The Kitasato University Hospital New Hospital Project is currently in the spotlight as a pioneering example of the full-fledged use of Building Information Modeling (BIM) in a complex, large-scale hospital construction project.

Autodesk Revit Architecture is playing a central role in the BIM process.

We interviewed the owner and the designer and construction companies involved in this project. The interviews are presented in the following four sections.

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Consensus-building in a complex, enormous project (construction of a large-scale hospital) and use of BIM from basic design through construction

Use of Revit Architecture for collaboration among design office, general construction contractors and subcontractors

The Kitasato University campus is located in the city of Sagamihara, Kanagawa Prefecture. On this campus, the Kitasato University Hospital Smart Eco-Hospital Project (tentative title; hereafter “New Hospital Project”) is being constructed. The new hospital will be an enormous one with complex functions. It will be a 14-story building with one basement floor, covering a total floor area of 92,700 m². It will be a seismically isolated structure of reinforced concrete and steel-reinforced concrete construction. The hospital will have 757 beds (total 1033 beds including the existing new wing).

Study of the project within the university began in 2005. The designer was selected in July 2009, and the construction companies were selected at the end of 2010. Construction began in September 2011 and is expected to be completed by the end of December 2013.

When completed, the new state-of-the-art hospital will replace the existing university hospital that was built more than 40 years ago, and it will be in the vanguard of medical progress for the next few decades.

This project has attracted a great deal of attention, not only for the nature of the state-of-the-art facility itself but also because of the full-fledged use of BIM as a tool for the efficient promotion of design and construction.

BIM has already enabled the processes up to now to be promoted smoothly. In the following pages, we will take a detailed look at the role of BIM in this project, centering on Autodesk Revit Architecture, to see whether it enables smooth collaboration among owner, designer and construction companies and what issues have been arisen in its use.
1 Consensus-Building with Client
Dynamic interchange between owner and designer made possible by the intuitive understanding achieved using 3D models made with Revit Architecture

Revit Architecture, a BIM tool, has been used for the design of this project from the outset. The unique nature of BIM has played a major role in the ongoing communication between client and designer throughout the course of the project. We asked both client and designer to tell us in detail about the role played by Revit Architecture in this project.

Core & shell approach achieves flexibility
“Above all, we wanted to create a hospital that was flexible. That’s the first thing I said to Mr. Fujiki about our needs.” So says Akitaka Shibuya, M.D., Ph.D. Vice Director, Kitasato University Hospital. Professor Shibuya is promoting the project as Assistant Director of the New Hospital Project Division. Professor Shibuya says that, at the new hospital that will play a leading role in medical care in the coming decades, the flexibility to respond rapidly to change will be indispensable in order to maintain an environment capable of state-of-the-art medical care in the constantly advancing field of medicine.

Makoto Fujiki, Assistant Director of the Design Department at Nikken Sekkei Ltd., who was in charge of the design of the new hospital, is an architect who has spent most of his career designing medical facilities. He says he was able to understand Professor Shibuya’s need for flexibility immediately.

“In order for a facility to remain an advanced medical environment for decades, it has to be designed for long life and flexibility,” says Mr. Fujiki. “For this reason, we used a basic approach known as “core & shell” for the planning of the hospital.” The elevators and vertical pipes and other parts of the structure that link the building vertically were placed in the central core and in the periphery (the “shell”). The other areas were designed so they could be flexibly partitioned and so on as needed. As we will see in the discussion of the design phase in the next section, this core & shell approach makes it possible to check detailed arrangements regarding equipment piping and so on at the detail design stage, and enables the interface arrangements on the construction side to be reassessed in order to reflect the results.

3D depiction as requested by the owner
According to Mr. Fujiki, one of the reasons leading to the decision to use BIM for this project was the desire on the part of the client, expressed at the design meeting, to use 3D models. Professor Shibuya said the reason was that 3D models enable an intuitive understanding of the design.

A 3D image created based on BIM data, showing the finished color, texture and even furniture. Such images make it possible to convey the design of hospital rooms to the owner in an easily understandable form.

Mockup of actual louver
Digital mockup of louver

The louvers on the outer wall are a major feature of the exterior design. Digital mockups were used to study the louvers at meetings. Subsequently, work focused on the design, and a mockup of the actual louvers was prepared. When the actual mockup had been completed, meetings were held to study the outer wall colors, also based on 3D perspective drawings.
After being put in charge of the New Hospital Project, Professor Shibuya visited the research institutes of general construction contractors and various construction companies to gather information. In the course of doing so, he realized that BIM was a powerful tool for promoting projects from a client’s standpoint. Unlike two-dimensional drawings, 3D models make it possible to print perspective drawings from a variety of perspectives, making it possible for even people who are not specialists in the field of architecture to gain an intuitive understanding of the design. Professor Shibuya says that, at the proposal stage when the designer was being selected, he checked with the participants at the meeting to see whether it would be possible to use 3D models.

