

**3rd ODA project Education and Human
Development Seminar at MRT Jakarta**

**Cost over run and schedule delay
problems in infrastructure projects
How do you handle those problems?**

2015.03.06.

**Shunji Kusayanagi
Professor Kochi University of Technology**

The characteristic of infrastructure projects

In case of infrastructure projects, commonly a project owner makes and set up planning, design, specification of the object”, and the contractor will make “the object” in accordance with.



- **The owner and the contractor need to work together and collaborate for making “the object”.**
- **This fact is normally not exist in other industries.**



- **If the project owner and the contractor fight each other, their project will not go well.**
- **This situation is the same in any countries in the world.**

Basic policy for execution of infrastructures

- Public infrastructure project shall be based on the fundamental philosophy of “**Functions integration**” in between the project owner and the contractor.
- The statement to the public made by the project owner and the contractor will be;

We, the project owner and the contractor will collaborate and integrate each function and properly execute the project

Need to put the contract conditions in between the project owner and the contractor so that the project can be executed with keeping transparency

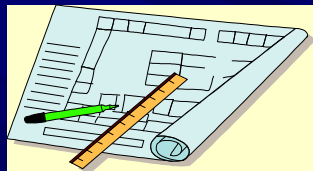
How to fix the Type contract



Investigation

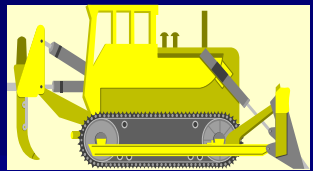
Basic Planning

Conceptual design



Basic design

Detail design



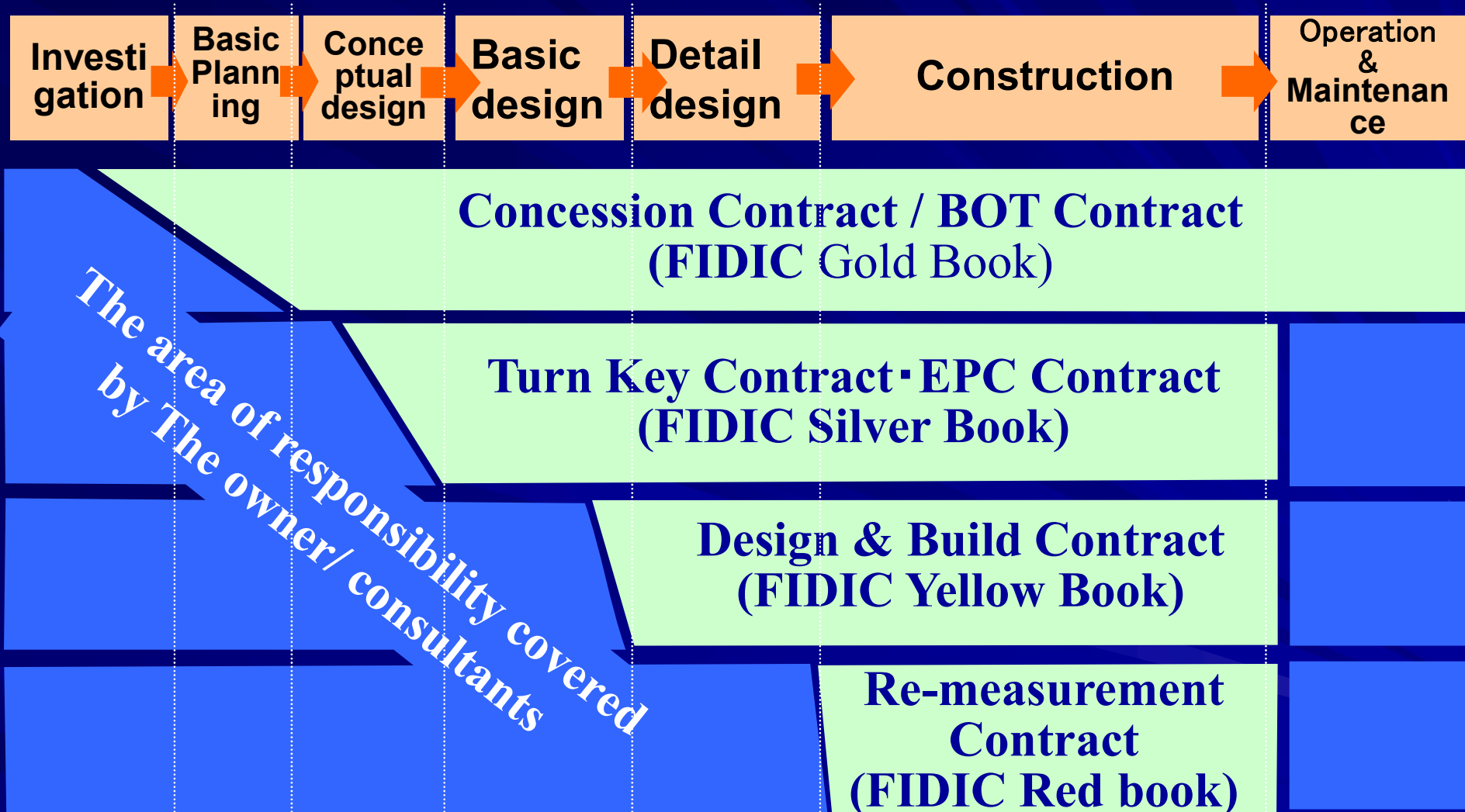
Construction

Operation & Maintenance

Project Management

- Contract type for the project shall be based on the concept of who has responsibility, and what kinds of responsibility and the
 - Abilities of owner
 - Abilities of Contractor
 - Technical Difficulties
 - Level of uncertainties
 - Condition of finance
 - Others

Project Execution Schemes and Types of Contract



Types of contract vs. Risk allocation

1) Concession Contract / BOT Contract



Concession Contract / BOT Contract

The area of responsibility covered by the owner/ consultants

The area of responsibility covered by the contractor

- The contractor who execute this type of contract needs to keep total project management abilities
- Required Capability ;
 - Design
 - Construction
 - Procurement
 - Finance
 - Operation management

(FIDIC Gold Book)

2) EPC Contract - Turn Key Contract

EPC; Engineering Procurement and Construction



EPC Contract - Turn Key Contract

The area of responsibility covered by the owner/consultants

The area of responsibility covered by the contractor

This type of contract will mainly be applied to performance guaranty projects, like a chemical plant or a power plant.

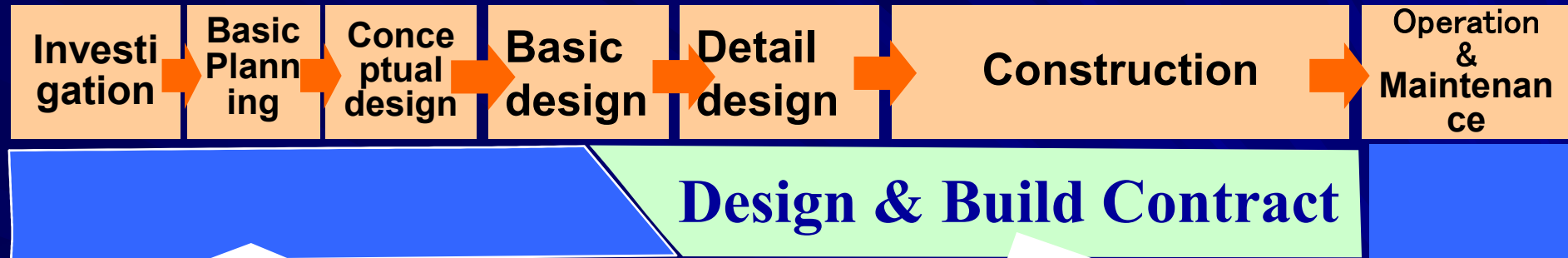
EPC Engineering Procurement and Construction Contract

