the connection.

1.2.1 A master plan or the architecture

Two big aims in engineering works information are the management of information from a viewpoint to say effective promotion of a business and an offer of country space comfortable safely and the management of information from a saying point of view. Various organizations and people share a role each to achieve them and have to be active while cooperating.

At first a master plan is necessary to manage information. An exaggerated thing master plans is needless and should agree about a form and an exchange method of data if you finish it if you exchange data and information with A with only during the extremely limited people who said B when I merely thought that it is necessary among two. However, various people and organizations carry each role from a general citizen to a consultant, a construction company, a local government, a government office and participate to achieve a big aim to manage the whole country well. Therefore it is necessary to arrange systematically it to a purpose, a basic policy, each participant and a role of a participation engine, a small data exchange rule if necessary to promote the information circulation and joint ownership. This is a master plan. Or it may be slightly unfamiliar words, but calls it system architecture. In system architecture in what kind of thing I must do to achieve any kind of aim therefore what kind of information is need to be available when it is necessary, I decide what kind of circulation form I should do the information that it is necessary.

With such architecture, data and the use of information and the roles line up observation , a measurement of data and collection, the collected data and rearranging , management and circulation of information more each. And investigation / a surveying company, construction / a design consultant company, an execution company move into action in cooperation with a country and local public entity to achieve the role.

1.2.2 Information technology and mutual linkage

When I divide necessary technology along a role such as the above greatly, rearranging manages observation, a measurement of data and collection technology (acquisition technology of information) of information, gathered data and information and it is it with technology (management, circulation technology of information) to distribute it to the user that it is necessary, technology (use technology of information) to use data and information more.

Observation, measurement technology of data, collection technology of information scrape up technology (primary data acquisition technology) to acquire direct data from an agenda so that it is represented more by surveying and satellite remote sensing and the data which it is already observed, and is provided, and technology (second data acquisition technology) to extract new knowledge and knowledge in what I edit can understand it. I access data saved in a Web site in second data acquisition technology, and there is technology to acquire only a necessary thing via a network. Because many of report from the spot and data of a measurement result come to be saved in form of all Web, it is expected if such a technology becomes more and more important, but what the information relates to pull out "important information" without an error; must mark it. It is management, circulation technology of information common label which I held so or that let all use it at the time when anyone can use a tag. Of course technology how save a large quantity of data effectively is important for management, the circulation of information. However, when various users are necessary, they can search for necessary information, and it is a basic aim to make up the environment that can obtain it. You must think that you manage it since the data acquisition.

In addition, it goes without saying, but it does not mean to t have technology to really use information in the spots if necessary information is not provided restlessly either. In this way technology to manage information is related deeply mutually, and therefore the architecture becomes important.

1.2.3 A life cycle of information

There are various things in the life cycle that information is born and used in a business. At first, in civil engineering business, information drifts with a design, execution, maintenance, use from investigation / survey with progress of a business to show it in figure 1-2-1. A structure and an institution are gone into details about with a figure of detailed plan, completion by the process from an outline plan, and

information and maintenance / repair information about the use situation add it more when really offered open. It often produces to refer to information made at a stage of the down stream if necessary by upper reaches process and, like a case to refer to design information to repair a structure damaged by an earthquake. A cycle that "design contents do not match the spot if I try to execute the work and change a design of" it occurs in an enforcement process of a business, and I send it back, and each time design information is changed there from an execution stage to a design.

On the other hand, when a landslide is generated by a heavy rain and must urgently do it for suspension of traffic, I collect information by real time if it is possible to notices from detection of a landslide to a user as possible quickly, and it is necessary to transmit it. It may be said that this cycle is necessary to turn most quickly.

In addition, there is for a cycle I take very long time, and to turn around. I accumulate an example of technical success and failure by piling up operative examples from a design example, an execution example and can get knowledge what kind of technology should apply when. I need heaping up advance of a lot of examples for a cycle of extraction / generation of such a knowledge and need long time in it.

It is necessary to develop a record method of the information that fitted a life cycle of such a various information, a management method, and it is necessary to beat its brains for an ideal method of an organization, incentive or a way of a grant of penal regulations as well as technology.