“What we want to understand about the proposed design is not how it looks but how it functions,” says Professor Shibuya.

“We need to know whether it will function satisfactorily as a medical facility, how the staff and patients will be able to move around in the course of medical treatment and so on.” From the plan views or section views, they need to be able to determine things like the following. Is there enough space in the hospital rooms for a nurse to transfer a patient from a wheelchair to the bed? To what extent can a nurse walking in the corridor see into the hospital rooms? How bright is the interior of the hospital that is illuminated by the natural light from the windows? Even for someone with a knowledge of architecture, it is undoubtedly difficult to get a clear picture of these actual use aspects merely by looking at plan and section views and so on. If the owner who will actually use the facility could gain a visual understanding of the designer’s proposal, it would be possible at that point to predict movement during medical care activities and determine further aspects for improvement. The use of the BIM tool Revit Architecture was able to achieve that type of design for this project, with the client and the designer working together.

Determining the needs of hospital staff

It is not only Professor Shibuya who is aware of the advantages of 3D models that enable people to gain a visual understanding of the proposed design. Takao Udagawa, who was involved in the New Hospital Project as the Assistant Manager in Charge of Special Assignments at Kitasato University Hospital, is another person who has high hopes for the easily understandable 3D models created using BIM. Based on the experience of being involved in the construction of the existing new wing of the Kitasato University Hospital that was completed fourteen years ago, Mr. Udagawa feels that there is a qualitative difference in the understanding of the hospital staff in the meetings held at the time, using primarily two-dimensional drawings, and the current meetings that are based on 3D models.

“For example, if nurses are able to get a clear grasp of the room planning and placement of furniture in their departments at the design stage, we can draw them out on their opinions about how to make further improvements,” says Mr. Udagawa. “From this point on, we’ll start on that process, and I have high hopes for it.”

“We’re at the stage at which we’re going to ask the people in each department about their needs for the room divisions in that department, and BIM will be a useful tool for this purpose,” says Mr. Fujiki. “We needed to be able to show them the area of each room, the placement of windows on the walls and other aspects of the medical areas that are difficult to determine just from plan view.”

Beyond mere 3D: the potential of BIM in showing space utilization based on the movement of shadows

Up to this point, the use of 3D models has provided results as expected. However, Professor Shibuya says that in some situations he has sensed advantages that only BIM could provide.

“When I viewed a video showing what kind of shadows would fall on the outside of the new hospital depending on the time, I realized that this could be used for studying space utilization as well,” said Professor Shibuya. “For example, we could put individual hospital rooms in the locations with the most exposure to sunlight, and put the staff meeting rooms in the areas without such good access to sunlight.”

BIM can also be used to calculate sun shadows, artificial light and other aspects based on the 3D model that has been designed. This example shows how the power of BIM can help achieve the type of facility desired by the client.

Facility management (FM) is another use of BIM that is frequently cited, one that goes beyond simple 3D. Reportedly Professor Shibuya had facility management in mind from the outset in wanting to use BIM. “You can see all the way to the rear of the rear of the building, so I think BIM will be useful in conducting repairs and maintenance after the building has been completed,” he says.

Mr. Fujiki is in agreement on this point. “BIM data will be useful for maintenance as well,” he says. “I feel that BIM will be a big help in facility management.”

Shared vision of the new hospital among participants

The New Hospital Project has just entered the construction stage, and work is progressing toward completion in December 2013. The project has attracted a great deal of attention as a hospital that will enable advanced medical care when it is completed, and it is certain that many people from within Japan and overseas will come to tour the facility. When asked whether he would recommend the use of BIM to visitors who are planning hospital construction of their own, Professor Shibuya’s response was immediate. “Without a doubt, yes.”

“Another advantage of BIM is the video introducing the project that we’ve posted on the hospital’s website,” he said. This video shows not only views of the exterior of the new hospital but the interior, the structure and so on, all in 3D.

“The hospital currently has a staff of approximately 2,000, but they’re all very busy and there are few opportunities for them to be involved in the New Hospital Project,” says Professor Shibuya. “But by viewing this video, they can gain an understanding of the new hospital and feel like they’re a part of the project. I think that’s important. Also, the graduates of the university who are now active in society in various parts of Japan can also see the video and gain an interest in their alma mater.” This is also something with major impact provided by BIM.

