3D/BIM applications toward construction innovation

IDDS & BIM Oneday Seminar
2013.11.1

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Shimizu Corporation

Outline of Presentation

1. Current state-of-the-art BIM applications

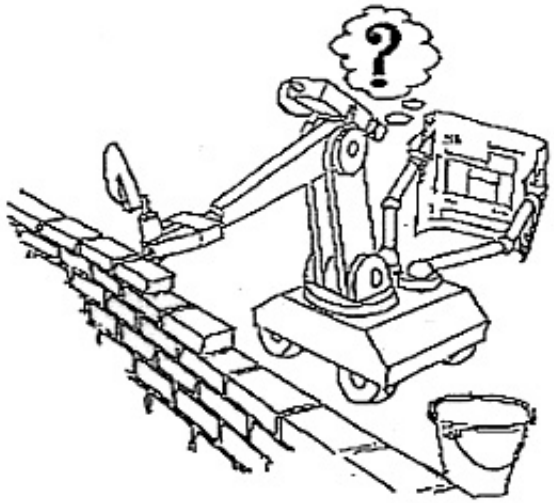
2. Concept of construction innovation by 3D/BIM and related research activities in CIB W78

3. 3D/BIM applications toward construction innovation in building construction projects

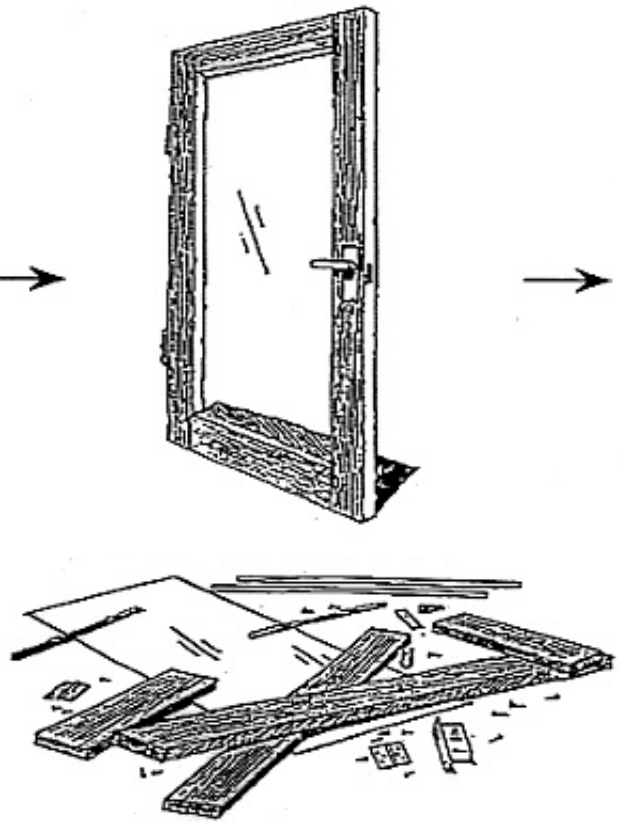
4. Future directions of BIM applications toward construction innovation

Concept of Product Model

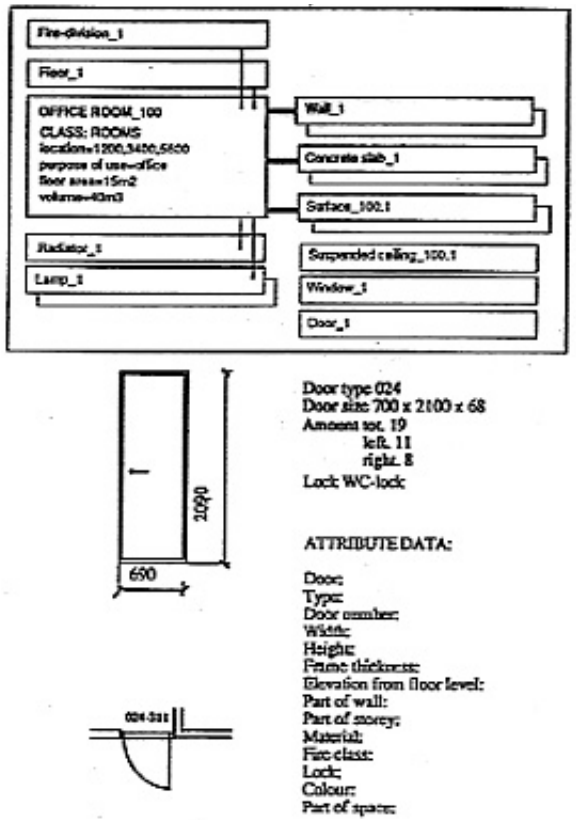
2D Model



3D Model



Product Model

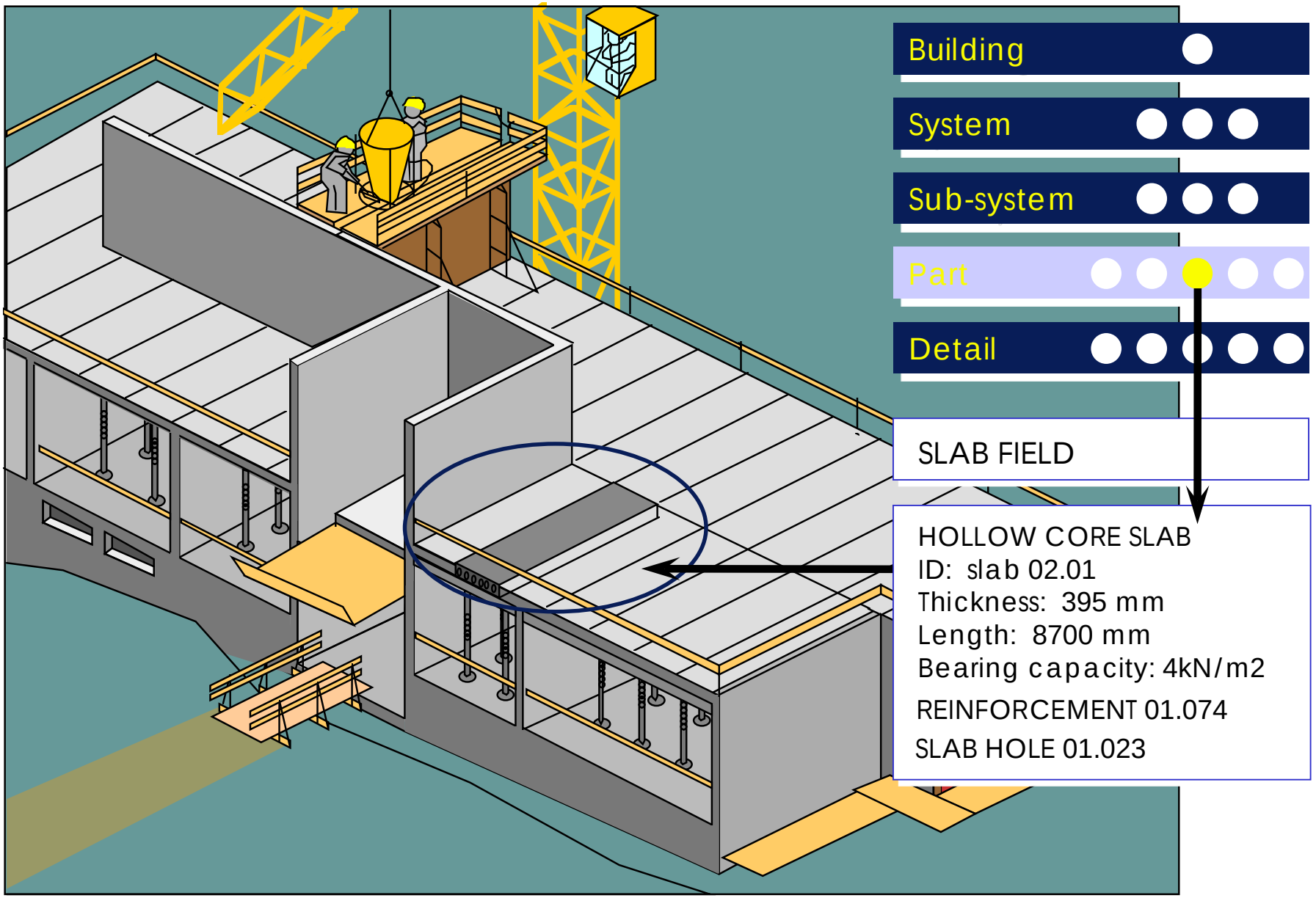


What is difference with Product Model and BIM?

Product Model : Machine/Production oriented information model ?

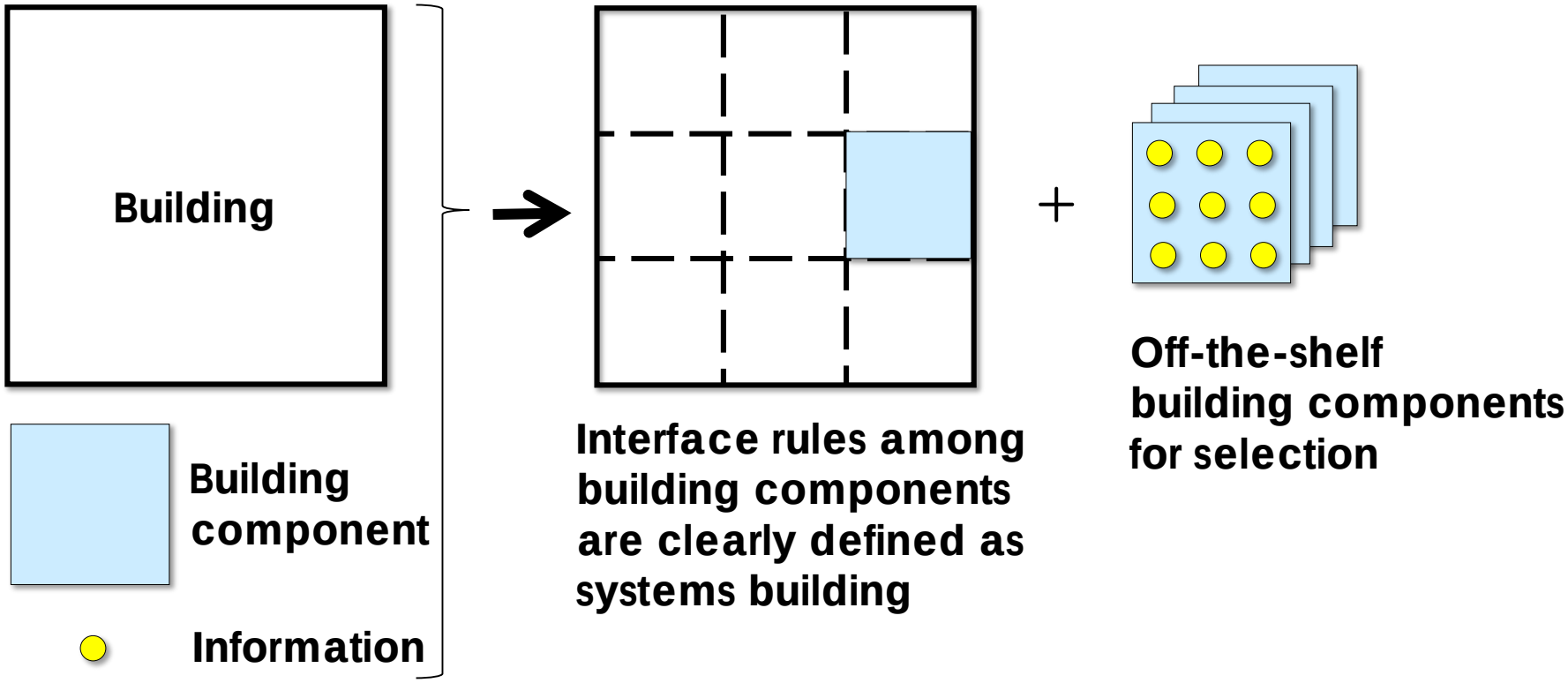
BIM : Human/Design oriented information model ?