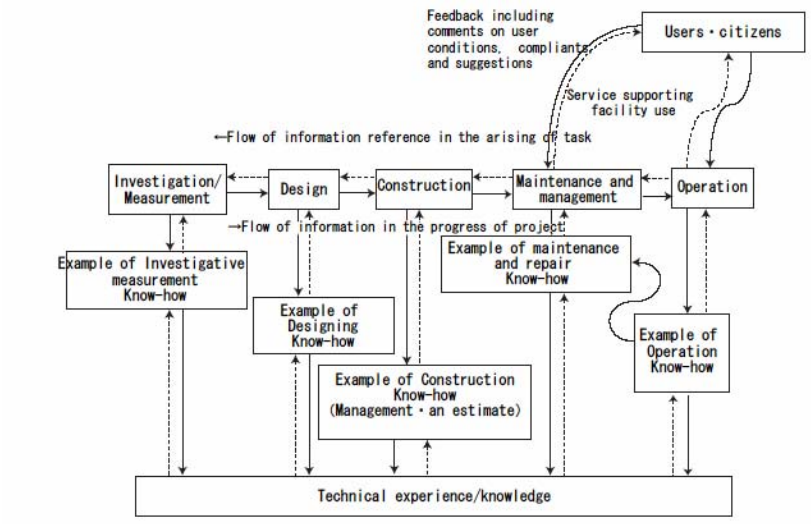

Figure 1-2-1 Civil engineering business and a life cycle of information

1.3 Technology of Civil Engineering Information

In order to improve the efficiency of projects and to provide the latest service in national land management, it is important to use information technology effectively. In this section, a portion of a specific technology is introduced based on the components of civil engineering information explained in the last section.

1.3.1 Architecture for Information Management

（1） Current Designing of Information System

Many information systems up to now, not necessarily related to civil engineering, have been designed and developed as an alternative for a specific process. In this case, the focus is on the designing of the function, and the designing of one of the data derived from the function will be assessed (Figure 1-3-1). This method of designing is effective in the development of a system supporting individual businesses. However, in GIS (Geographic Information System), when using one system's data in another system, it is difficult for both systems to correspond to the data, and in most cases, labor and cost equivalent to that of drawing a design diagram of a whole new data is required. Today, where creation, saving, and transaction of bulk data are now possible, demand for data exchange or sharing between these systems is becoming extremely high. To accomplish data exchange or sharing, one data must be used efficiently with high precision. To do this, we must take another look at data as an object to be managed, and not just as an object to be processed.

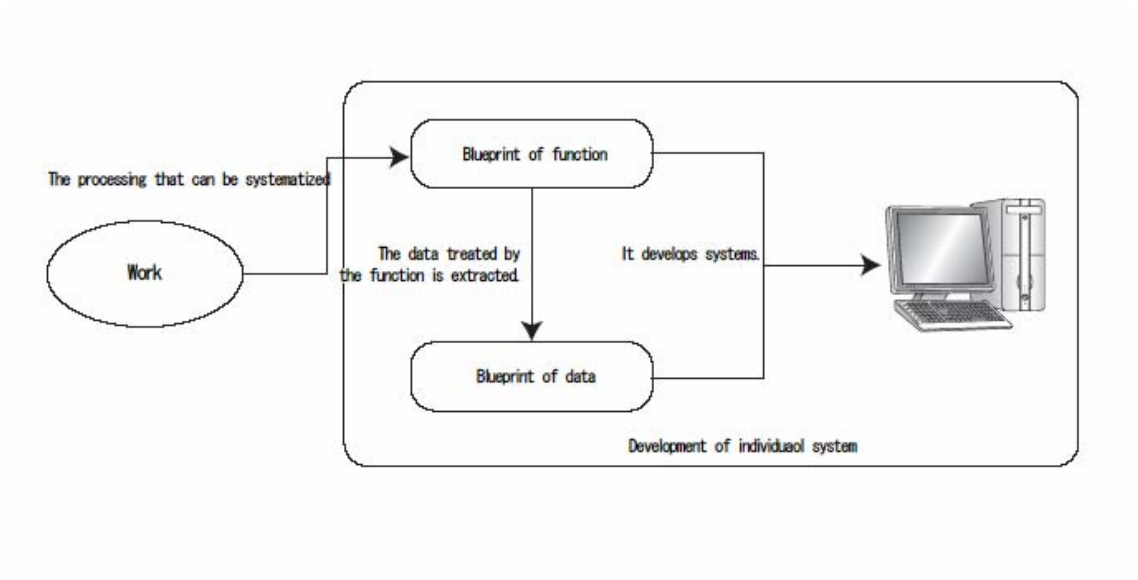

Figure 1-3-1 Designing of System From Now on

(2) Designing of System From Now on: Architecture-Oriented Design

Because we have to bear in mind that multiple systems will be cooperating when developing a system that requires data management, it is especially important to design data assuming its wide range of use in advance. Hence, there is the need to add the following 3 steps to the current designing process.

・Set up main people concerned who are expected to exchange or share data, in advance .
・Model a situation about the kind of job each people concerned mainly does, and about the way in which information ought to be handled in each job.
・ Extract things that can all be common, from all the modeled job and information.