Finally, we asked Professor to evaluate the design created using BIM. “It enables you to see all the way to the rear of the rear of the building and so on,” he said. “At this stage, it has exceeded my expectations.”
2 Basic Design and Detail Design
Reducing reworking at the construction stage through front-loading with BIM used for the overall design

The use of BIM in Japan has just begun, and the support environment is far from complete. Accordingly, from the detail design stage onward, the construction companies teamed up with the designers who had decided to use BIM for the design of this complex, large-scale hospital project, and they contributed to the design through their expertise as builders. From the perspective of their pioneering efforts, we asked them what they thought about the potential of BIM, methods for ensuring its effective use and so on.

Complex design handling enabled by BIM
Mr. Fujiki, Nikken Sekkei Ltd., who is in charge of the design on this project, decided to use BIM from the earliest stages. One of the reasons for this decision was the aforementioned desire of the clients to use 3D perspective drawings. But there was another reason as well: the complex shape and complex, large-scale functions of the hospital that he was attempting to design. Mr. Fujiki is an expert in hospital architecture, and he anticipated that many changes would arise in the course of the design and construction of such a structure.

“So some people within the company said it was foolish to use BIM to design a large-scale hospital,” says Mr. Fujiki. “But I thought that, because of the large scale and complex nature of the building, accurate and efficient design would not be possible without the use of BIM.” A method that relies primarily on 2D drawings, in which design, structural and equipment design data are handled separately and combined when needed, is not capable of handling complex designs like the one for this hospital. Mr. Fujiki thought that, with a BIM 3D model, these different types of data could be integrated and unified, enabling the design, structural and equipment design data to be referenced individually and allowing the design work to be promoted efficiently. This was the first time that Mr. Fujiki had used BIM, but he had heard about its potential and had used it for the basic design. And, as noted earlier, he had realized that, for a complex, large-scale building in particular, BIM was needed to provide an integrated grasp of the design, structure and equipment. So he decided to use BIM in a quest to create a “new way to produce buildings.”

Detail design using BIM, with collaboration between designer and construction companies
In conventional projects, in which the design and construction are contracted separately, the construction company is usually selected after the detail design has been finalized. In this project, however, due in part to the intent of the owner, the construction companies were selected at the point at which the basic design had been completed. The three construction companies that were selected — Takenaka Corporation, Kinden Corporation and Toyo Netsu Kogyo (Tonets) Corporation — needed to work together on the detail design. So, together with Nikken Sekkei Ltd., they began working on the detail design using BIM.

Genichi Mori, Manager of the Design Section, Product Division, Design Department in the Tokyo Office of Takenaka Corporation, was in charge of the detail design. He says that the decision to use BIM for the detail design was a major one for the construction companies as well. Given the current state of BIM, in which an environment for full-fledged dissemination and use has not yet been established, the decision to embark on the full-fledged use of BIM for this type of large structure was seen as adventurous in some ways. However, Mr. Mori, who had used BIM for design on other structures, was certain that the nature of this project meant that the use of BIM would provide major advantages.

“In design using two-dimensional drawings, for example when you’re producing a 1/50 detailed drawing from the basic 1/150 drawing, after you finish the 1/50 drawing you need to put the two drawings next to one another and compare them,” he says. “And if changes arise, you have to correct each of the drawings separately. With BIM, you can create drawings of multiple scales automatically from a single model, so you only need to make the correction once. And you never need to worry about discrepancies among the drawings.”

In a large-scale hospital with complex functions, the interface between the building and the equipment is necessarily complex. To handle this complexity, Mr. Fujiki decided from the earliest stages of the basic design work that the abilities of BIM, which provides 3D CAD capabilities and also functions as an architectural database that handles a wide variety of data, would be needed.
Revit Architecture 3D models can automatically generate drawing data with three different scales. In the screens shown above, if the room division is changed on the 1/150 drawing (for example), the change is reflected simultaneously in the 3D model, the 1/250 drawing and the 1/50 drawing. This makes the process easy even for people who are using Revit Architecture for the first time.

Revit Architecture enables drafting to be created with intuitive ease of use.

1. Indicates drawing area in explanation

2. The number of doors is increased by copying the door on the left and pasting it on the right.

3. The selected door is colored blue.

4. As soon as an object is pasted, it appears on the aforementioned detailed drawing and on the 3D perspective drawing at left.

