The aim of these workshops and conference is to help transfer and spread newly appearing design technologies, educational methods and digital modelling supported by information technology in architecture. By organizing a workshop with a conference, we would like to close the distance between practice and theory.

Architects who keep up with the new designs demanded by the building industry will remain at the forefront of the design process in our information-technology based world. Being familiar with the tools available for simulations and early phase models will enable architects to lead the process.

We can get "back to command".

The other message of our slogan is "Back to command".

In the expanding world of IT applications there is a need for the ready change of preliminary models by using parameters and scripts. These approaches retrieve the feeling of command-oriented systems.

Why CAADence in architecture?

"The cadence is perhaps one of the most unusual elements of classical music, an indispensable addition to an orchestra-accompanied concerto that, though ubiquitous, can take a wide variety of forms. By personally selected or invented musical phrases, interspersed with previously played themes – in short, a free ground for virtuosic improvisation."

Edited by Mihály Szoboszlai
CAADence in architecture
Back to command
Edited by Mihály Szoboszlai
CAADence in Architecture
Back to command

Proceedings of the International Conference on Computer Aided Architectural Design

16-17 June 2016
Budapest, Hungary
Faculty of Architecture
Budapest University of Technology and Economics

Edited by
Mihály Szoboszlai
The aim of these workshops and conference is to help transfer and spread newly appearing design technologies, educational methods and digital modelling supported by information technology in architecture. By organizing a workshop with a conference, we would like to close the distance between practice and theory. Architects who keep up with the new design demanded by the building industry will remain at the forefront of the design process in our IT-based world. Being familiar with the tools available for simulations and early phase models will enable architects to lead the process. We can get “back to command”.

Our slogan “Back to Command” contains another message. In the expanding world of IT applications, one must be able to change preliminary models readily by using different parameters and scripts. These approaches bring back the feeling of command-oriented systems, although with much greater effectiveness.

Why CAADence in architecture?
“The cadence is perhaps one of the most unusual elements of classical music, an indispensable addition to an orchestra-accompanied concerto that, though ubiquitous, can take a wide variety of forms. By definition, a cadence is a solo that precedes a closing formula, in which the soloist plays a series of personally selected or invented musical phrases, interspersed with previously played themes – in short, a free ground for virtuosic improvisation.”

Nowadays sophisticated CAAD (Computer Aided Architectural Design) applications might operate in the hand of architects like instruments in the hand of musicians. We have used the word association cadence/caadence as a sort of word play to make this event even more memorable.

Mihály Szoboszlai
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Members of our local organizing team have supported this event with their special contribution – namely, their hard work in preparing and managing this conference.

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Kajima’s BIM Theory & Methods

Kazumi Yajima

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Abstract: KAJIMA [1] is one of the largest construction companies in Japan. We have been applying BIM to more than 350 projects in Japan for the last 4 years (740 projects worldwide). We believe that there is nothing comparable to this scale of BIM implementation in the world. What makes our BIM different from others is our collaborative approach both internally and externally. We plan when and how much BIM effort we assign to each project. In other words, we optimize our efforts to make our BIM efficient on each project, not only for ourselves, but for the industry as a whole. Flexibility is the essence of BIM collaboration. In general, it is said that front-loading is Key Success Factor (KSF) of BIM. However, we believe that the essence of KSF is to adopt BIM flexibly in each phase of each individual project.

Keywords: OPEN BIM, MacLeamy Curve, Yajima Curve, Global BIM®, IoT

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INTRODUCTION

KAJIMA was established in 1840. We are a Tokyo-based company with 12 branch offices in Japan. We are also a global company, with 4 regional headquarters in Europe, USA, Asia and Australia. We provide “Total Engineering, covering the life cycle of building construction.”

In our history, KAJIMA was first well-known for Western-style buildings, later for railways, skyscrapers and nuclear power plants. Now we want to be known as “OPEN BIM KAJIMA.”

We also have an official role to promote “OPEN BIM” internationally. Beginning this year, we are an invited member of the “Strategic Advisory Council” of buildingSMART International [2], which is the most prominent BIM standardization organization in the world. SAC consists of only 6 companies in the world and KAJIMA is the only company from the Asian region and from the construction industry.

We are No.1 by the number of BIM projects, too. In 2015, we managed approximately 300 BIM projects in Japan. The total number of BIM projects we have managed worldwide is now 740. In this paper, I would like to share our Theory and Methods based on our experience.