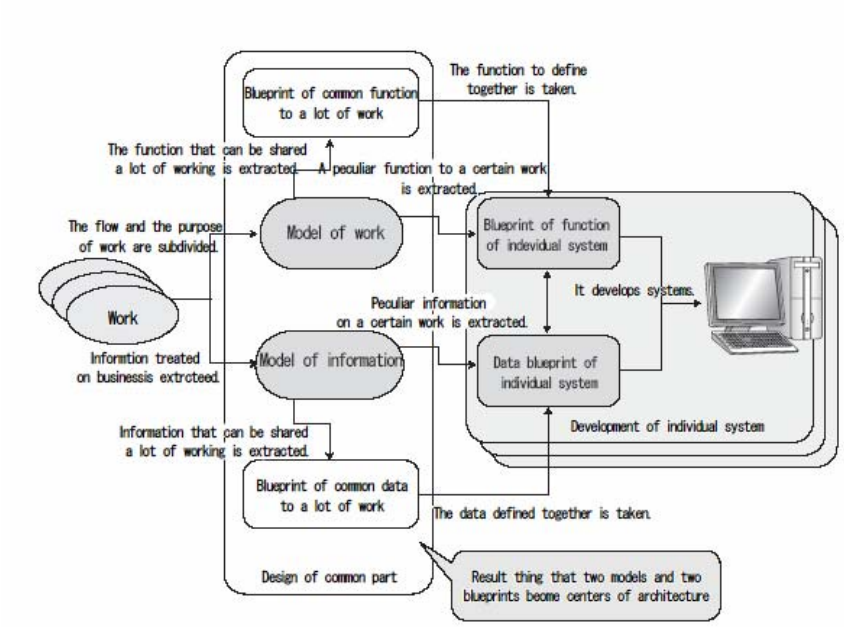

Figure 1-3-2: Architecture-Oriented Design

At this moment, people who are concerned with the exchanging and sharing of data and are included at the set up stage, aims to ensure data is exchanged and shared smoothly during the said designing stage. In order to exchange and share data smoothly, it is important not to look at the data being handled presently, but to overlook as much as possible on what kind of job each and every people concerned ought to do and on what kind of information is necessary. Here, all the contents (Whether specified or unspecified; on paper or digital) recognized along with jobs are

called information, and digitalized objects or objects that can be digitalized, which are included in this information, are called data. Model overlooking jobs and information as a whole, and design diagram where common parts extracted from the model are defined, added together are called “Architecture”. Individual system is designed by using architecture, definition of common parts, as much as possible, and by adding definition of data and proper function to the individual job. These designs can be described by using modeling language (Notational system of design diagram such as flow chart) such as IDEF （ ICAM DEFinition ） and UML （Unified Modeling Language） .

(3) Example of Architecture-Oriented Designing Method: Enterprise Architecture

Enterprise Architecture (EA) is one of the designing methods developed for the purpose of designing an overview of an advanced and efficient system for a certain organization or community, by orienting the architecture. EA was originally conceived by J. A. Zachman in 1987 as a designing method for planning correspondence between business strategy and IT strategy of an enterprise. For this reason, in EA, a business scope (BS) of a business strategy, such as the purpose of activity and direction the strategy is aiming towards, is illustrated first, prior to illustrating the architecture for the system (Introduction of IT). Having done that, action and activity required for realization of business strategy (BA: Business Architecture), process and function (AA: Application Architecture), information (DA: Data Architecture), and usable technology (TA: Technical Architecture) are developed in this order (Figure 1-3-3).

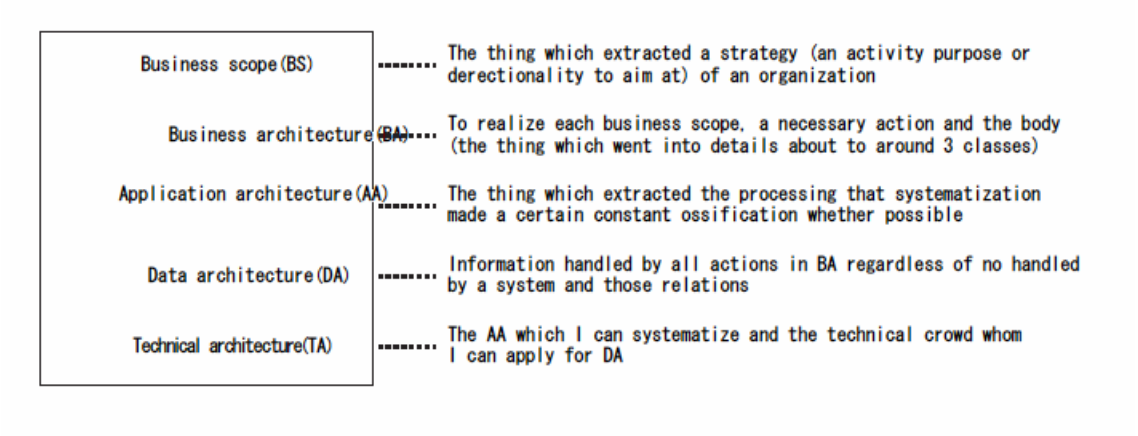

Figure 1-3-3: 5 layers of EA

At this time, BS and BA can be developed using a list or a tree diagram, and use case diagram can be used in UML. Also, use case diagram or sequence diagram can

be used in AA, and class diagram can be used in DA.