Product model for a prefabricated building system[3]



Former Concept of Component Building

Confirmation process of building Information in design



(1) Building components are recognized as physical objects which information are consistent through whole design stage

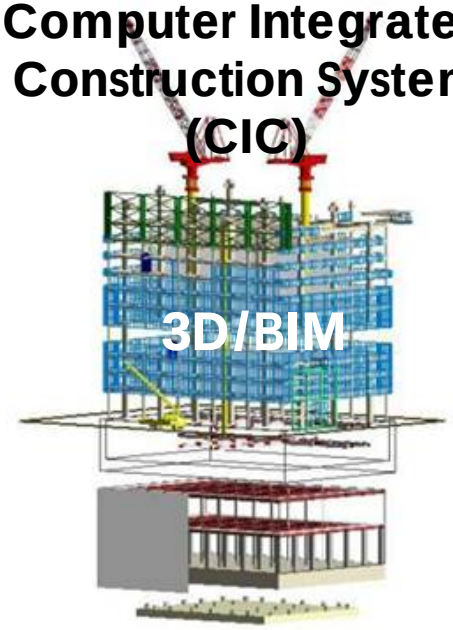
(2) Building object information is delivered to users in formal one way Unified data representation scheme to be selected by user are relevant

Matsumura, S. (1994), A study on the Effectiveness of Component Building,1994

Concept of Innovative Construction System

Superstructure Construction System

Computer Integrated Construction System (CIC)

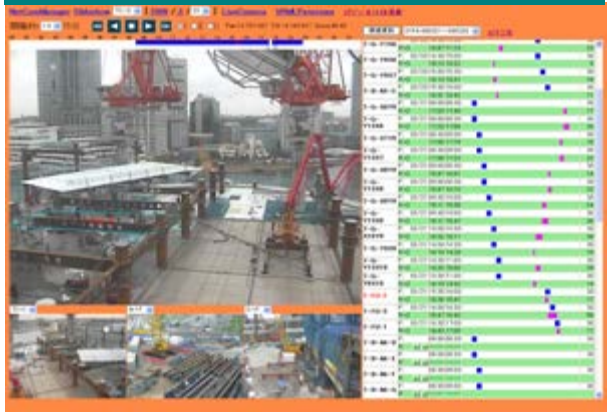


Site Prefabrication System

Logistic Management System

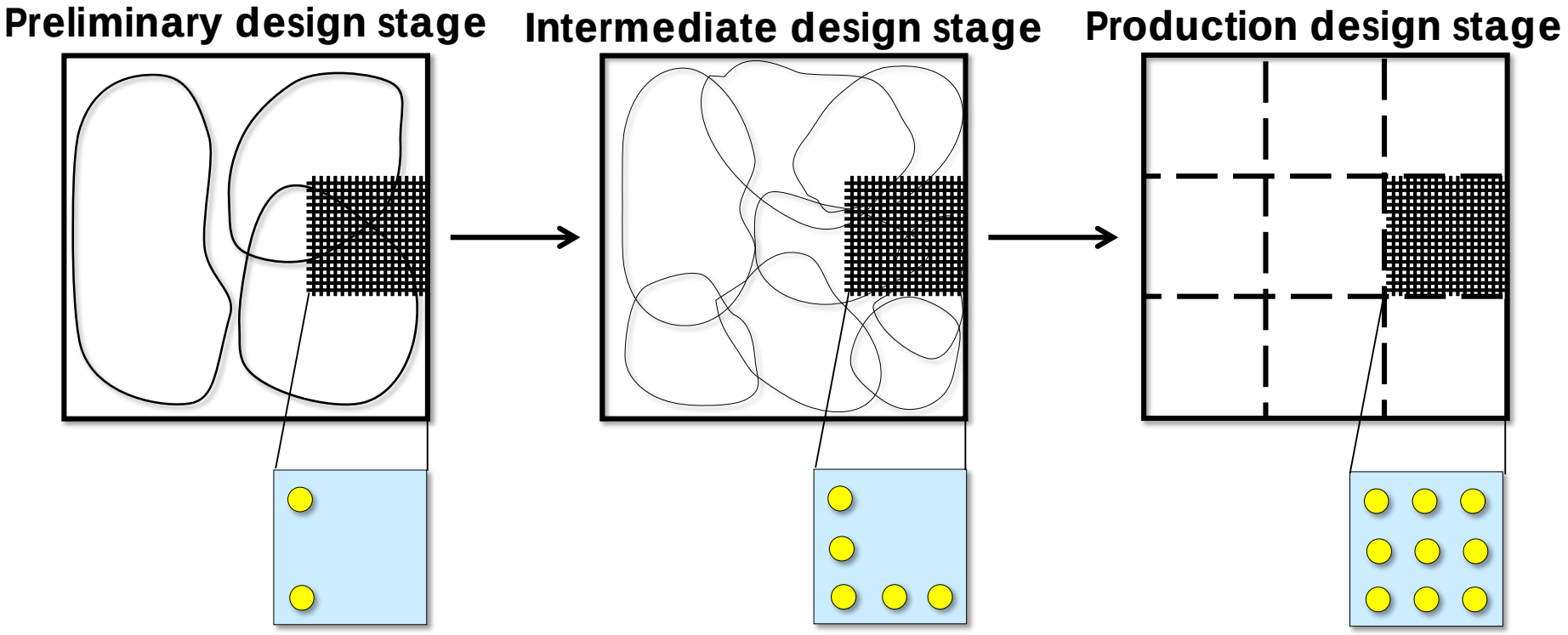
Underground Construction System

Site Information Management System



New Concept of Component Building

Confirmation process of building Information in design



(1) Building components are recognized as capsules of information which are flexibly confirmed depending on design development

(2) Building object entities are confirmed not by selection of building components but by designing/engineering of building objects

Matsumura, S. (1994), A study on the Effectiveness of Component Building,1994

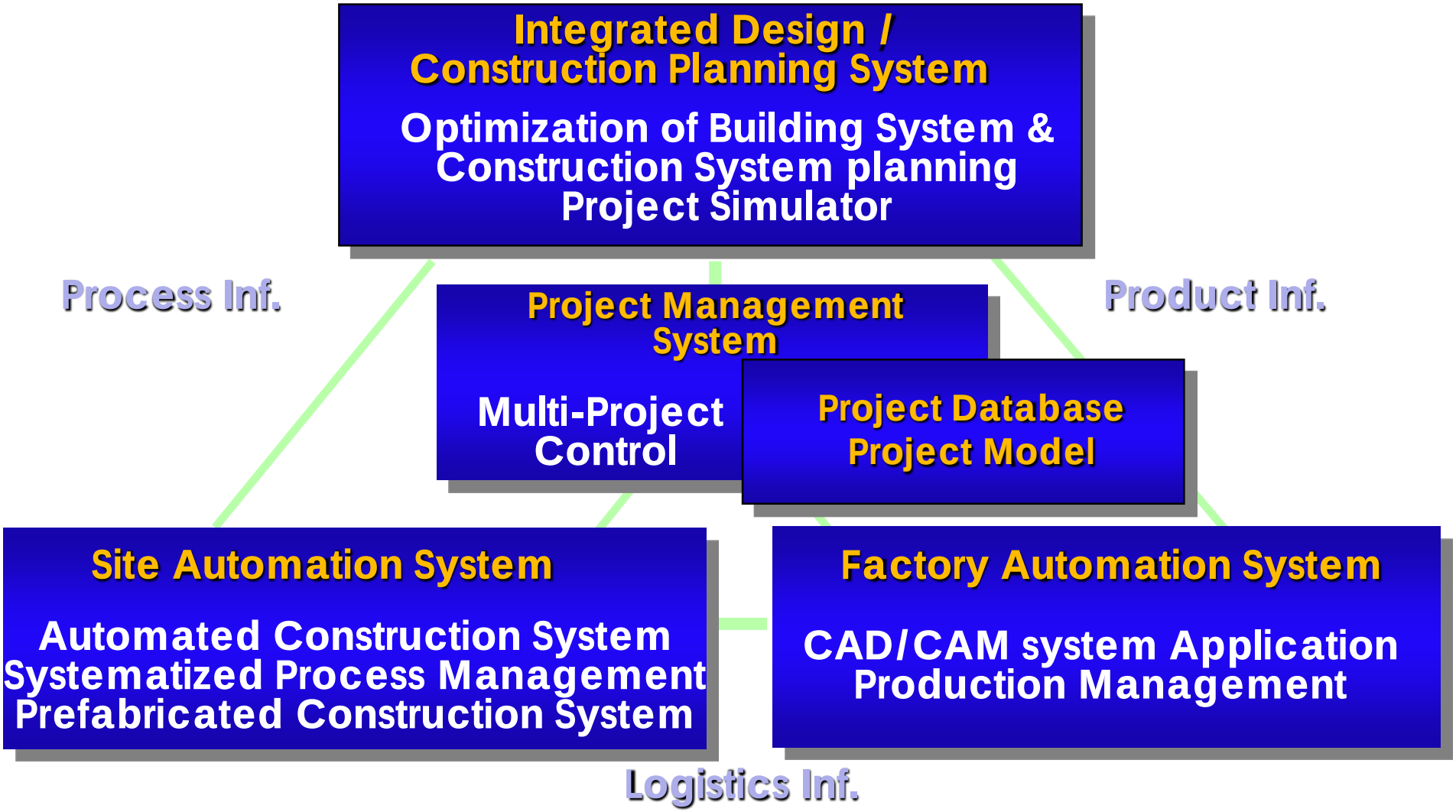
Automated Construction System

A full-scale implementation of CIC by integrating industrialization, mechanization, automation and information technology

SMART System at Yokohama Nisseki Building(1994-1996)

A CIC Conceptual Model

A strategy for functional integration and decomposition of design/ construction to effectively introduce advanced technologies