5. The direction in which the door opens has been changed to the opposite direction. The results are reflected immediately in the detailed drawing and the 3D perspective drawing.

The figure can be enlarged to make the work easier.
Project BIM tools
In this section, we will take a look at the BIM tools used in this project.

In the basic design, the main tool that was used was Revit Architecture. A comparison study was conducted for multiple tools in order to select the BIM tools to be used. Mr. Fujiki says Revit Architecture was selected because of its outstanding score in terms of data compatibility with AutoCAD and other programs, ease of use and all-around capabilities.

In the detail design, the team members expanded to include designers, construction personnel and those involved in structural, equipment and other types of design. Each of the specialist tools that they used in their respective fields were added to the tools used for BIM. Different dedicated CAD data was used for the skeleton and the equipment, based primarily on the detailed 3D model constructed with Revit Architecture that was based on the design 3D model that had been prepared at the basic design stage. The data were exchanged using Navisworks, a program whose specialty is data integration.

Naturally other programs were also used in addition to these tools. For example, 3ds Max was used to prepare more detailed computer graphics, and AutoCAD was used to handle two-dimensional drawings.

The outstanding data compatibility of Revit Architecture that had been selected for the basic design stage enabled BIM to be used smoothly throughout the detail design stage.

Front-loading of interference checks, etc. increased the efficiency of the overall process
For the detail design, Mr. Fujiki aimed for a “new way to produce buildings.” In this effort, one of the things he hoped BIM could do was to front-load the equipment and building interference check and so on, which are usually performed at the construction stage, to the design stage. The aim was to use front-loading to reduce the reworking needed at the construction stage and improve efficiency at that stage. Toyo Netsu Kogyo Corporation and Kinden Corporation, which were in charge of equipment for this project, were able to use the building data in the detailed 3D model to study the piping arrangements, etc. in the data to perform the building and equipment interference check prior to construction. This also made it possible to change the design of the interface arrangements and so on for the building when necessary.

“Normally in a building with such complex functions, a great deal of reworking needs to be done at the construction stage,” says Mr. Fujiki. “However, if the designer and the construction companies are able to use BIM and reduce the amount of reworking that will raise the consciousness of everyone at the site, and ultimately this will benefit the owner.”

As has been mentioned earlier, one of the factors that enabled this type of front-loading was the fact that the construction companies were selected prior to the detail design and was able to participate in the detail design. Another factor was specific to this project, says Eiichi Hosoda, who served as Work Site Manager. The core & shell that became the foundation of the building was finalized at an early stage. This enabled the front-loading of various studies of details that previously could not be done until the construction stage.

“Even if you do the piping arrangements and the interference check at the design stage, if the skeleton changes, you’ve got to do them all over,” says Mr. Hosoda. “But for this project the core & shell had been established as the design intent, so we were able to move ahead on our studies with confidence.”

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Study of shafts on transition floors (6F - 7F)

On the transition floors between the low-rise wing and the high-rise wing, the shape of the piping space was also complex, and various types of piping arrangements had to be placed in a complex manner. It was difficult to determine the shape of the space merely by consulting plan views, section views and other two-dimensional data. Loading the 3D model created in Revit Architecture into the equipment dedicated 3D CAD model enabled the complex piping design to proceed smoothly.
BIM Manager: Indispensable for the use of BIM

The presence of affiliate companies with a thorough knowledge of BIM is said to have been a major factor ensuring that data integration proceeded smoothly from the basic design through the detail design, and that the enormous volume of detail design data was constructed in a stress-free manner. BIM’s capabilities are not limited to creating 3D models. By providing the model with various types of building data, it is possible to output drawings and perspective drawings, determine part and member quantities, output member fabrication data, create history data that can be used for facility management and so on. In other words, it can model all of the “I” (information) in BIM.

Because any type of information can be entered, however, it is essential to identify how the data have been constructed. If an enormous quantity of switches and outlets are entered as 3D data, the quantity of data will become too large, and this will result in stress when moving the model. For this type of data, two-dimensional drawings are provided, and the functions of Revit Architecture which can display these drawings within a 3D model are used to check compatibility with the 3D model. Mr. Mori says BIM is a useful tool, but design costs will be adversely affected if the amount of time and trouble becomes too great. He says it is important to determine the degree to which information should be provided.

In this way, Mr. Fujiki emphasizes that a BIM manager is indispensable. The BIM manager should have a thorough familiarity with BIM functions and should be aware of the manpower and hardware resources that are available and so on, and should be able to play a role in creating rules for the efficient construction of BIM data.