Meanwhile, in the United States, EA has been named Federal Enterprise Architecture (FEA) in 2001, and materialization and development of the organization and political setup are being planned in order for the government to develop EA (Figure 1-3-4). In FEA, Department of Treasury Office of Management and Budget (DOT OMB) creates BS and BA, and each government agencies indicates that the relevant policy correspond to any BA and provides that adjustments are made in advance in case there is a possibility of related policy including that of other facilities exist, upon submitting their budget. Moreover, in OMB, each government agencies creates and releases analysis tools and templates required for developing FEA. Therefore, adjustment of concept at a higher level, namely Architecture, is required in order to manage information effectively with high precision.

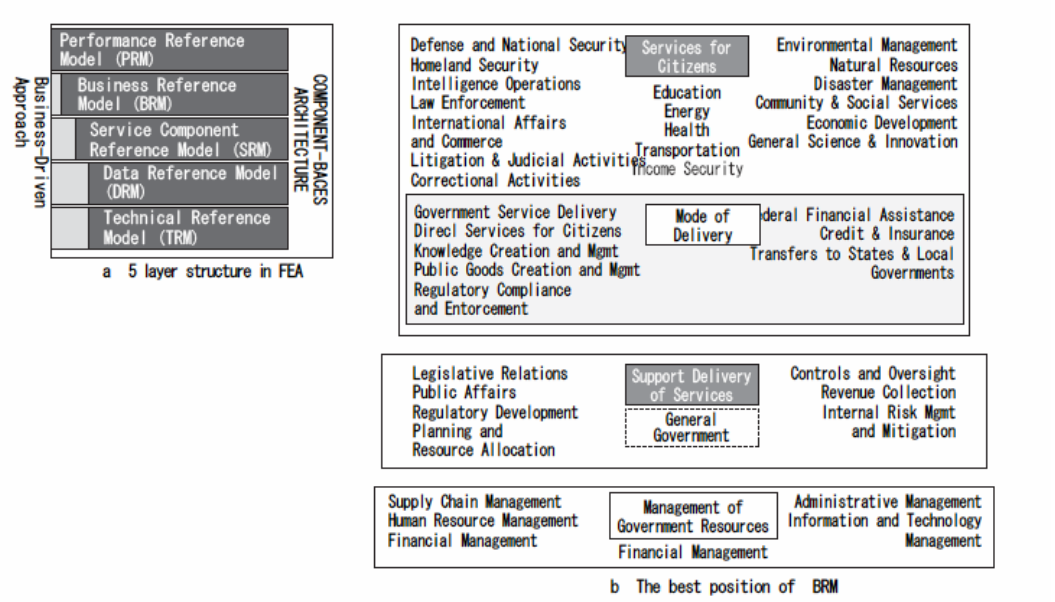

Figure 1-3-4: Specific Development of EA in FEA
（http://www.whitehouse.gov/omb/egov/a-1-fea.html）

1.3.2: Information Acquisition Technology

When we talk about civil engineering information acquisition technology, surveying, remote sensing (RS), geophysical exploration, or non-destructive inspection usually come to mind. It may be abrupt to include geophysical exploration and non-destructive inspection, but these will be summarized as “Technology for acquiring

quantitative and qualitative information as well as location information related to the earth (land)" and it will be called (Geomatics) 1). One end of civil engineering information acquisition technology will be introduced from the perspective of Geomatics.

(1) Civil Engineering Information and Geomatics

Civil engineering information is widely spread from one infrastructure to a global area such as the earths' environment. Demand for information will vary depending on the implementation stage of civil engineering project. Topographical information that can provide a bird's eye-view of the progress in the project's plan and appearance of the site is required when formulating a plan. When you get to the designing and construction stage, information needs to be enlarged considerably; and it can be said that topographical information fine enough to be seen with a naked eye, and progress of the construction on daily basis or in a lesser time-frame are required. After completion, maintenance information of an infrastructure itself is necessary in order for the infrastructure to continue providing a safe and secure service.

A rough idea of the relationship between civil engineering project and Geomatics is illustrated on figure 1-3-5. Geomatics stands between civil engineering project and the real world, and provides shape and nature of the feature; the position of static information; and dynamical information concerned with alteration in shape, nature, and position of the feature; to the project by using each type of measuring method and measuring apparatus. However, consideration on not just the spatial aspect, but on the aspect of time such as the required accuracy of the measurement and the required amount of period of change, is unavoidable in order to acquire information consistent to the purpose.