Former related research activities in CIB W78

1990 Computer Integrated Construction
2nd CIB W78+W74 Seminar, Tokyo(AIJ)

Remarkable Research Topics:

- Object-oriented CAD
- Object-oriented Project Planning
- Object-oriented Database

Remarks:

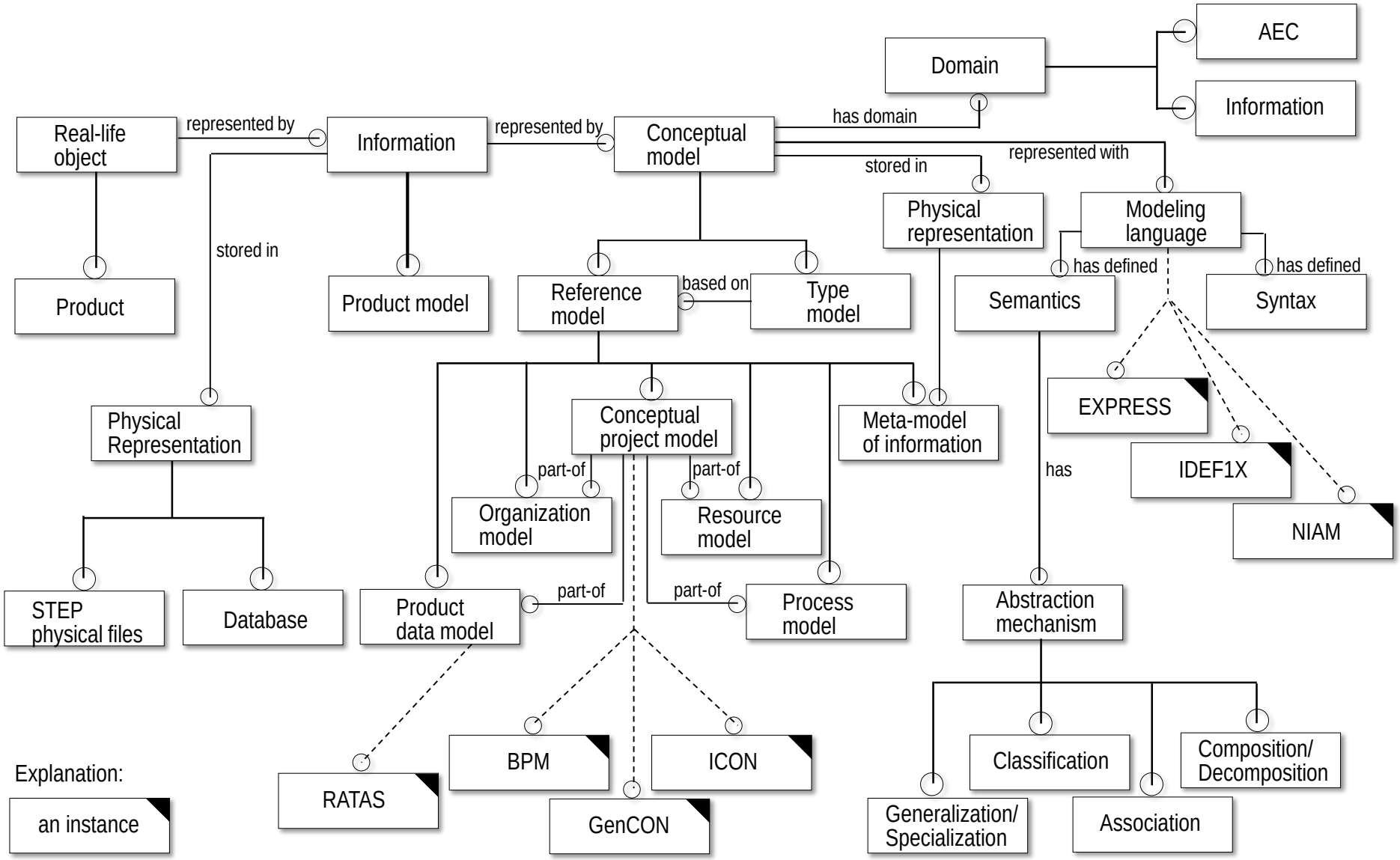
Many researches proposed specific conceptual models and approaches to CIC

1992 Models for Computer Integrated Construction
CIB W78 Workshop, Helsinki, Espoo(VTT)

Discussion Topics:

- Information reference model for AEC
- CIC framework

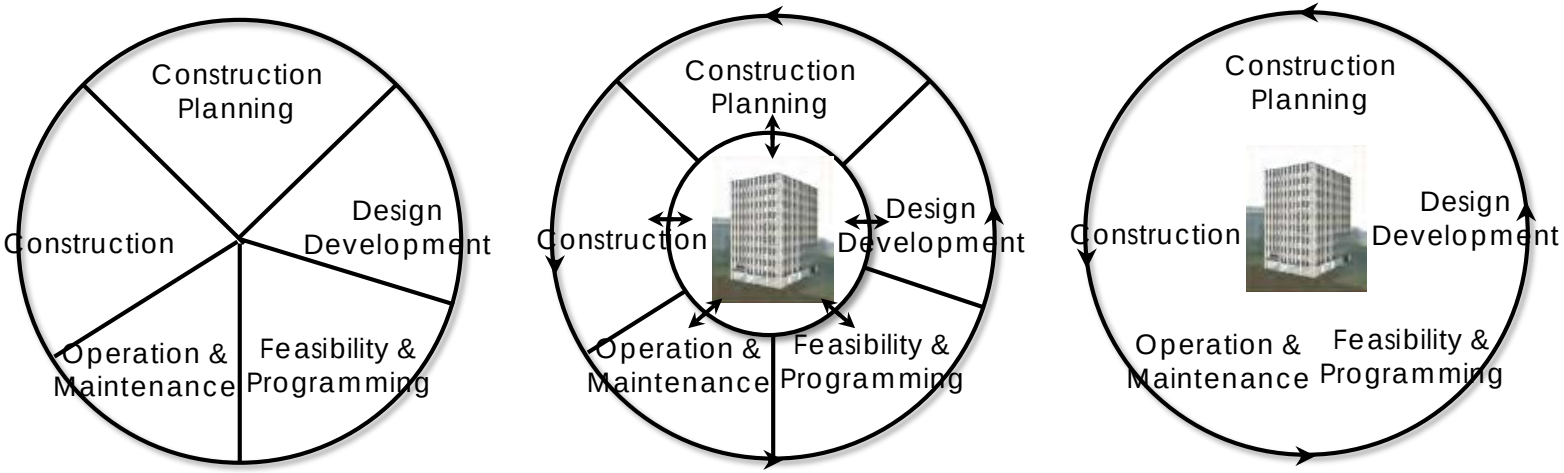
Discussion on Information reference model for AEC



Luiten, G. T., Frose, T.M, Björk. B. C., et al.,"An information Reference Model for Architecture, Engineering and Construction", Management of Information Technology in Construction, in Singapore, World Scientific, Publishing Co. Pte, Ltd., 1993, pp 391-406.

CIC Frame work

Several Options and Strategies of Automation and Integration



Dimensions and Levels of Integration

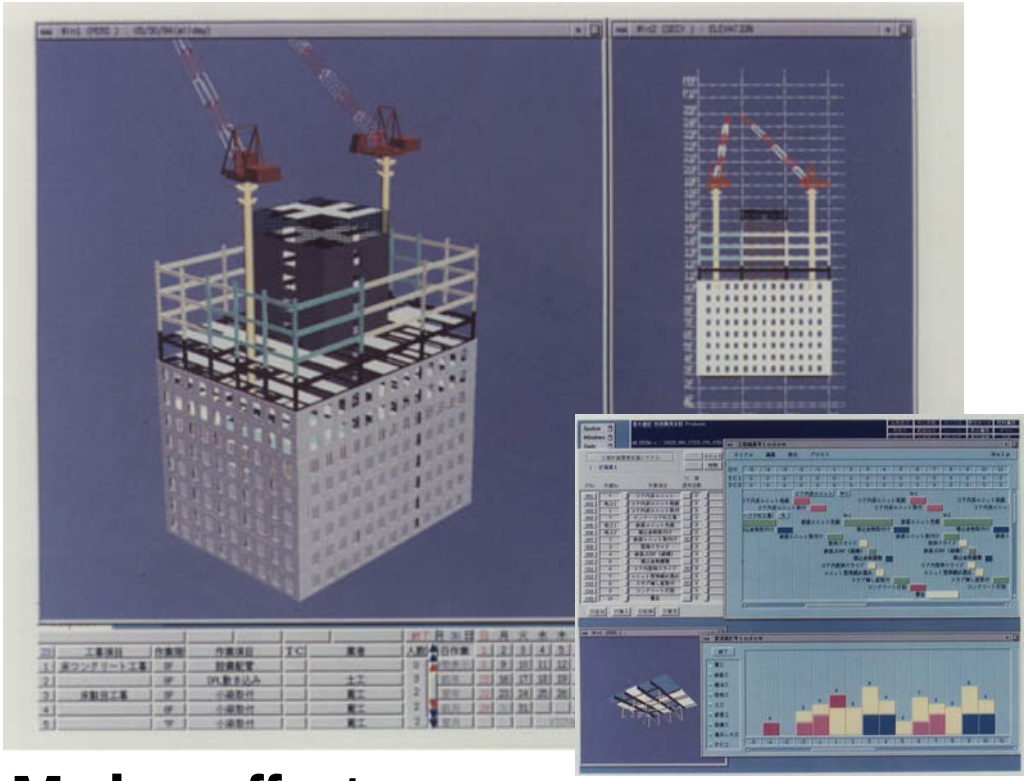
	(1)Low Integration	(2)	(3)	(4)	(5)High Integration
Who?	Individuals	Depts.	Entire Org., Firm	Whole Project Life Cycle	Entire industry
What?	Data	Models	Knowledge	Goals	All Project Information
When?	Islands of Automation	Multiple Apps in one Discipline and Phase	Multiple Apps from several Disciplines in one Phase	Multiple Apps from several Disciplines in and Phases	All Apps in Project Delivery Process
Why?	Survive, Stay in Business	Increase Profit	Increase Market Share	Enter New Market	Create New Market

Fisher, M., Betts, M., et al., “Goals, Dimensions, and Approaches for Computer Integrated Construction", Management of Information Technology in Construction, in Singapore, World Scientific, Publishing Co. Pte, Ltd., 1993, pp 421-433.