The detailed 3D model created in Revit Architecture was kept to a single file with a file size of approximately 400 MB. This was done to make it easy to use as an architectural database. However, as the entire building was not needed when creating drawings or making corrections and so on, the overall data were divided into several working sets. One of the important roles of the BIM manager was to consider the type of data configuration and make sure the staff members were familiar with the configuration.

“Even in conventional design methods, there is a head staff member who brings the staff together under the designer, who is the leader, to manage the compatibility of drawings and so on,” says Mr. Fujiki. “If you’re using BIM, that role would be handled by the BIM manager.”

For this project, the BIM consulting firm 3D Innovations, Inc. which is knowledgable about Revit Architecture, played this role in the basic design. 3D Innovations, Inc. participated in the detail design with the same role, and reportedly this made a major contribution to the smooth use of BIM.

“The 3D model used in the project was made a single file to enable direct access to all of the data,” says Mr. Mori. “It’s a 400 MB file, and several staff members use it to build and correct the model. In order to proceed with the work in a stress-free manner, portions of the data are split off into working sets. It is the BIM manager who determines how to split off the data.”

As Mr. Fujiki had hoped, the detail design created using Full BIM, with collaboration between the designer and the construction companies, was done while front-loading various detailed studies. In line with expectations, the design was completed in a short period (approximately six months).

Superimposition of the building and the piping on the underground floor for the equipment interference check. As this building is a seismically isolated structure, in the event of an earthquake the skeleton will move out of sync on the floors above and below the seismic isolation equipment. The parts of the model were moved separately (using Revit Family and Navisworks) in order to confirm that there would be no interference between pipes even in such situations.
3 Construction

The understanding of the overall building provided by the detailed 3D model enables construction documents to be generated smoothly.

Issues faced at the dawn of BIM

At the start of the detail design, the design team’s vision was to provide greater detail to the 3D models created with BIM in order to prepare construction documents at the site. In reality, however, two-dimensional data were output in AutoCAD from the 3D model when the detail design had been completed. Based on the data, the construction documents were prepared on top of the two-dimensional drawings. The reason for this decision was clear.

“This was a large-scale work site. So even for the comprehensive diagrams, which were the main interface arrangements needed for the construction documents, 16 to 20 A1 size drawings were needed for each floor,” says Mr. Hosoda. This large quantity of drawings had to be prepared rapidly in accordance with the progress of work at the site, to meet a demanding work schedule, and the interface arrangements needed for the construction documents had to be added to the detailed data in the detail design.” When 3D models are used, a number of operators with a knowledge of architecture must be mobilized. But as the use of BIM has only just begun, Mr. Hosoda said it was difficult to secure the necessary number of persons who both knew how to use Revit Architecture and had an understanding of the interface arrangements for construction. So the decision was based on the fact that the project was a large-scale construction project with a short deadline.

Currently, such personnel can be secured in the case of AutoCAD, and this situation will undoubt-edly change as the use of BIM becomes more widespread. At Takenaka Corporation, affili-ate staff members are now being used as Revit Architecture operators with the aim of accumulat-ing technology and expertise in preparation for promoting the use of BIM in other projects as well.

Schedule and overview of work from the detail design stage to the initial construction stage. “Plan A” and “Plan B” in the detail design are for the purpose of reflecting in the model all of the changes to the design that are made while the data is being entered into the detailed 3D model. Many staff members have a knowledge of interface arrangements and can also use AutoCAD, but there are still not many with a knowledge of interface arrangements who can also use Revit Architecture. The staff for this project are being selected with the goal of personnel training also taken into consideration.

Use of 3D-CAD enables the same 3D data to be used from design drawings to comprehensive drawings.

- Design drawing data that can be used for comprehensive drawings can be incorporated.

At the stage of preparation of the construction documents, comprehensive drawings were prepared based on the AutoCAD data output from the 3D model created using Revit Architecture, and the AutoCAD data output from the dedicated equipment CAD model. The equipment interference check was done by incorporating into Navisworks the Revit Architecture data and the 3D DWG data output from the dedicated equipment CAD. Part of this process was front-loaded to the detail design stage.
Using the detailed 3D model for the design study
Since the construction documents were prepared based on two-dimensional drawings, one might suppose that the 3D model for the detail design was not needed. Nothing could be further from the truth. For one thing, as has been mentioned earlier, the 3D model was used throughout the entire construction process for consensus-building with the owner. Although many aspects were able to be front-loaded to the detail design stage, naturally various design studies have to be conducted with the owner even after operations at the site have begun. For example, many issues need to be discussed with the staff of each of the departments in the new hospital from this point on, such as the color and materials used to finish the interior.