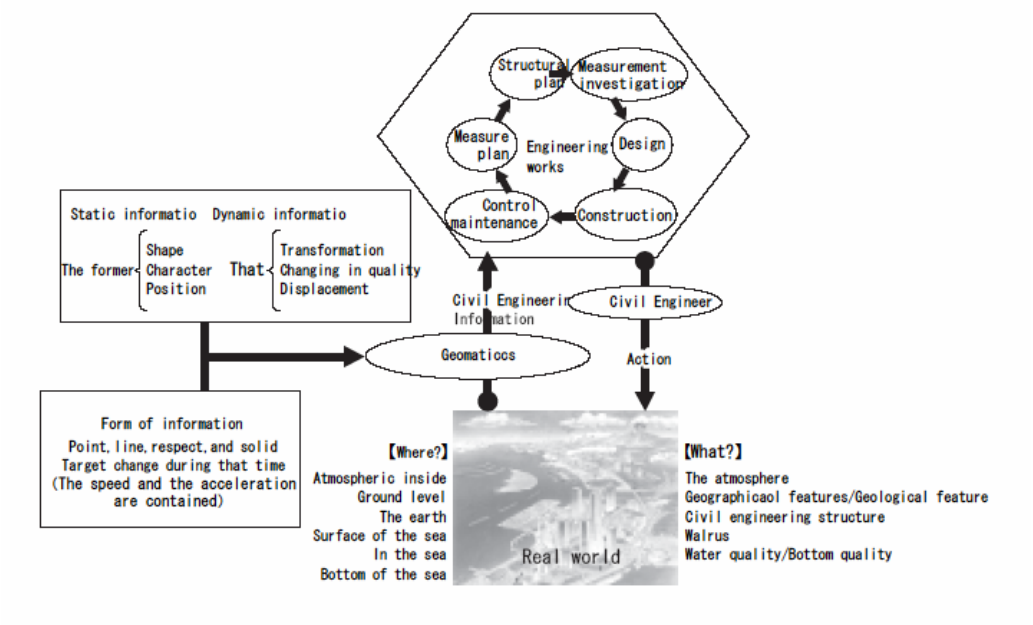

Figure 1-3-5: Connection between Geomatics and Civil Engineering Information

(2) The Way of Measuring in Geomatics

There are many measurement technology and apparatus in Geomatics. Figure 1-3-6 shows the principal measurement technologies. Furthermore, Table 1-3-1 lists the main use of the apparatus for each region of measurement.

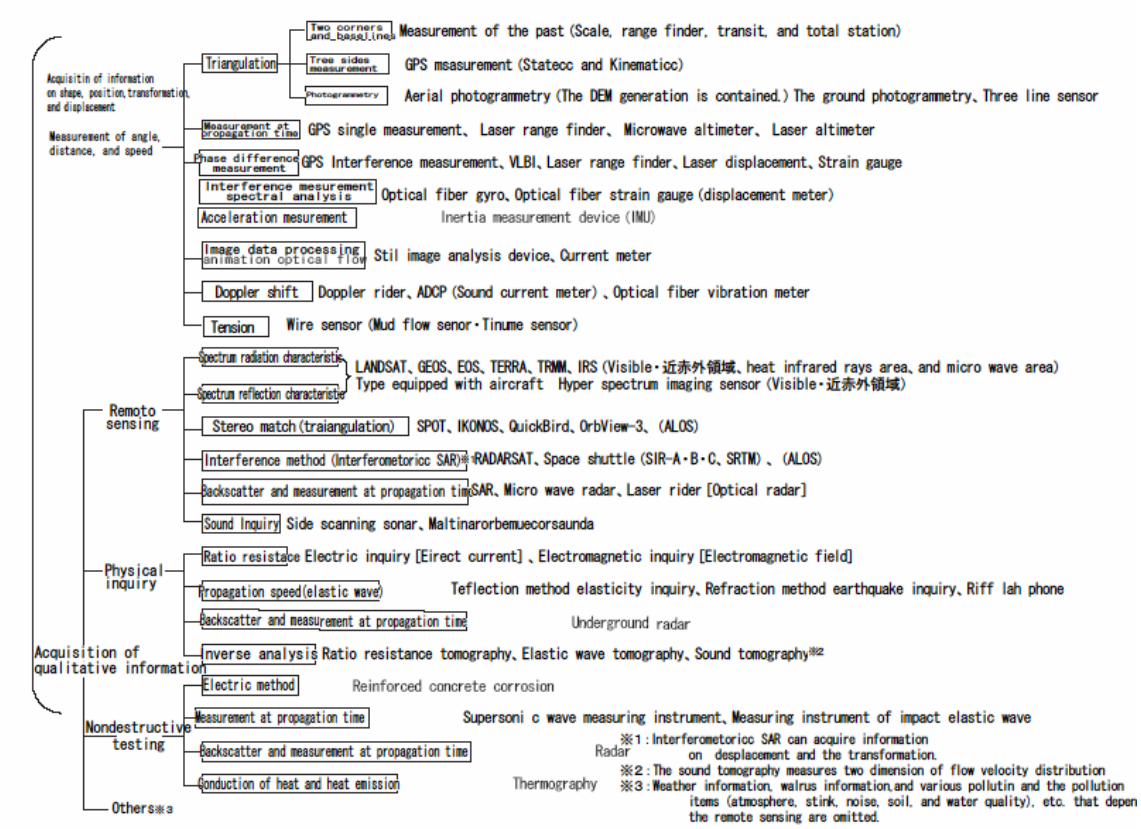

Figure 1-3-6: Principal Measurement Technology

Table 1-3-1: Principal Measurement Apparatus and its use

① Acquisition of Information on Shape, Position, Transformation, and Displacement

The basics of measuring shape or position is to find the position of unknown point and the length of line by measuring the angle and the distance. Measurement is the most important example of this; however, the law of triangulation is employed in most of the previous measurement methods.