THEORY

Figure 1 describes the famous theory of Patrick MacLeamy [3]. The vertical line indicates the project-timeline, from Design till Operation. The green line indicates “Cost of Design Changes.” It shows that later, in the construction phase, the cost of design change is higher. The blue line is the “Ability to control cost.” It shows that you can control costs better in the earlier phases.
those two conditions, the optimized “effort curve” should be the RED line. This is well-known as the “MacLeamy Curve.” Compared to the traditional curve (shown in black), the MacLeamy Curve has its peak in the earlier stage of the project, in the design phase. Because of the influence of the MacLeamy Curve, the focus for most of the people has been BIM in the design phase.

Now we have a variety of BIM software and in the “OPEN BIM” world, many BIM Software are standardized and have interoperability among them. So, we can apply BIM at any phase of construction. Under these circumstances, BIM data can be driven by users and BIM data can be distributed for various purposes. In other words, you do not need to optimize BIM data at the early stage of a project; you can just use the existing data and do your best in your process.

In most countries around the world, design drawings typically include all information, and construction is carried out using this documentation. However, in Japan, design drawings usually do not have enough information for construction purposes and we need to re-create them by ourselves. It is a specific character of the Japanese construction industry, that construction companies create construction drawings by themselves.

Under these circumstances, the optimized effort curve is yellow, which I propose to call the “Yajima Curve.” If it is a Design-Build project, the MacLeamy Curve works quite well. However, if a construction company joins a project in the construction phase only, the Yajima Curve works better.

The Yajima Curve has 4 phases (Figure 2). The first is “Rapid Modeling”: It is a handover phase from Design to Construction. In this phase, construction companies analyze and thoroughly comprehend the design intent and transform them into a construction-BIM model as quickly as possible. Naturally, we spend significant effort in this phase.

The second phase is “Sharing”: We share the basic BIM model for project review as soon as possible. The third is called “Long Tail”: During the rest of the construction period, we continuously update the BIM data. Therefore, the BIM effort curve is shaped like a long tail. We maintain the BIM model to create construction drawings throughout the project, and use them for various purposes. The last phase is “Forward-Looking” described as an arrow. You can look back right at construction-handover. After that, you should look forward to use BIM for completing your project.
METHODS
Modeling & Drawing

Figure 3 shows the main flow of Modeling & Drawing. At first, we make a “Basic BIM model” for all projects. Next, BIM data is adapted flexibly for each project. Most of all, we use the BIM model for creating 2D construction drawings.

There are three reasons why we put so much effort into creating construction drawings. The first is to understand the designer’s intentions. As I mentioned, some Japanese design drawings do not include detailed shapes, dimensions, and specifications. So we clarify these and add detailed information to the construction drawings.

The second reason is to achieve the client’s needs. In Japan, even though the design phase is finished, the updated requests from the client are added and reflected. So we need construction drawings to keep track and organize those design changes.

The third reason is to maintain Quality, Cost, and Delivery. There are many hidden risks with regard to these. Therefore, in the process of making construction drawings, we examine and solve them one by one. In short, we, as a Japanese contractor, manage projects using BIM modeling and drawings.

BIM significantly changes the way construction drawings are created. Drawings are generated by cutting out from the BIM model and transforming them to plans, elevations, and sections. Next, we add some dimensions and hatchings using 2D functions. Moneywise, there is an obvious advantage, as well. With the help of BIM, the cost of creating drawings has been reduced drastically. In 2015, we achieved a 60% cost reduction compared to 2012.

We have also improved the quality of drawings (Figure 3 right). We improved the expression of construction drawings. Using BIM data, we are able to create 3D isometric drawings, thus we can deliver much more information to workers directly. It can improve the quality of buildings, too.
Flexible Production System

We built a modeling network similar to the supply chain of Japanese car manufacturers used worldwide. We have 3 modeling partners abroad, and 2 in Japan (Figure 4 Left). By collaborating with those modeling companies and using our cloud platform (Global BIM®), we can flexibly allocate staff to various projects and manage BIM projects effectively. In addition, we want to expand this supply chain to 24 hours’ operation and try to find partners in Central Europe and South America.

Global BIM® [4]

We have been using ARCHICAD® [5] for more than 20 years. In 2012, we started to use BIM Server and the TEAMWORK function in ARCHICAD 15. With this function, 30 people can work together on the same file, simultaneously. But at that time, this collaboration function could be used only in a closed network. So, we migrated it to a Cloud server and named it “Global BIM” (Figure 4 Right) in 2013.

Now we have Global BIM version 2. It is also on the Cloud server and based on BIMcloud® [6] technology. There are many small sub-contractors working together in site offices. We wanted to help them start using BIM with less investment. Using “ARCHICAD BIMcloud Team Client,” KAJIMA can lend licenses to them. Sub-contractors can freely install the “BIMcloud Team Client” on their PCs and can borrow our licenses through the Internet.