Normally such design decisions are not made using only 3D perspectives, no matter how realistic the depictions are. Samples and numerous mock-ups are prepared in accordance with the construction schedule.

Construction 3D models useful for equipment construction as well
Toyo Netsu Kogyo Corporation and Kinden Corporation, the companies that handled the equipment construction, performed not only the interference check for the piping, etc. that had been front-loaded to the detail design stage but also the preparation of the equipment construction documents, using the detailed 3D model created in Revit Architecture.

One reason for doing this was that, although normally the skeleton data must be entered into the dedicated equipment CAD while consulting the architectural drawings, for this project it was done by outputting compatible data from the detailed 3D model and loading it in, enabling both speed and accuracy to be increased.

Another reason was that the information about how useful the 3D models would be had come from Mitsuo Tanimura, Manager of the Equipment Construction Section at the site. “Because it’s such a complex building, it’s not easy to comprehend information about, say, how the equipment piping is placed just by looking at two-dimensional drawings,” says Mr. Tanimura. “A 3D model enables you to view the shape of a detailed section from a variety of angles, so it’s easy to gain a visual understanding of it, and I think that also increases the speed with which the equipment piping construction drawings can be prepared.”

Yoshiharu Fujita, Toyo Netsu Kogyo Corporation agrees. He says that 3D models make it much more quickly and easily to understand the space in which the equipment and pipes are fit.

Daisuke Honma and Kazutoshi Nomiyama of Kinden Corporation, which is in charge of the electrical work, too, cited the wiring of the ground cables for the lightning rod on the roof of the building as an example of the advantages of these types of 3D models. Due to the presence of a heliport on the roof, the differences in height on the roof were complex, so it was necessary to get a three-dimensional picture of the entire roof to do the ground cable connections properly. Accordingly, they reportedly viewed 3D models with the roof area enlarged.

“If you’re a specialist, then maybe you could get the same level of understanding from looking at plan views and section views. But it’s actually really difficult to understand design drawings,” says Mr. Tanimura. “Another huge advantage of 3D models is that you can share the shape no matter what parts you slice out.”

Potential of BIM based on experiences at the work site
At the work site where the construction work is currently underway, the building construction has not yet gotten to the stage of finishing or other complex detail work. But at that stage as well, the use of 3D models is anticipated, not only for the preparation of construction documents but for actual construction. Looking at the 3D model for a section before starting the construction work makes it possible to get a clear grasp of what is to be constructed. The more complex the location, the more the efficiency of the construction work will be affected by whether or not construction personnel have a clear understanding of exactly what is to be built. “BIM made it easy to get an understanding of the entire building,” says Mr. Hosoda. “Even in the places we’ve worked on up to this point, it had a major impact on the understanding of the workers at the site.”

We asked Mr. Hosoda, who was using BIM for the first time in this project, whether he planned to use it in future projects as well. He said he was considering using Full BIM up through the construction documents stage. It appears that there is a real sense that, as the number of operators is increased and other elements of the use environment are put in place, the use of BIM will expand, and the advantages of its use will increase as well.

Deployment to comprehensive drawings using 3D data

- Finishing schedules were also prepared using 3D-CAD (Revit)

Plan view data output from the 3D models created in Revit Architecture and used as the basis for comprehensive drawings. The finishing schedules were also output from the 3D models.

Skeleton model prepared using the dedicated skeleton 3D CAD program (J-BIM construction document CAD). The skeleton drawings were output from these data. Although not done for this project, it is also possible to perform simple estimations for concrete, formwork and steel reinforcements from the skeleton model.

Equipment 3D data prepared using the dedicated equipment 3D CAD program (CADWe’ll-Tfas). The data were entered in the form of a construction document.
Future Expectations and Prospects for BIM Use

Future Issues and new ways of using BIM revealed through its use in the complex, large-scale hospital construction project

BIM is a tool that is expected to bring about new ways of constructing buildings.

In this section, we take a look at current issues with BIM that were revealed through its use in this project, new ways of using BIM that are anticipated, and future expectations for BIM use.

**Issues**

This project revealed several current issues that must be resolved in order to use BIM for the construction of large-scale, complex buildings:

(1) **In consensus-building with the owner**

For this project, the owner requested that meetings be held based on BIM. Our research for this article confirmed that efforts to use BIM were conducted in order to meet this request. However, some on the owner’s side (Professor Shibuya) had hoped for an even more prompt response. These people wanted a laptop computer to be brought to meetings so the 3D model could be viewed and changed and thereby refined on the spot. It seems evident that these people felt this way based on their own experience of having meetings based on 3D perspective drawings, and in the course of these meetings gaining a real sense of how easy 3D perspective drawings could make the process.