Generally speaking, in order to acquire 2 or 3 dimensional information, vast number of lateral lines and survey stations will be required. This was difficult to achieve with previous measurement method, but image processing and Laser Range Finder (LRF)

are trying to solve this difficulty. However, measured values themselves are merely a collection of 3 dimensional coordinate data, or dense point sets, therefore, modeling and structuring of data is required as back-end-processes in order to process information 2 or 3 dimensionally using CAD.

Displacement and transformation can be figured out from the difference of measurement values in 2 periods. As for finding the distortion of infrastructure, measurement by using optical fiber to observe interference or Doppler shift is conducted. Global scale movement, namely crustal movement is being understood accurately by applying space engineering such as Global Positioning System (GPS), Interferometric SAR (Synthetic Aperture Radar), and Very Long Baseline Interferometry (VLBI). As something new, there is a device that uses dynamic image analysis (optical flow) for measuring the flow velocity of river surface.

② Acquiring Qualitative Information

Qualitative information is being acquired mainly by RS 2), geophysical exploration 3), and non-destructive inspection. Because image is used for measuring in RS, it has a merit of acquiring information as a surface. In RS, electromagnetic radiation reflected or emitted from earth's surface is transformed into an image; then its intensity, transparency, and spectrum distribution is image analysis, and its corresponding earth's surfaces are classified. Moreover, sound wave is used when observing the surface of seabed. This is because electromagnetic radiation is attenuated considerably underwater, making observation difficult.

In geophysical exploration, transmission speed of elastic wave and resistance of electric current are observed, and soil-structure and groundwater distribution are analyzed. They are trying to estimate the 2 dimensional structure and 3 dimensional structure of soil by installing 発振源 and receiving apparatus in multiple places, and inversely analyzing results observed simultaneously. This method is called seismic tomography and specific resistance tomography. Similarly, a method where sound sources and receivers are installed in multiple places and transmission time is inversely analyzed after observing simultaneously is called acoustic tomography. Lateral distribution of flow direction and flow velocity can be measured.

Non-destructive inspection is conducted to detect faults formed on the surface or inside, or to inspect internal structure. Image processing is mainly used for detecting faults on the surface, and infrared thermography, ultrasonic waves, impact echo, and electromagnetic wave radar are used individually for detecting internal faults. Then there is the method called acoustic emission for detecting faults during its formation.

(3) Stages of Geomatics Application

Several stages of Geomatics application and facts, which are topic of each stage, are introduced here.

①Stages from planning of a measure to precise surveying and designing

Surveying for creating topographical map, and geophysical exploration for investigating bedrock and geological feature are conducted, and if anything, static information is acquired. As for technical survey, a new method is being put into practical use by fusing electronics technology and digital technology.

・ Digital Photogrammetry

Digital Mapping Camera has been put into practical use. Digital photogrammetry workstation that is operated by personal computer has been developed and creation of topographical map is advancing itself towards acquisition of 3 dimensional data. Digital Mapping Camera is being utilized easily as a method for acquiring 3 dimensional information, which serves as a basis of landscape analysis.

・ Position and Orientation System (GPS/IMU<Inertial Measurement Unit)

Shooting position of the picture and parameter of camera position, both necessary in photogrammetry, are surveyed directly. Process of photogrammetry has been greatly shortened. Furthermore, if it is combined and used with Digital Mapping Camera, aerial photogrammetry can be commenced within few hours following the shooting, hence the usefulness in acquiring disaster information 4).

・ Photo Survey with LIDAR (LIght Detecting And Ranging)

Aircraft carrying 測距レーザ装置 scans the land and its altitude is measured 面的 . Horizontal measurement accuracy of 50 cm and vertical measurement accuracy of 15 cm were assured from an altitude of 1,000 m, and part of the land that appears and disappears is also measured efficiently.

・ Virtual Reference Station Method

GPS-based control station net built at 1,224 spots, each within an interval of 20 ～ 30 ㎞ all over Japan, is complemented. Control center connected to GPS-based control station creates a situation as if there is a reference station near GPS Mobile Station. RTK-GPS positioning can be performed by using a mobile phone to send and receive revised data.

②Construction Stage

Measurement high in spatial density and in real-time is needed in order to manage the difference between the daily progress of construction and its scheduled value. Measurement is commenced with the use of Ground-based LRF on this measurement site. Laser spot is within few millimeters even from a place 50 m away, and

measurement accuracy of 2~6 mm can be acquired. Grasping of the present state and extraction of arbitrary cross section has been made easier. Modeling of Landscape CG and digital archiving of ruins and relics are mentioned as other applications of Ground-based LRF.

Also, 3 dimensional measurements by the use of digital camera is being put into practice. For example, DEM (Digital Elevation Model ） Measurement based on stereo image is applied as a method for measuring the volume of soil reclaimed in airport construction in real-time, and is being put into practical use as 運土管理システム .