Ebina Prime Tower （1992-1995）

Development of Integrated Construction Planning by 3D CAD

RC core wall + Steel rigid frame



Major efforts:

- **Product/process data modeling based on in-house developed 3D CAD**
- **3D construction planning of integrated building/construction system**

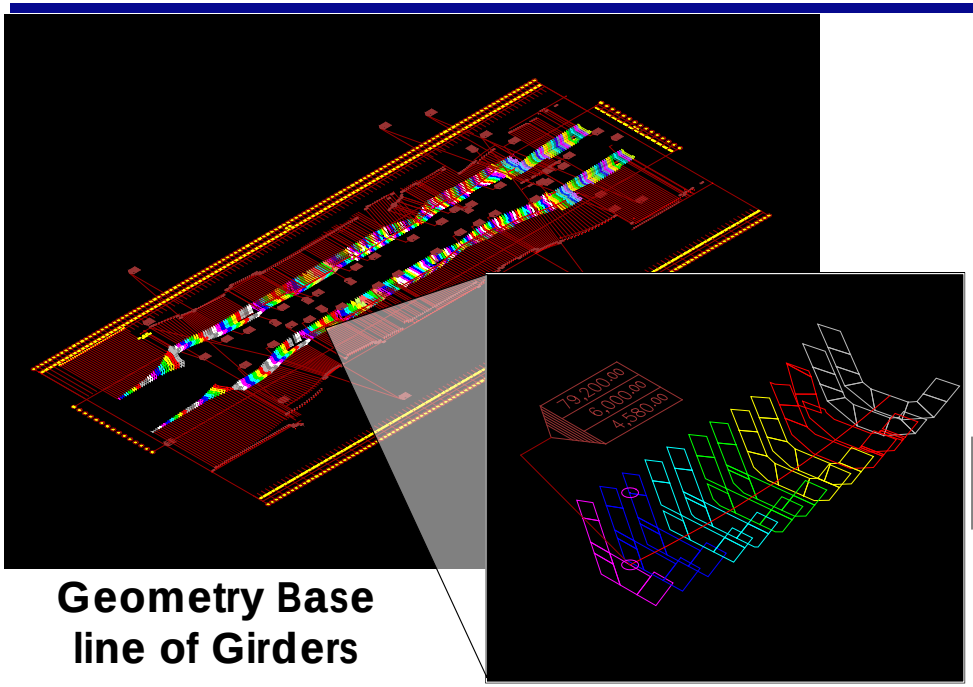
Yokohama International Passenger Terminal (2002)

Flexible production system for complex structure by 3D CAD

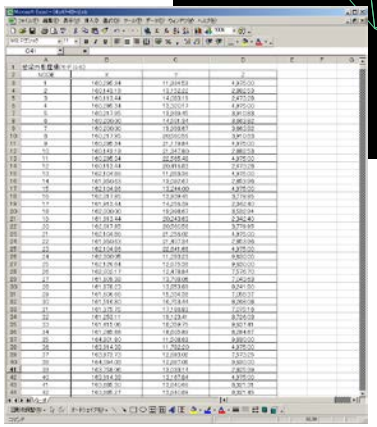
Major efforts:

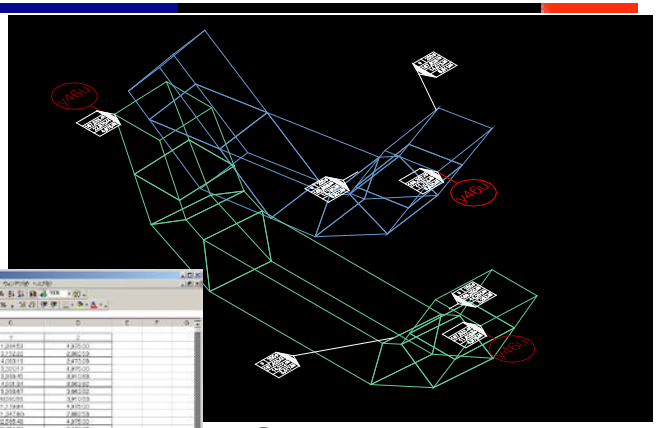
- **3D modeling of complex structure**
- **3D based product design/ production planning**
- **Structural analysis based on construction process**
- **Application of 3D measurement system**

3D data modeling

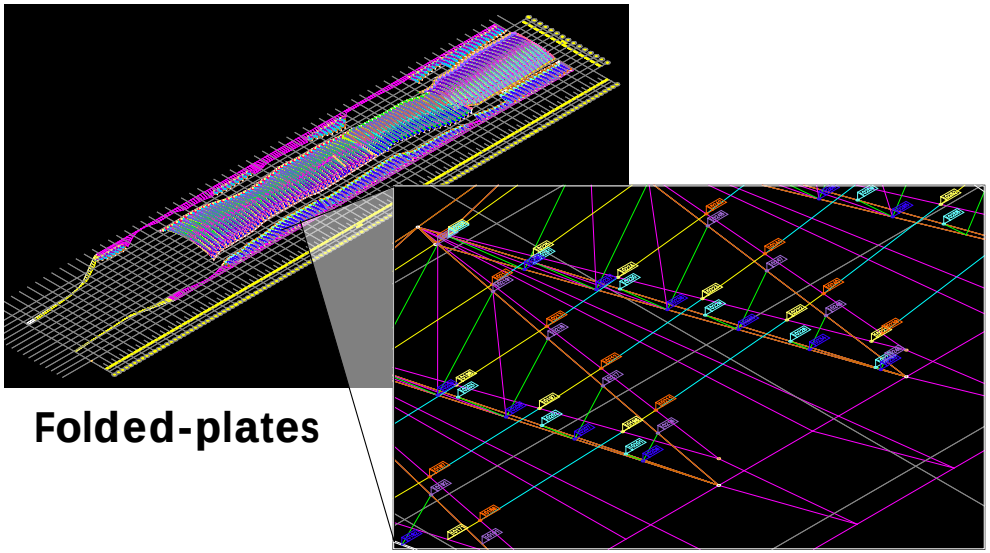


Geometry Base line of Girders

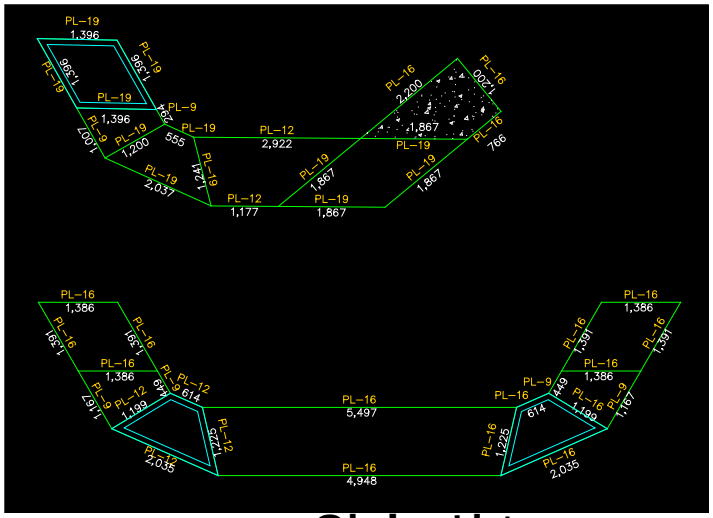




Geometry Data



Folded-plates



Girder List

3D based Product Design/Production Planning

2D

Design Data

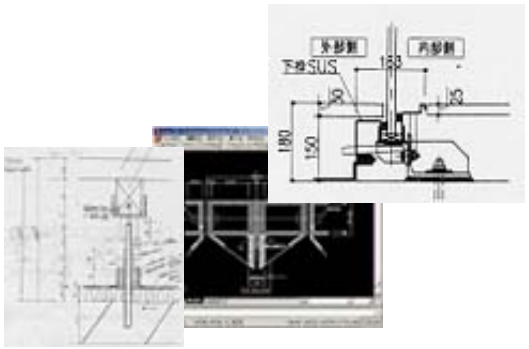
Architecture 2D 3D

Structure 2D 3D

Piping/Equipment 2D 3D

3D

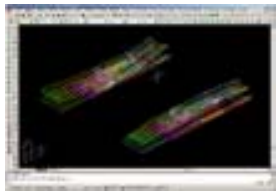
Integrated Drawing
Plan
Detail



VAD(3D CAD)
(Visual Advanced Design)

3D Model

Analysis/
Simulation
(VRML)

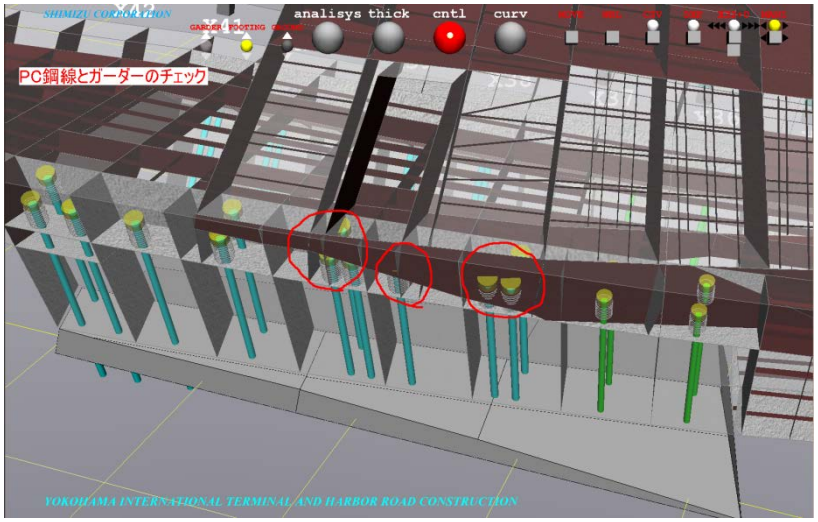


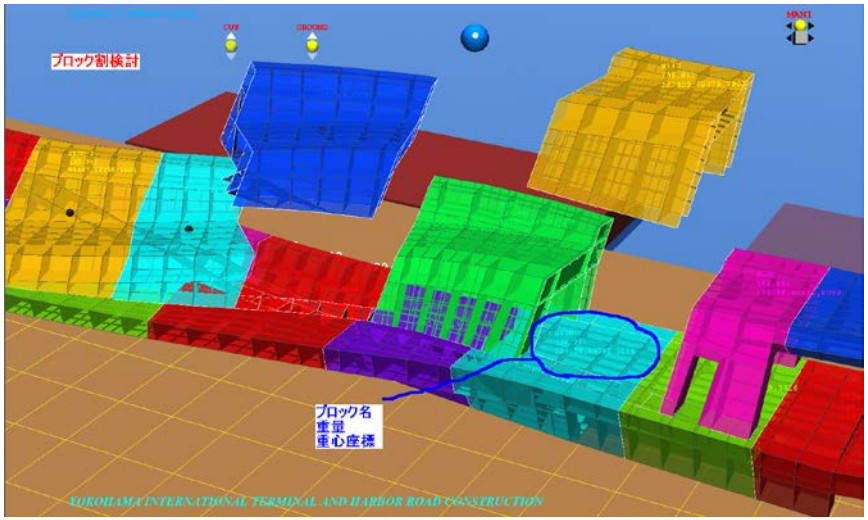
Visualization
(AUTOCAD)