- **Engineering:** Basic Design · Detail Design · Supervisions
- **Procurement:** Plants & Equipment
- **Construction:** Structure works, Setting **Plants & Equipment**
· test & operation

- The contractor will have **all responsibility from design to test operation**
- Basically **the contractor have no right to claim** for time extension and/or additional costs except otherwise the project owner changes the design and/or contract conditions.
- Design changes and contract conditions must be manageable by the contractor

(FIDIC Silver Book)

3) Design & Build Contract



The area of responsibility covered by the owner/ consultants

The area of responsibility covered by the contractor

- This type of contract is commonly use for **function oriented projects**, like plants, equipment and residential buildings.
- Now day it is seen that this type of contract selected for bevy civil projects like, high ways & MRTs etc.
- Generally, the owner/ consultants will have responsibility **till basic design phase** and contractors will cover following areas.
- the lump-sum contract will be applied.

■ FIDIC standard conditions of contract: **Yellow Book**

The Design & build Contract

- It has not yet set up the clear rules clarifying “**design**” covered by contractors in the design & build contract.
- However, Design work shall be classified as follows;

1st phase Conceptual Design

The design clarify the concept and out line of the structure. Essential Performance Requirements (EPR)

2nd phase Basic Design

Requirement efficiency [performance] design based on the **Conceptual Design**.

3rd phase Detail Design

The design the structure in accordance with the **Basic Design**. Technical specification shallt be made

4th phase Manufactural Design

The design of the equipment in accordance with the **Detail Design**. Manufactory specification shallt be made