③ Maintenance and Management Stage

Information for maintaining functions of constructed infrastructure will be necessary. This information includes the present state of infrastructure and its slow transition, or transition needed in real-time in case of an emergency for detection when disaster strikes. This information is rather dynamical. Not only is it important to measure the deformation, it is also important to comprehend its advancement when acquiring information for maintenance of functions.

Mobile Mapping System that measures the present state of road slope and position of road facilities by loading GPS/IMU into a vehicle, and vehicle that measures the road property by installing laser profiler are mentioned as examples of measurements. Moreover, when inspecting during tunnel lining, deformation formed on the surface is captured by image measurement. Meanwhile, non-destructive inspection apparatus such as ultrasonic waves, radar, impact echo, and infrared thermography is being used to detect faults inside the lining 5).

Strain sensor and ワイヤセンサ based on optical fiber are being used as debris flow sensor along with a rain gauge as examples of detection apparatus at the time of disaster.

(4) Geomatics from Now On

Digital technology has cut back the time required for information acquisition, improved the control, and revealed invisible information. Furthermore, communications and network technologies have facilitated the delivery and sharing of information. With these technologies as a background, research on Sensor Web that unites network technology and sensor technology has started in the discipline of environment measuring and security. Sensor Web is a system that integrates each and every scattered sensor by the use of a network, and tries to acquire live information of the sensors as one. This type of sensor technology is thought to be one form of Geomatics, and is receiving much attention as one of civil engineering

information acquisition technology. Needless to say, meta data, encoding, and standardization of communication protocal becomes indispensable in realizing information integration by network.

1.4 Project of Civil Engineering Information

Currently, various organizations are launching a project using information technology to realize the following goals: Work efficiency in Japan's civil engineering project; enforcement of prevention measures against disaster; assurance in quality; cost reduction; assurance in transparency; and improvement in services to the people. Outline of the major projects being conducted in Japan as civil engineering projects is introduced below.

1.4.1 Cyber Japan

(1) Overview of Cyber Japan

In the 21st century's society, formation of high-speed and inexpensive network has advanced, and various type of geographical information can now used by integration, with the maintenance of information network and the development of information processing technology. On the other hand, it is difficult for a limited number of specific facilities to maintain and provide all the necessary geographical information to meet their various demands, and also causes inefficiency. For this reason, an environment where the creator of each geographical information can send information using geographical information infrastructure, and users can search the necessary information and process it own their own to use it for various purposes is in demand.

Geographical Survey Institute is proposing "Cyber Japan" conception, where a wide variety of geographical information possessed by various subjects of maintenance, such as the country and the local government, is integrated on the Internet and reproduced on the Internet as real Japan to be shared and applied by various users. In order to realize this conception, Geographical Survey Institute is aiming to realize a society where anyone can utilize the latest various geographical information and location information anytime and anywhere, following "6th Basic Measurement Long-term Plan （Fiscal 2004 ～fiscal 2013）" decided by the Minister of Land, Infrastructure, and Transport. As a policy to put this plan into effect, Geographical Survey Institute is promoting construction and application of "Cyber Japan". By constructing "Cyber Japan", administration (providing of administrative information, national land management, work of each type of plan), corporate activities (area marketing, vehicle service management, business support), and family or private activities (travel, leisure, information sending, voluntary activities) are expected to diffuse rapidly (Figure 1-4-1).

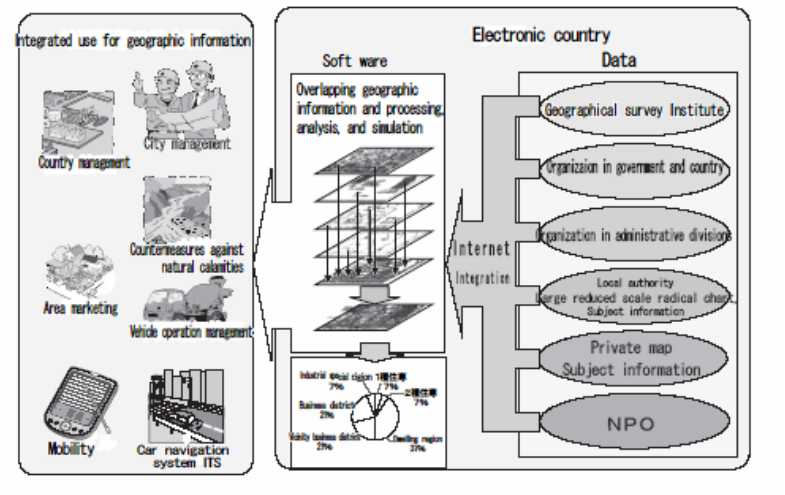

Figure 1-4-1: Effective Use of Geographical Information Based on Cyber Japan

(2) Cyber Japan Web System

On July of 2003, Geographical Survey Institute has released "Cyber Japan Web System" as a system that realizes "Cyber Japan" on the Internet for the country and the local governments （ http://cyberjapan.jp/ ） .