Mr. Fujiki apparently wanted to try this if the resources allowed, but the response would undoubtedly be different depending on the designer, due in part to the fact that some parts of the design need careful consideration. For this reason, it is essential to hold discussions with the owner and identify the areas that require meetings and those that may not necessarily be so important and adjust the use of BIM accordingly. In any event, a method must be found to hold meetings between the owner and designer that combines both promptness and scrupulousness.

(2) **At the design stage**

The BIM manager plays an important role in ensuring the successful use of BIM, for example by creating rules for the types of data that should and should not be incorporated into the 3D model.

At present, there are not many people who have this kind of capability, and whether a suitable person can be found for the project in question will be a major factor determining success.

(3) **At the construction stage**

At work sites where large quantities of construction documents must be produced quickly, securing an adequate number of BIM operators with a knowledge of architecture will become a problem. Producing construction documents from the detailed drawings in the detail design requires a knowledge of the interface arrangements for construction, such as the positional relationship of connecting members. With AutoCAD and other 2D CAD programs, it is not difficult to secure people with the required expertise. However, there still tends to be a shortage of BIM operators, so future training of operators is another issue that needs to be resolved. Of course, this is a problem that will be resolved as BIM comes into more widespread use.

(4) **Use of BIM data after completion**

The larger and more complex the building, the greater the maintenance, renovation and other costs will be throughout its service life. BIM data is expected to be useful in facility management (FM), enabling such buildings to be managed efficiently. In this project as well, both the owner and the designer were aware of this possibility. However, in order for BIM to be used in facility management, the BIM data created for design and construction will need to be converted to data for FM use. Many issues need to be studied for the use of BIM data in facility management, including: What BIM data are needed? What data should be added for FM? What level of costs will be produced in this process, and who will cover them? (etc.)
New anticipated uses

Mr. Mori, Takenaka Corporation, who was involved in the project from the construction side, has a detailed knowledge of BIM and has used it in other projects as well. He has many ideas regarding how BIM can be used. These ideas are examples of the use of BIM in combination with Revit Architecture, Navisworks and other Autodesk products.

Here are a few of them.

(1) In manufacturing
In most projects, similar sectional shapes are used for curtain boxes and so on. The data for these shapes are loaded in from the 3D model created in Revit Architecture and transferred to Inventor, Autodesk 3D CAD program for mechanical design, and CAM data for manufacturing are added. This makes it possible to perform actual manufacturing with the data. The data can be parametrically deformed, so if several types of section shapes are prepared, they can be used in a variety of projects.

(2) In design
Adding the unit cost and so on to the attribute data included in the BIM data for members and parts makes it possible to conduct estimations directly from the BIM data. A study must be conducted to determine the extent to which data should be entered. In this project, a dedicated 3D CAD program was used for the skeleton drawings, but the quantities of concrete, reinforcements and formwork can be easily estimated from the model.

(3) At the work site
Using Revit Architecture to determine the placement of the scaffolding improves the accuracy of construction planning. Simplified on-screen representations of the scaffolding units can be placed around the 3D model of the building quickly to enable detailed perspective drawings and drawings to be output (and this was done on a trial basis in this project).

Moreover, in Navisworks, which was used for the interference check, time data can be assigned to each of the objects included in the model to establish the date and time at which that object is expected to be constructed. If this is done, the objects can be displayed on a time axis to visually depict the construction schedule.

Moreover, the interference check function of Navisworks can be used to study the placement of cranes at the site. The 3D model created in Revit Architecture can be used to visually determine a placement that will minimize the movement of the crane arm (and this was done on a trial basis in this project).

Significance and effect of this project

The Kitasato University Hospital New Hospital Project was a pioneering effort in the full-fledged use of BIM.

This was the first project in Japan in which BIM was used for a large-scale construction project from basic design through construction, and with the aim of using it in facility management as well.

Moreover, the Kitasato University Hospital was a famous project that attracted considerable attention both at home and abroad.

The use of BIM for a building with an outstanding complex shape in design terms, and one with complex functions, is also noteworthy.

Mr. Fujiki, Nikken Sekkei Ltd. used the term “epoch-making” to describe the full-fledged use of BIM in this project, and we agree with his assessment.