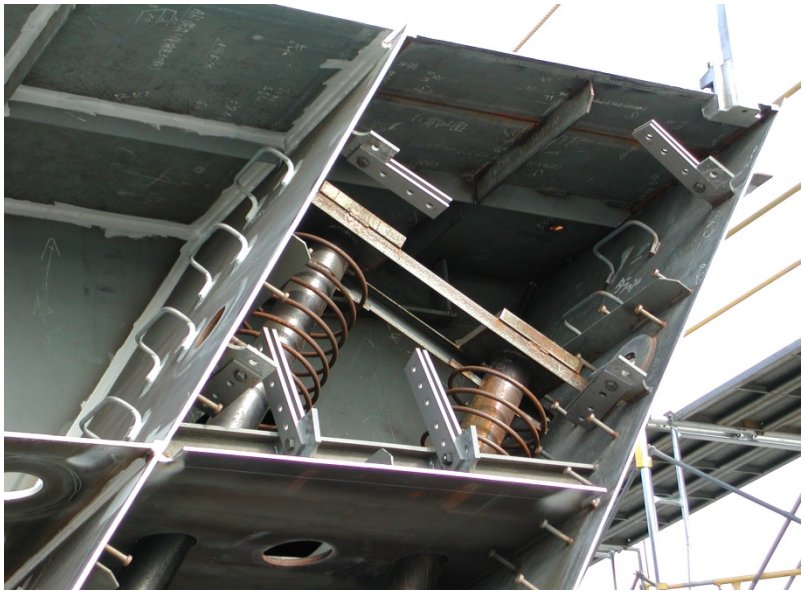
Estimation
(Excel)

3D Production Data
Steel Component
Wood deck

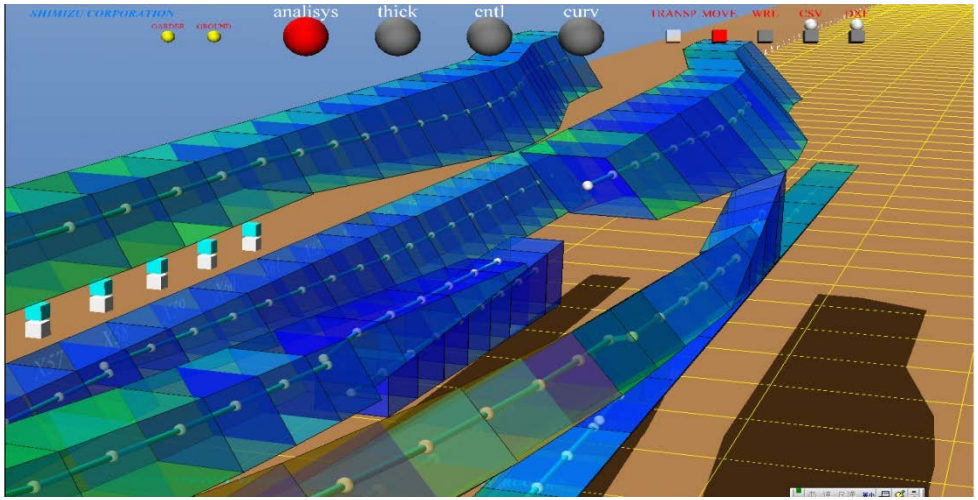
Confirmation of Details and Construction Process



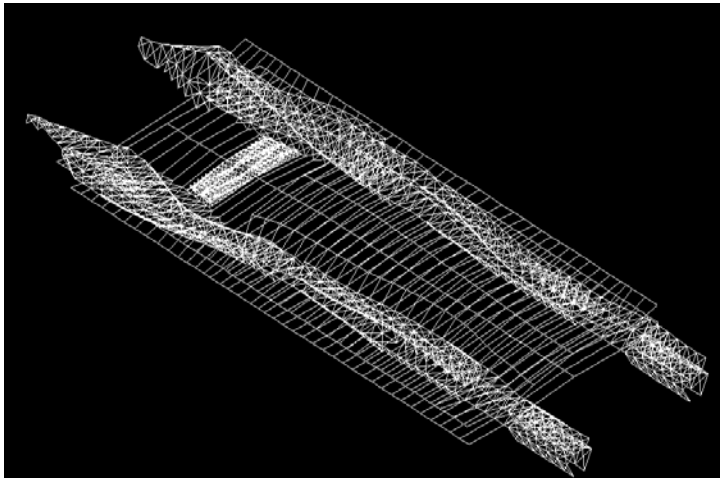




Structural Analysis based on Construction Process[17]

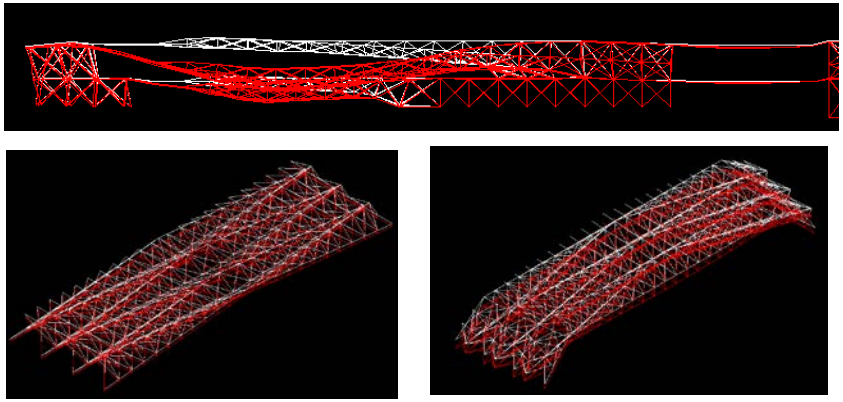


3D Data



Structural Model

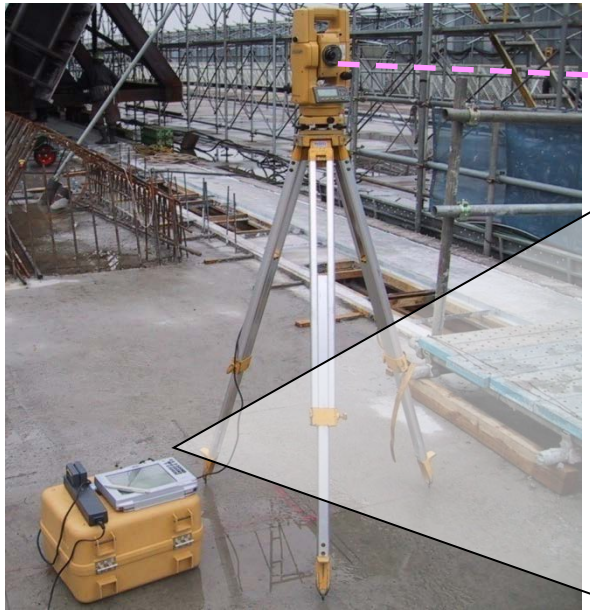
Construction using setting-beam



Structural analysis
reflecting construction process

Application of 3D Measurement System

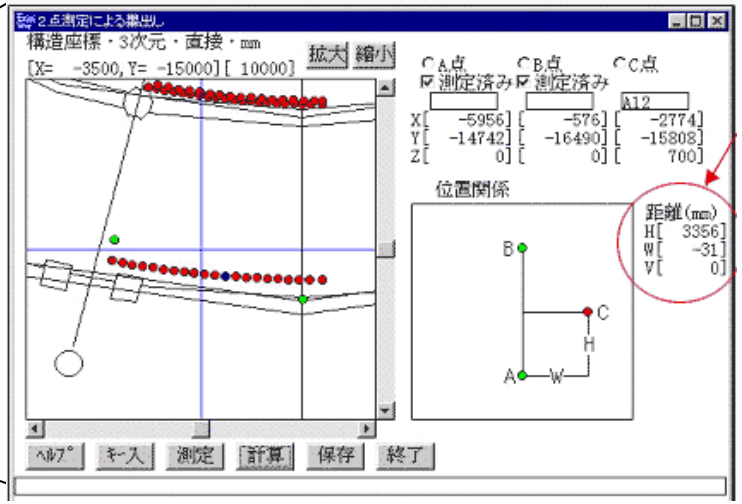
Total station

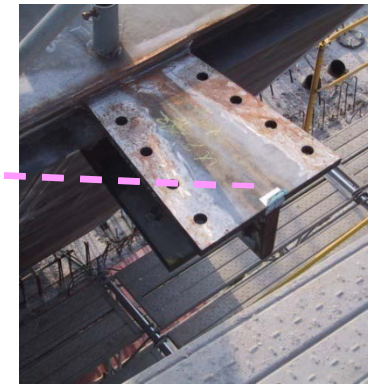


Collimation angle

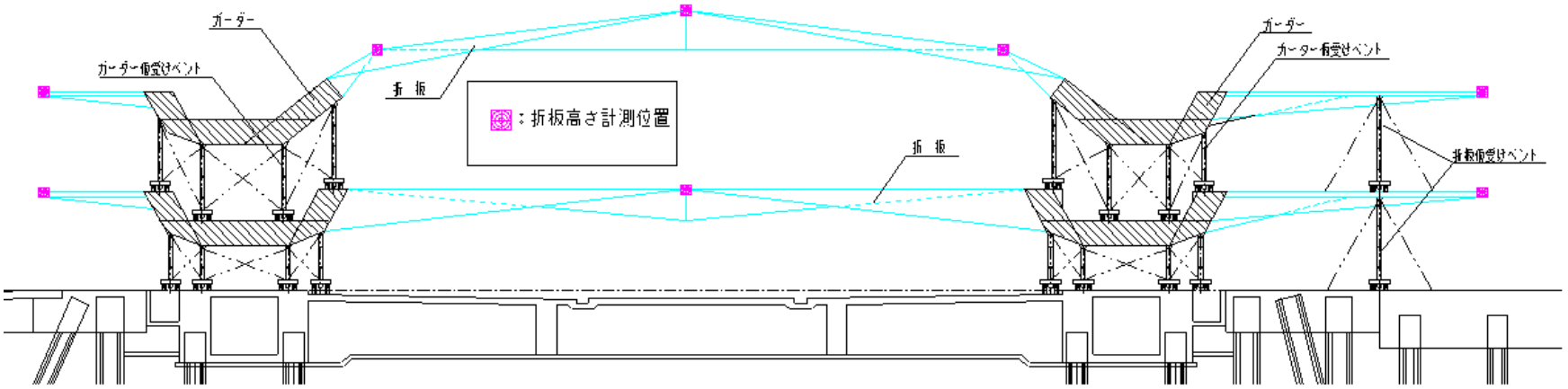
Light wave

Distance





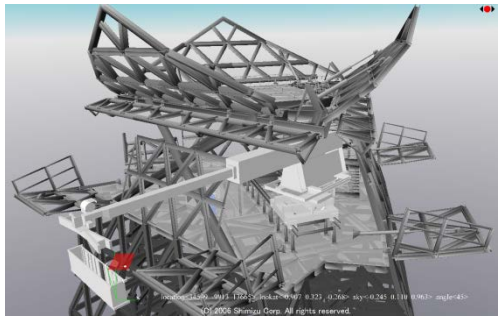
Target

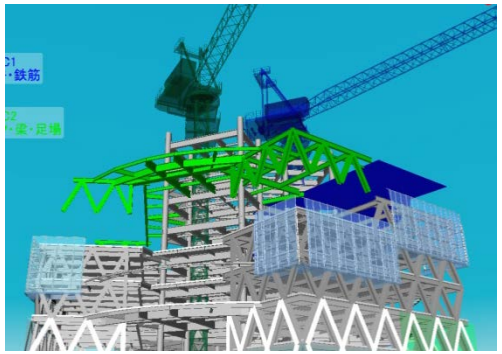


Measuring points in the erection of folded-plates' blocks

Cocoon Tower(2006-2008)