Automation Tools

To support BIM collaboration, we developed three systems—“BIMS,” “Automated Design Documentation” and “SMARTCON Planner.” “BIMS (BIM Issue Management System)” is for communication among BIM users. Because our modeling network expands abroad, BIM managers need to be able to handle requests from users and inform the modelers precisely. To make it smarter, we developed BIMS. It consists of an ARCHICAD add-on and a web-based system. If managers find some issues, they can add Pop-Up marks on the model and save screen-shots in ARCHICAD. At the same time, the data is uploaded to the web-based system to share with modelers (Figure 5 Left). BIMS will be distributed in global markets via Doalltech [7] as an add-on tool to ARCHICAD.

“Automated Design Documentation” is designed and developed together with AIDEA [8]. The purpose of this system is to remove repeated works for documentation including setting of scale, layer and drawing’s frame (Figure 5b).

“smartCON Planner” is developed for construction planning. Construction planning is the essential work of general contractors. We developed BIM parts written in GDL [9] and filed them as “smartCON Planner” (Figure 6). It includes many temporary objects such as cranes, shoring, and scaffolds. They also have menus, which can change GDL objects dynamically by changing parameters.

Figure 4: Flexible Production System with Global BIM
Figure 5a: BIMS,

Figure 5b: Automated Design Documentation

GENERATING REFLECTED CEILING PLANS
To make construction planning more efficient, we applied AI and automated its process. First, we set the basic BIM model on the ground. Following that, the program creates the excavation area by recognizing underground shapes. After that, the program allocates “Temporary Shoring,” “Temporary Struts,” and “Working Platform” automatically (Figure 7). We have an initial plan within a few minutes. Finally, site engineers can start further planning.

IoT

Now we are getting into IoT (Internet of Things). First, we started from “Formwork.” There are three steps for Formwork. The first is cutting wood plates to make panels at the factory. The second is assembling and adjusting those panels at sites, done manually by workers. If the panels are cut precisely, the assembling process is easier. The third step is removing those panels after casting the concrete. At first, we applied BIM during the cutting-wood-process. We optimize how to cut panels and allocate them on BIM and create input data for cutting machines. We can also estimate materials, and create “construction drawings” and “assemble process,” too (Figure 8). If we put them on tablets, workers can easily understand the working process on sites. With wireless technology, we can also automate on-site-work. By integrating data of various sites, we can optimize distribution of materials, as well.
Figure 8: Formwork automation with IoT

Automation of Formwork

Create Construction Drawing

Create Assemble Process Sheet

Estimation of Panel & Materials

Figure 9: BIM as Interface
CONCLUSION

In this paper, I introduced our theory and methods. I would like to show my future vision as a conclusion. We have been continuously thinking about the role of BIM. Initially, we tried to set BIM to the center of our production system. Now we think of BIM as an interface (Figure 9). BIM gives us a good interface for add-on tools and other programs. With these tools, we can provide various services to new customers. Now we are trying to change “our construction sites” into “Centers of IoT” (Internet of Things). We want to apply BIM to IoT for establishing a new production system. To make it possible, OPEN BIM must be expanded in both the construction industry and the manufacturing industry.

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http://www.kajima.co.jp/english/welcome.html


[4] GlobalBIM® is registered trademark in Japan by KAJIMA CORPORATION.

[5] ARCHICAD® is the product of GRAPHISOFT SE, see more at http://www.graphisoft.com/archicad/

[6] BIMcloud® is the product of GRAPHISOFT SE, see more at http://www.graphisoft.com/bimcloud/

[7] Doalltech Co., Ltd is a technology provider in Korea, an Official KAJIMA partner since 2016. See more at http://global.doalltech.com/


[9] GDL (Geometric Description Language) is the programming language of ARCHICAD® library parts, developed by GRAPHISOFT.
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The aim of these workshops and conference is to help transfer and spread newly appearing design technologies, educational methods and digital modelling supported by information technology in architecture. By organizing a workshop with a conference, we would like to close the distance between practice and theory.

Architects who keep up with the new designs demanded by the building industry will remain at the forefront of the design process in our information-technology based world. Being familiar with the tools available for simulations and early phase models will enable architects to lead the process. We can get “back to command”.

The other message of our slogan is <Back to command>.

In the expanding world of IT applications there is a need for the ready change of preliminary models by using parameters and scripts. These approaches retrieve the feeling of command-oriented systems, although, with much greater effectiveness.

Why CAADence in architecture?

"The cadence is perhaps one of the most unusual elements of classical music, an indispensable addition to an orchestra-accompanied concerto that, though ubiquitous, can take a wide variety of forms. By definition, a cadence is a solo that precedes a closing formula, in which the soloist plays a series of personally selected or invented musical phrases, interspersed with previously played themes – in short, a free ground for virtuosic improvisation."