In this major endeavor, the benefits of BIM were received by all of the people involved in this project — owner, designers, construction company personnel and personnel at affiliates. The success of the project will undoubtedly have a major impact on the client stance, design process and building production in future projects, and will certainly result in major achievements.
Autodesk products used

**Autodesk Building Design Suite**
Combines Building Information Modeling (BIM) and CAD tools to help you design, visualize, and simulate more efficiently. Design and build better buildings with a comprehensive building design software solution.

**Autodesk Revit Architecture**
Designed to function in line with architects’ and designers’ wishes to enable them to prepare accurate, high-quality building designs. Built for Building Information Modeling (BIM), Revit Architecture helps you to capture and analyze design concepts, and more accurately maintain your vision through design, documentation, and construction. Models containing a wealth of information are used to ensure that consensus-building is based on as much information as possible, in order to support sustainable design, construction planning and processing. The automatic update function ensures that designs and design documentation are always consistent, increasing reliability.

**Autodesk Navisworks**
Enables architecture, engineering and construction specialists to maintain appropriate control over the results of the project. Integrate, share, and review models and multiformat data with all your project stakeholders. A comprehensive set of integration, analysis, and communication tools helps teams better coordinate disciplines, resolve conflicts, and plan projects before construction or renovation begins.

**Autodesk 3ds Max**
Provide powerful, integrated 3D modeling, animation, and rendering tools that enable artists and designers to focus more energy on creative, rather than technical challenges.

**AutoCAD**
Design and shape the world around you with the powerful, flexible features in AutoCAD® 2013 software, one of the world’s leading 2D and 3D CAD design tools. Maximize productivity by using powerful tools for design aggregation and documentation, connecting and streamlining your design and documentation workflows.

**Autodesk Inventor**
Contains a variety of flexible tools to aid in mechanical design and analysis, mold design, engineering-to-order and design communication. Using Inventor for product design, visualization and analysis makes it possible to locate and resolve problems prior to manufacture and achieve perfect digital prototyping. Digital Prototyping with Inventor helps companies design better products, reduce development costs, and get to market faster.

**Introduced products / solutions**
- Autodesk Revit Architecture
- Autodesk Navisworks
- AutoCAD
- Autodesk 3ds Max
- Autodesk Inventor

**Purpose of introduction**
- As a design handling tool for complex, large-scale projects
- As a BIM design tool for use up through the detail design stage
- As a tool for creating 3D models for owner meetings
- To increase the efficiency of construction through front-loading
- As a tool for preparing construction documents
- As a tool for collaboration between designers and construction companies

**Key points for introduction**
- Ease of use of 3D model data
- High data compatibility with multiple programs
- Convenience and functionality as a BIM database
- Data linkage with dedicated equipment 3D CAD and dedicated skeleton 3D CAD and other programs

**Effect of introduction**
- Enhanced consensus-building with owner
- Improved owner satisfaction
- Smooth design handling
- Achievement of BIM design
- Reduction of construction reworking due to front-loading
- Smoother collaboration between designer and construction companies
- Greatly improved understanding and grasp of overall building on the part of site workers

**Future issues**
- Training of BIM operators
- Full BIM use including construction documents
- Use in estimation
- Use in facility management

**Overview of project**

<table>
<thead>
<tr>
<th>Title</th>
<th>Kitasato University Hospital Smart Eco-Hospital Project (provisional title)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>Kitasato University Hospital</td>
</tr>
<tr>
<td>Design / Supervision</td>
<td>Nikken Sekkei Ltd.</td>
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<tr>
<td>Detail Design</td>
<td>Nikken Sekkei Ltd., Takenaka Corporation</td>
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<tr>
<td>Construction</td>
<td>Takenaka Corporation</td>
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<tr>
<td>Period</td>
<td>September 2011 - December 2013 (planned)</td>
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<tr>
<td>Total floor area</td>
<td>Approximately 92,700m²</td>
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<tr>
<td>Structure</td>
<td>Reinforced concrete / steel-reinforced concrete</td>
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<tr>
<td>Size</td>
<td>14-story building with basement floor</td>
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<tr>
<td>Use</td>
<td>Hospital</td>
</tr>
<tr>
<td>No. of beds</td>
<td>757 (1033 including existing new wing)</td>
</tr>
<tr>
<td>Notes</td>
<td>Selected as Ministry of Land, Infrastructure, Transport and Tourism</td>
</tr>
</tbody>
</table>

Introduction of “Model Project for Promoting CO2 Reduction in Housing and Buildings.” Uses seismically isolated structure.