"Cyber Japan Web System" is simplified Web/GIS that presents background map, delivered from Geographical Survey Institute, by overlapping various information; and provides a simple analysis, function that indicates graph, and function that prints map (Figure 1-4-2). Information to be overlapped is created as data in a form based on geographical information standard (national standard of ISO19100 series provided for the purpose of exchanging geographical information, and is bound to be JIS systematically). Since information is sent in a common form, information sent by various organizations can be overlapped and presented on the same screen.

(3) Example of Cyber Japan Site

Presently, on April 1st, 2005, 54 organizations such as the country, the local government, educational institution, and NPO are constructing sites for various purposes (disaster prevention, tourism, environment, etc.) using "Cyber Japan Web System". A site of 防災情報提供センター from the Ministry of Land, Infrastructure,

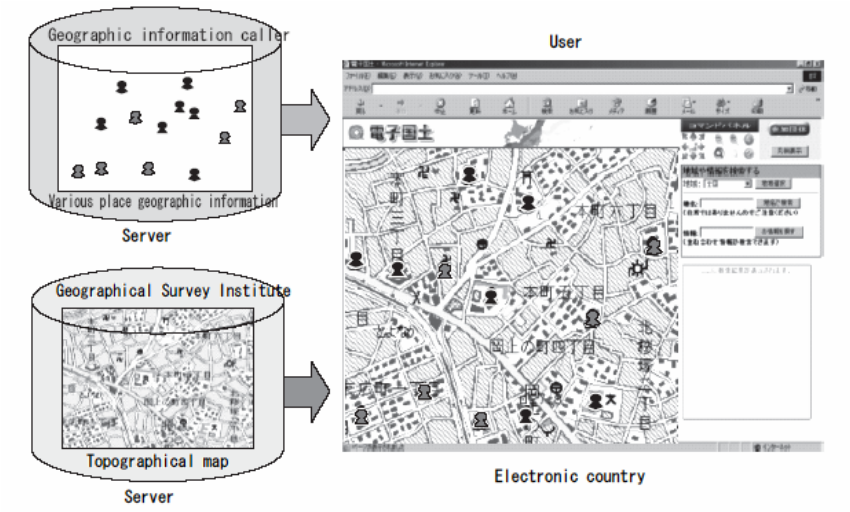

Figure 1-4-2: Use of Cyber Japan Web System

and Transport, will be introduced here. 防災情報提供センター condenses disaster prevention information within the ministry and provides this information to the people through the Internet. Information that can be used is precipitation information in real-time and each type of disaster prevention information. "Cyber Japan Web System" can be used to observe information within this information, such as weather/river/costal data, crust movement data, and storm and flood damage information. For example, when crust movement data is selected, background map is presented (any scale from a scale greater than 1/1,000,000 can be selected), and position of GPS-based control station, vector of 水平移動量 in the last month or year (Figure 1-4-3), and deformation graph can be presented. Please refer to 防災情報提供センター's web site （http://www.bosaijoho.go.jp） for other observation information.

(4) Example of Application of Cyber Japan and its Prospects

One of the example of application that uses "Cyber Japan Web System" is "Support and confirmation service for creating attached map for electronic application". This service has been put into practice based on the government's "Plan to build electronic government", in March of 2004. With this service, map needed to go through the online application and notification procedure can be created easily using topographical map for electronic application delivered from Geographical Survey Institute. Since applicants can submit this map along with other documents for submission through the Ministry of Land, Infrastructure, and Transport's online application system （http://www.goa.mlit.go.jp/） , they do not need to prepare a map by themselves. This application and notification procedure can be used to issue a transcript or an abstract of measurement results, or to submit public measurement enforcement plan.

We are coping to realize the use of other procedures in this system (Figure 1-4-4).

In Geographical Survey Institute has released “Cyber Japan Web System” that facilitates the use of geographical information on the Internet, and is planning to spread its use among the people. In the future, it intends to add user friendly functions on the wishes of users. Moreover, Geographical Survey Institute has released technology information to the people in general, from the perspective of promoting the use of “Cyber Japan Web System” even further, in March of 2005. It hopes the range of users of map and geographical information expands, and as a result, new businesses related to map and geographical information arise, and expects “Cyber Japan Web System” to be used as even more familiar and convenient system.

Figure 1-4-3: Screen of 防災情報提供センター
（http://www.bosaijoho.go.jp）

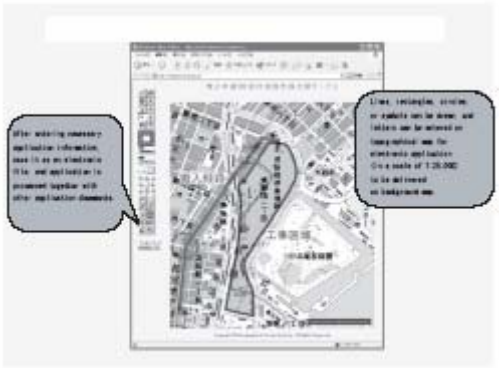

Figure 1-4-4: Map Creation Screen of Support Service for Creating Attached Map for Electronic Application