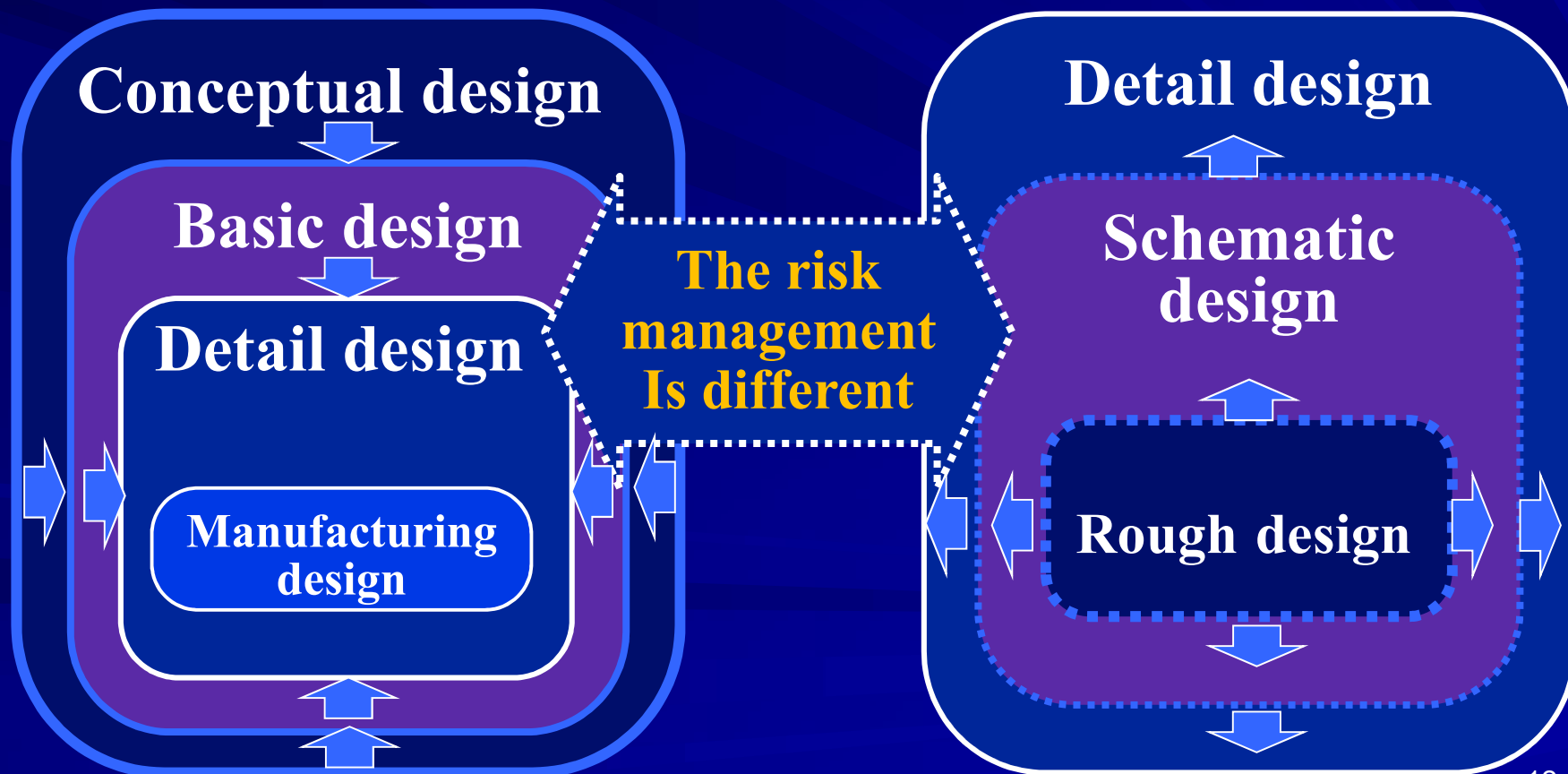
Design works & types of contract

Service contents & level setting	<div style="text-align: center; border: 1px solid black; padding: 10px;"> <p>F/S</p> <p>BOT (PFI/PPP) FIDIC Gold Book</p> <p>Turn key • EPC FIDIC Silver Book</p> <p>Design Bit Build FIDIC Yellow Book</p> <p>Design Bit Build FIDIC Red book</p> </div>						
Essential Performance Requirements (EPR)							
Requirement efficiency [performance]							
Technical specification							
Manufactory specification							
Construction							
Manufacturing							
<div style="display: flex; justify-content: space-between;"> <div style="width: 25%; text-align: center;"> <p>Work</p> <hr style="border: 0; border-top: 1px solid black;"/> <p>Designing</p> </div> <div style="width: 75%; display: flex; justify-content: space-around;"> <div style="text-align: center; width: 12.5%;"> <p>Manufac turing</p> </div> <div style="text-align: center; width: 12.5%;"> <p>Constr uction</p> </div> <div style="text-align: center; width: 12.5%;"> <p>Manufa. design</p> </div> <div style="text-align: center; width: 12.5%;"> <p>Detail design</p> </div> <div style="text-align: center; width: 12.5%;"> <p>Basic design</p> </div> <div style="text-align: center; width: 12.5%;"> <p>Concep tual design</p> </div> <div style="text-align: center; width: 12.5%;"> <p>Basic Plan- ning</p> </div> </div> </div>							