Visualization of Production/Construction planning by 3D System





Major efforts:

- Production planning

Extensive utilizations of 3D System in constructability investigations

-Construction planning

Adaptations of rational and creative construction methods (Horizontally-layered Construction System)

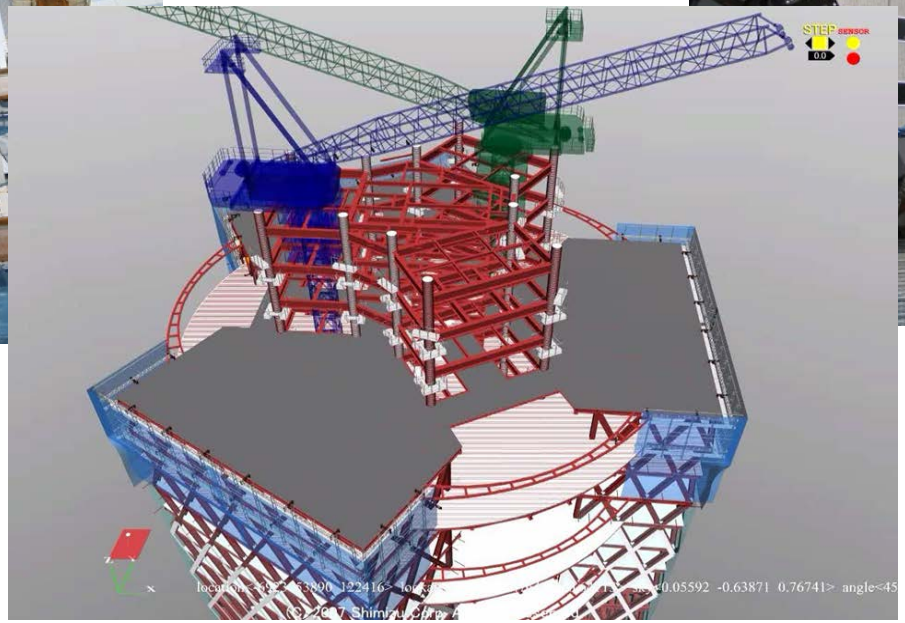
-Procurement

Introduction of new purchasing and ordering methods by standardization and unitization based on 3D system

Construction simulation for erection works

Construction simulation for Specific figure high-rise building by 3D system

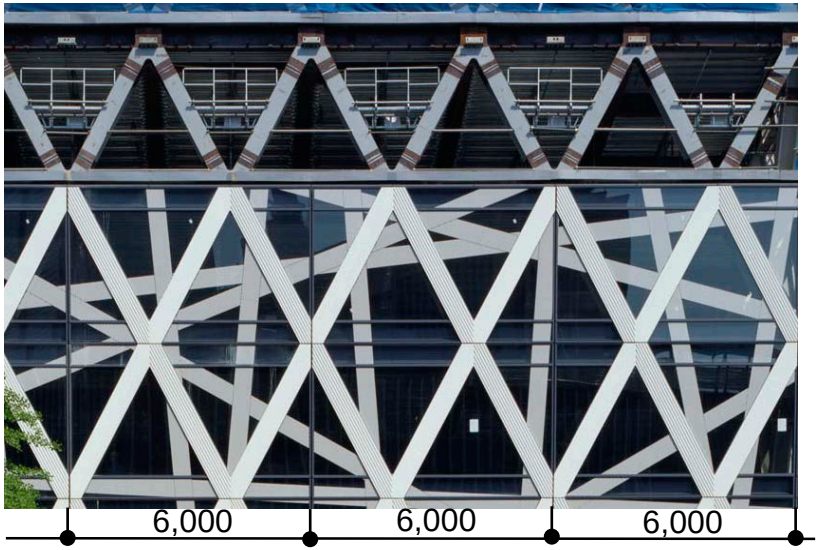
Core zone
(Concrete filled steel tube)



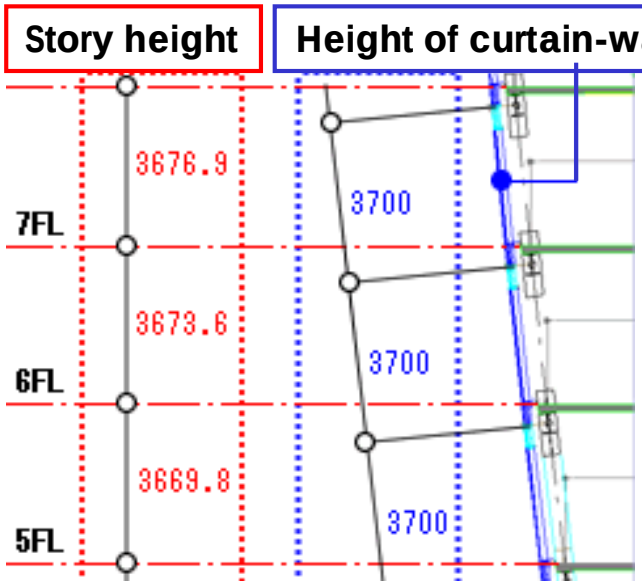
Exterior zone
(Diagonal steel frame)

Confirmation of construction process with 5 days/floor

Standardization of Unitized Curtain Walls



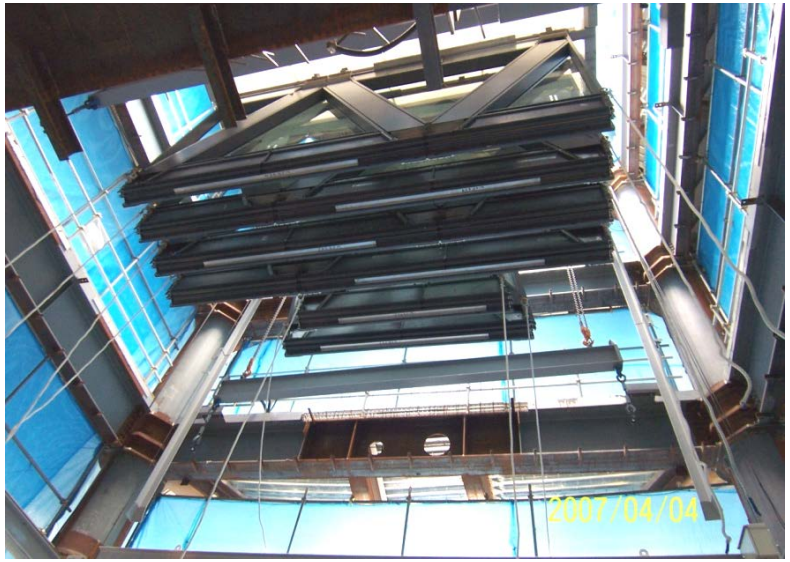
Transportation of curtain-wall components

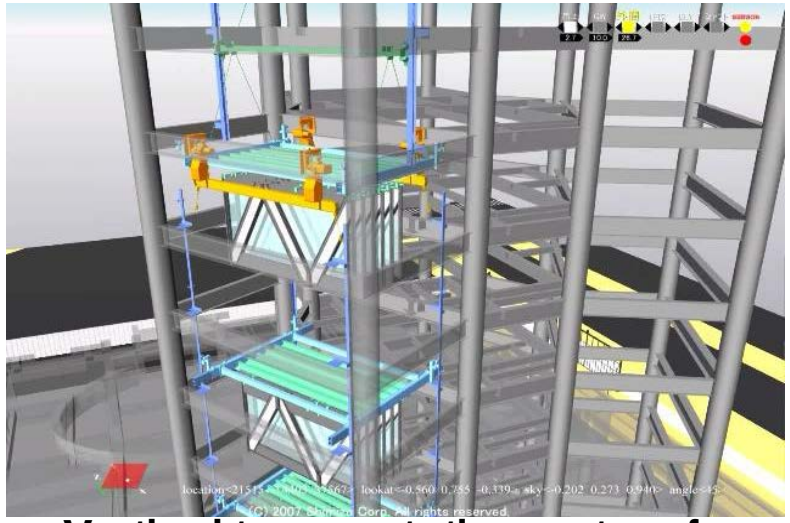


Standardization of curtain-wall units

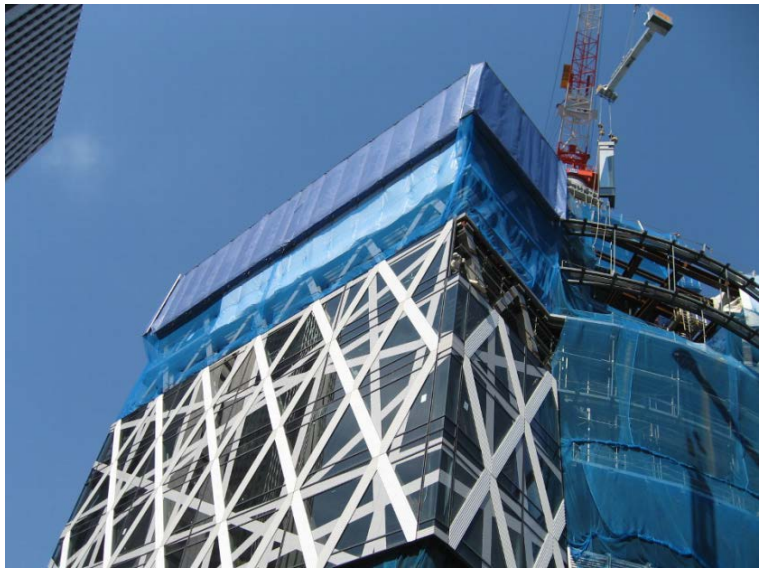
Joint and sealing of curtain-wall units

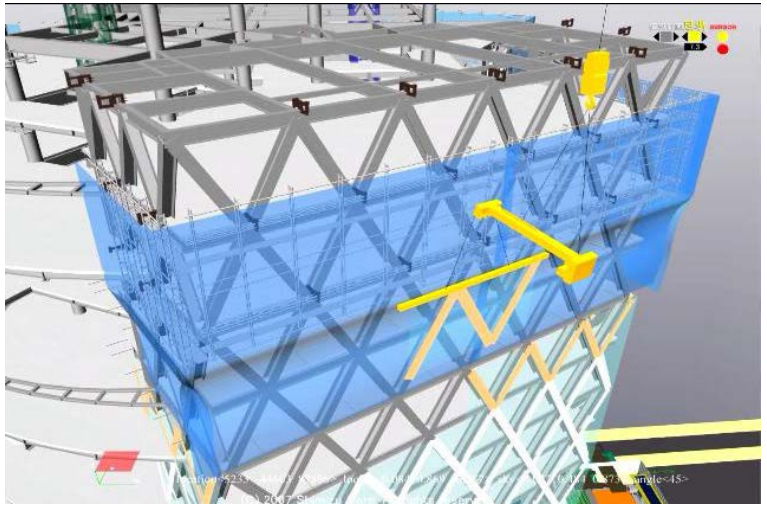
Transportation/Installation of unitized exterior curtain walls[22]





Vertical transportation system for unitized exterior curtain walls using elevator space





Installation of unitized exterior curtain walls using balancer

Shimizu Head Quarters（2009-2011）

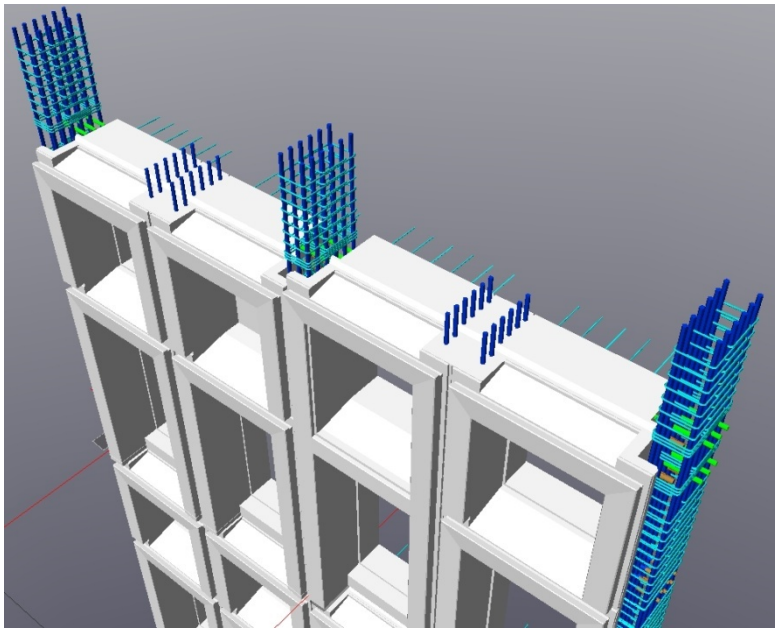
High-performance Design/Construction system for hybrid structure building by 3D/BIM

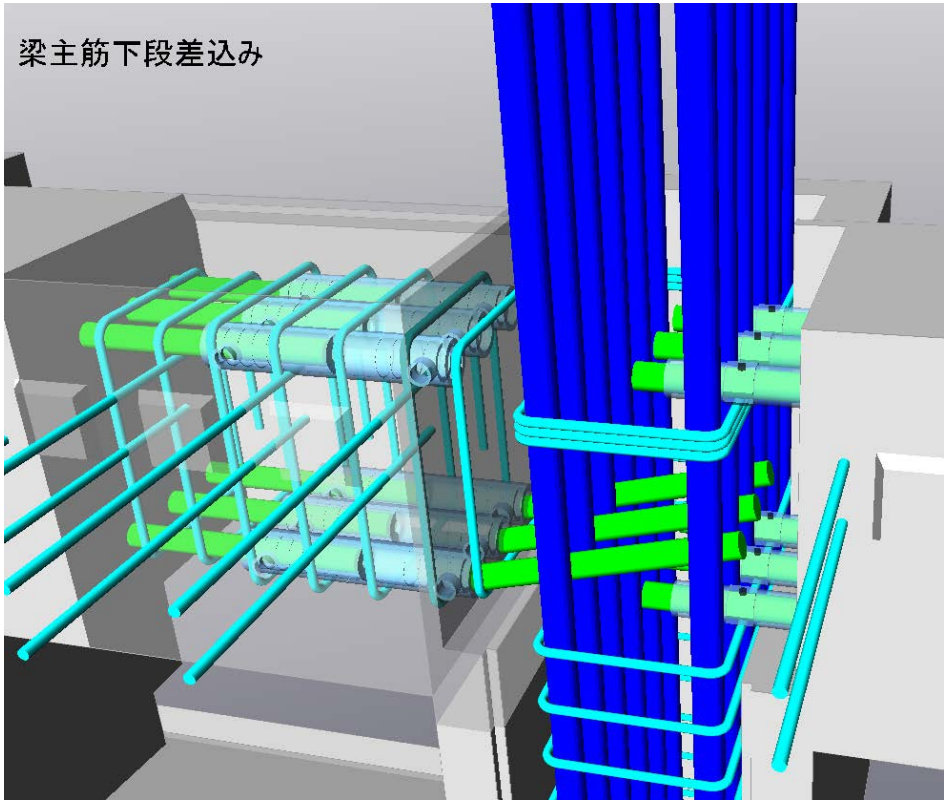
RC core wall + Hybrid perimeter frame

Major efforts:

- **Application of commercial BIM tool to constructability investigations**
- **Accuracy improvement of sequence simulation (Real-time simulation)**
- **Association of process planning with monitoring**

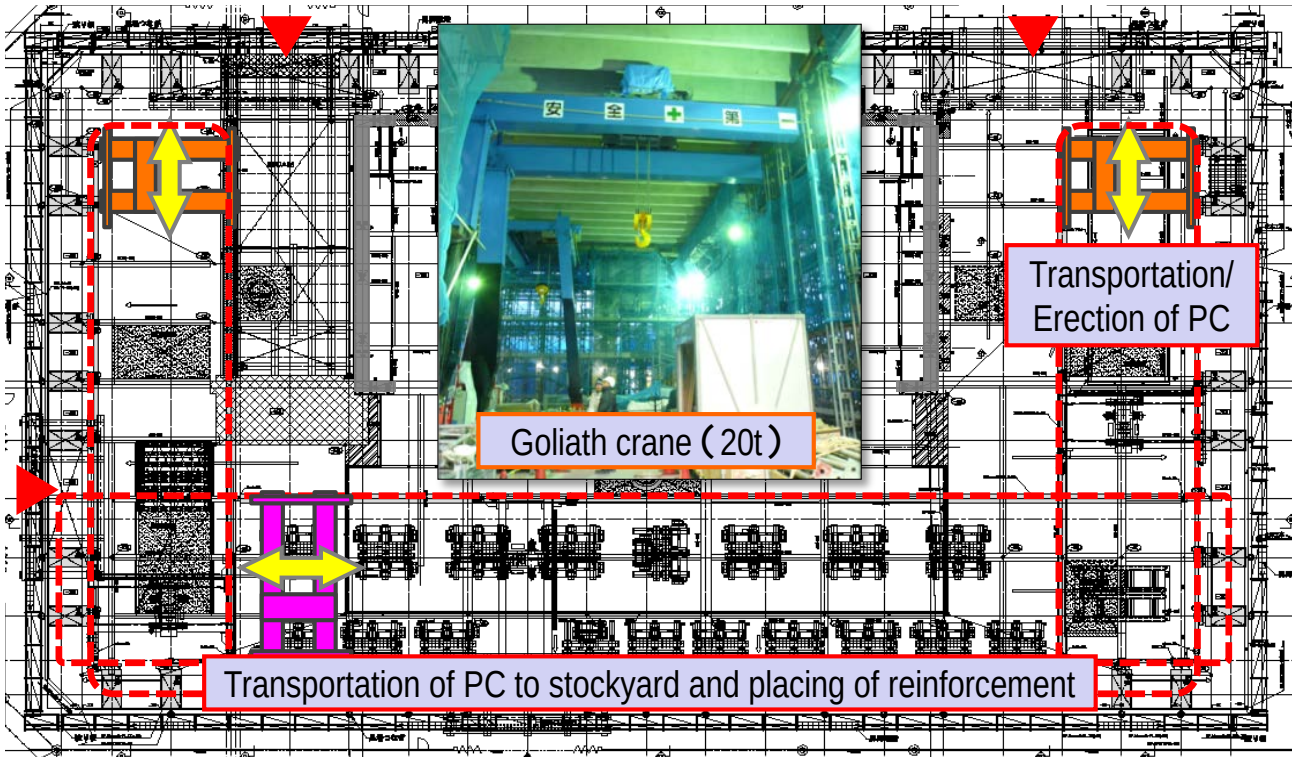
Investigation of details and construction process



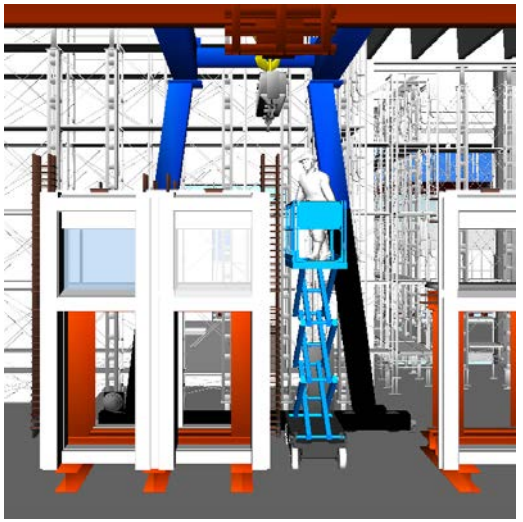


Investigation of details and construction process with placing of reinforcement

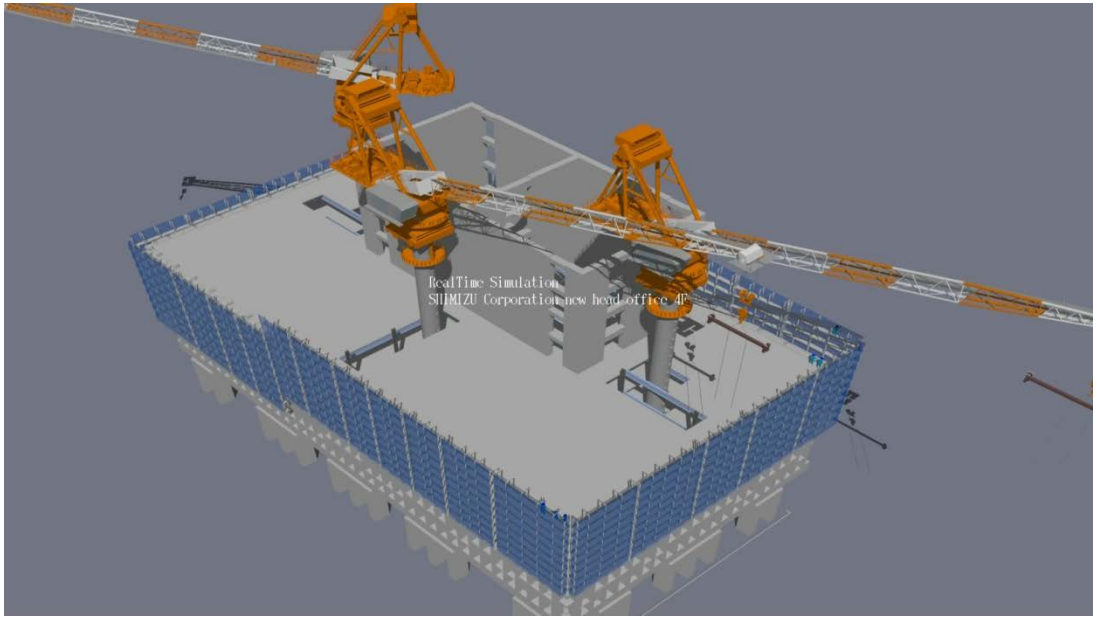
Material handling/transportation planning



Layout of temporal facilities and machines at ground floor of the building



Construction Sequence Simulation

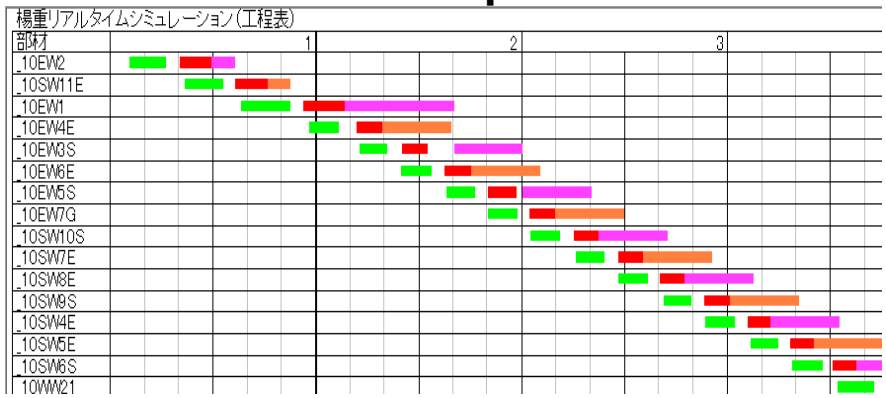


Real-time construction process simulation based on standard operation time

	A	B	C	D
Start crane operation		10:00	11:09	10:43
Start lifting-up	13:24	10:02	11:11	10:45
Lifting-up	13:26	10:06	11:12	10:49
Waiting			11:38	
Rough positioning		10:08	11:39	10:52
Precise positioning	13:29	10:10	11:43	
Installation	13:38	10:12	11:46	
Form work	13:50			
	13:55			
Supporting	13:59	10:18	11:46	10:59
End crane operation	14:03	10:27	11:28	11:04
Total operating time	39min	27min	50min	21min

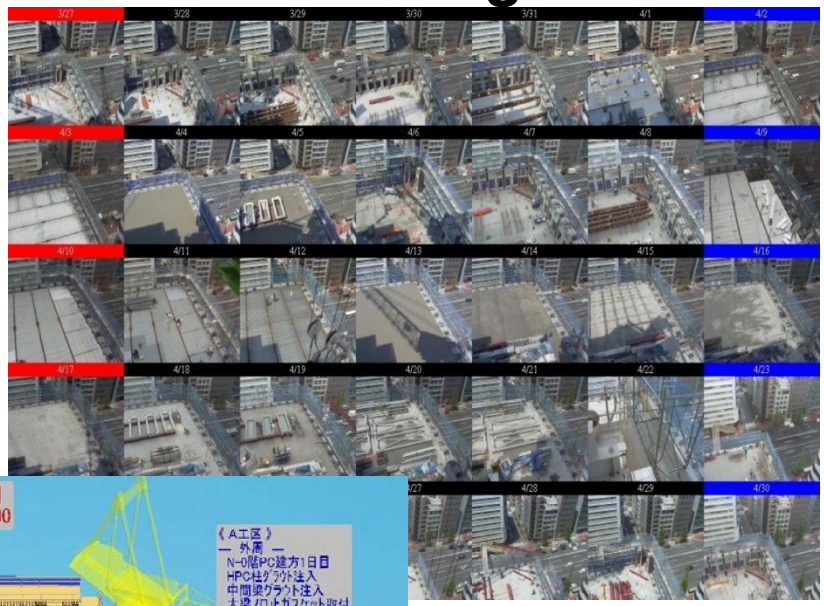
Measurement of operation time using full-scale mock-up

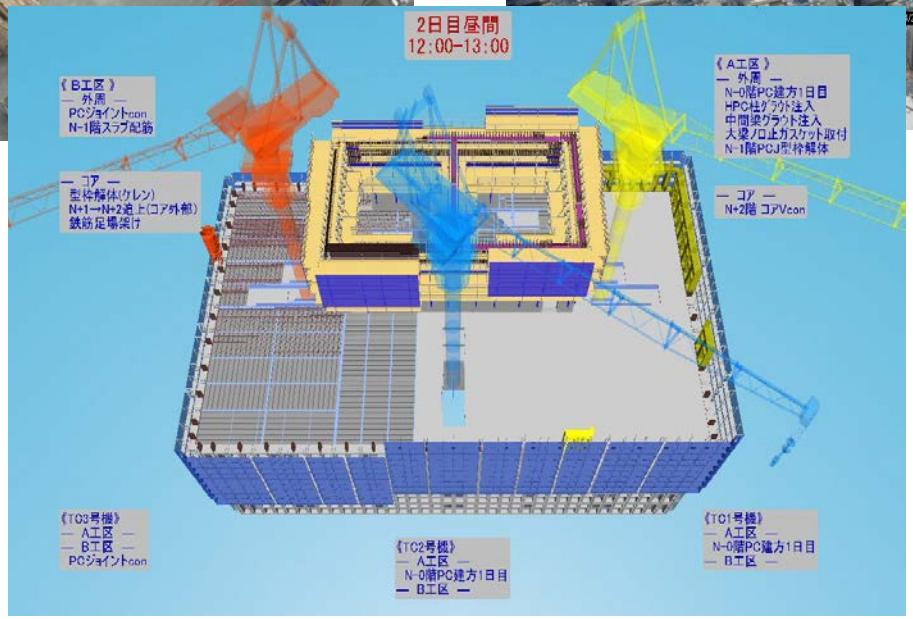
Result of construction process simulation



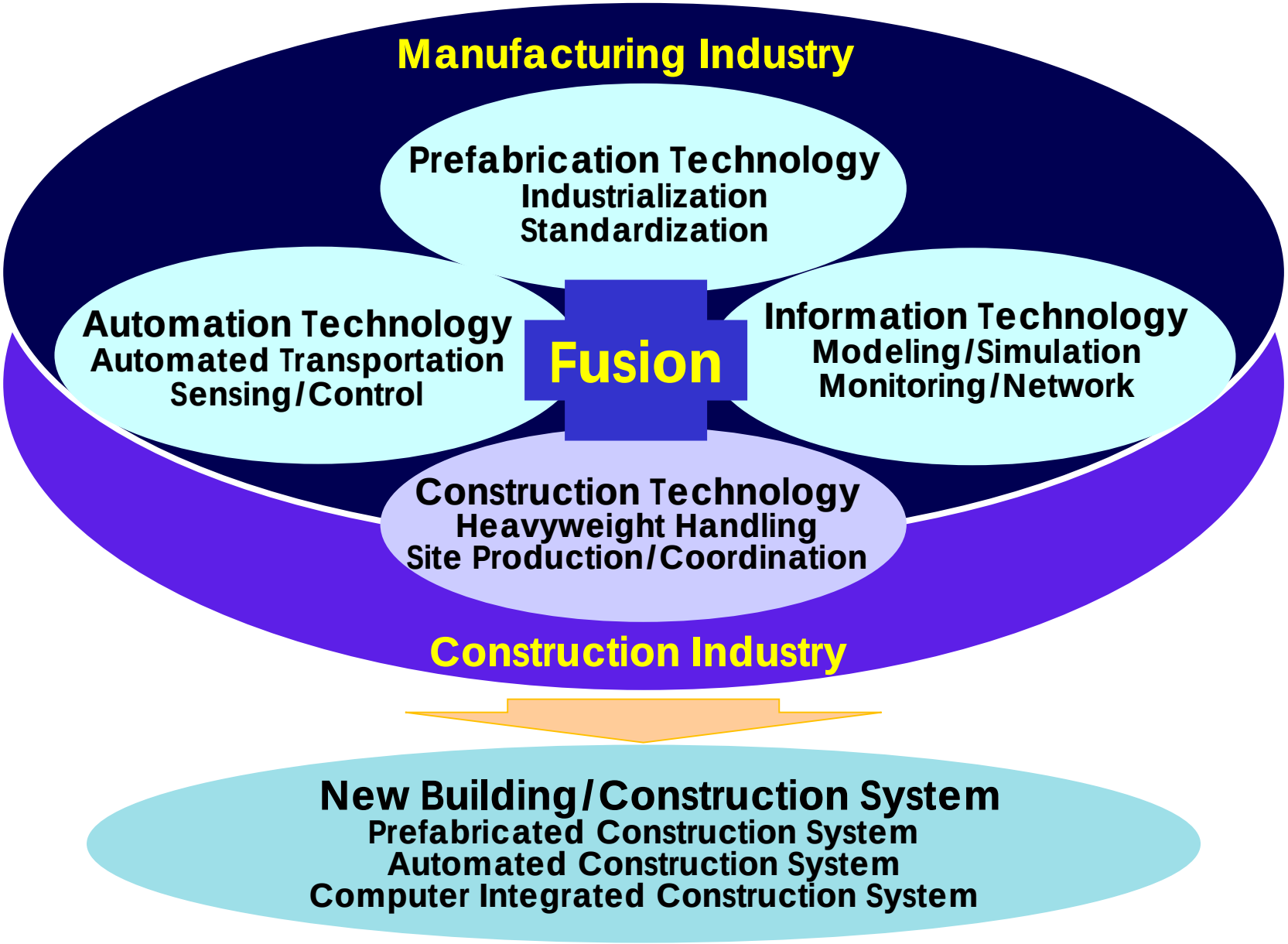
Comparison of sequence simulation and monitoring

Modification of work schedule through comparative analysis of planning data and monitoring data





Concept of technology/knowledge fusion



Concept of Industrialization

Defined by ECONOMIC COMMISSION FOR EUROP, UN (1959）

（ｉ） Continuity of production, implying a steady flow of demand

（ii） Standardization of products

（iii） Integration of the different stages of the whole production process

（iv） A high degree of organization of work

（v） Mechanization to replace manual labor wherever possible

（vi） Research and organized experimentation integrated with production

BIM applications toward Construction Innovation

- **Sophistication of collaboration environment with AEC functions**
  by improving production/delivery systems trough investigations using BIM
- **Promotion of technology and knowledge fusion toward higher level of automation and integration**
  by reviewing BIM as tool for fusion
- **Continuity of research and technology development toward construction innovation**
  by promoting basic research and organized experimentation with CIC based on BIM

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