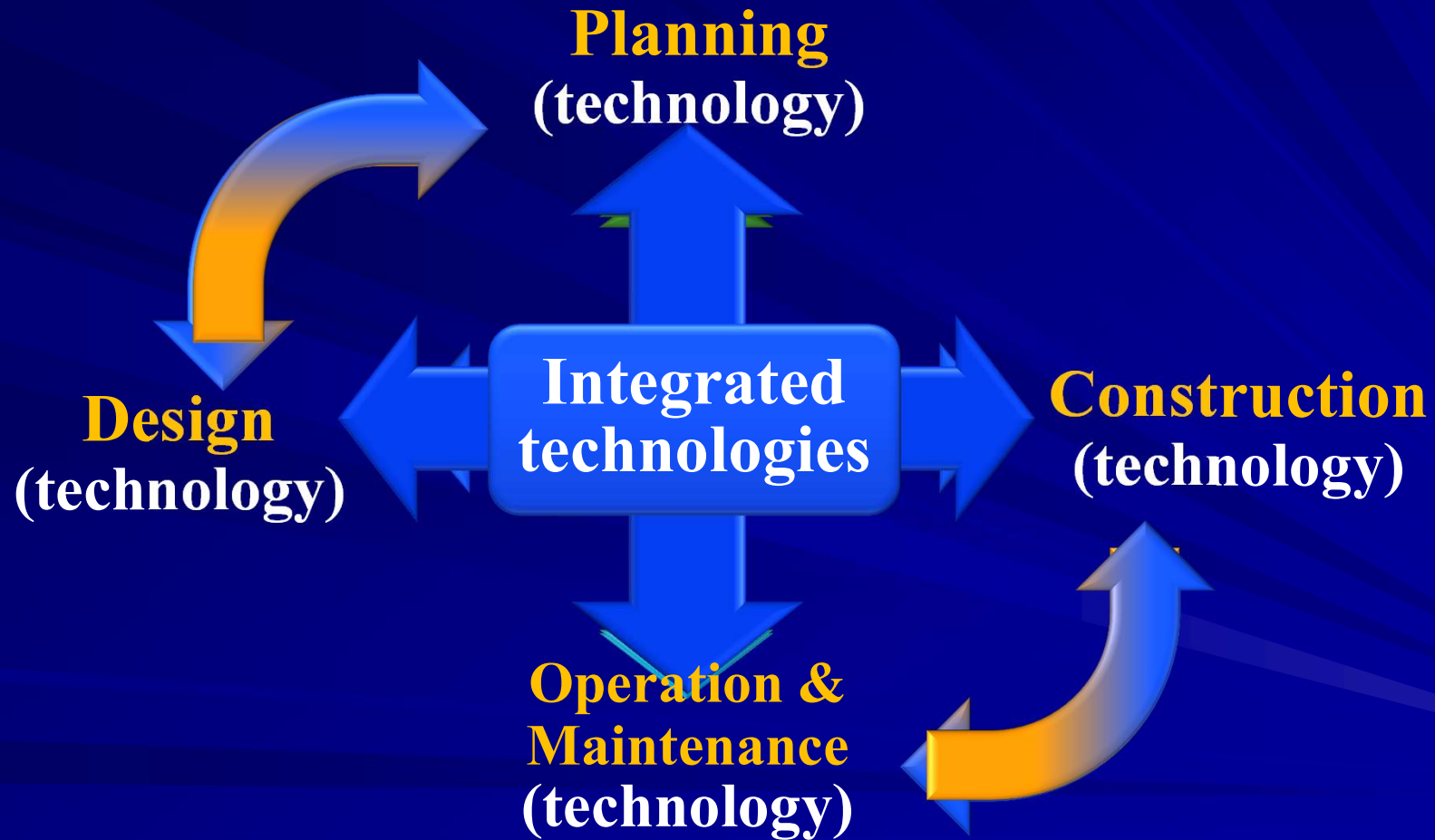
The Design & build Contract

The out line of the works
will be decided by
conceptual design
(Risk intensive type)

The out line of the works
will be clarified by the
detail design
(Risk extensive type)



3. Grade up Engineering Technology required for sustainable infrastructure development



BIM; Building Information Modeling can do enable this concept

A study of LCC : life cycle cost

■ An Apartment house project

100units. Life span35years

■ Planning & investigation cost	1.0~2.0%
■ Design cost	3.0~4.0%
■ Construction cost	55.0~60.0%
■ Maintenance & operation cost	35.0~40.0%

■ Industrial Zone project

250hrs. Life span35years

■ Planning & investigation cost	1.0~1.5%
■ Design cost	2.5~3.0%
■ Construction cost	45.0~50.0%
■ Maintenance & operation cost	50.0~55.0%

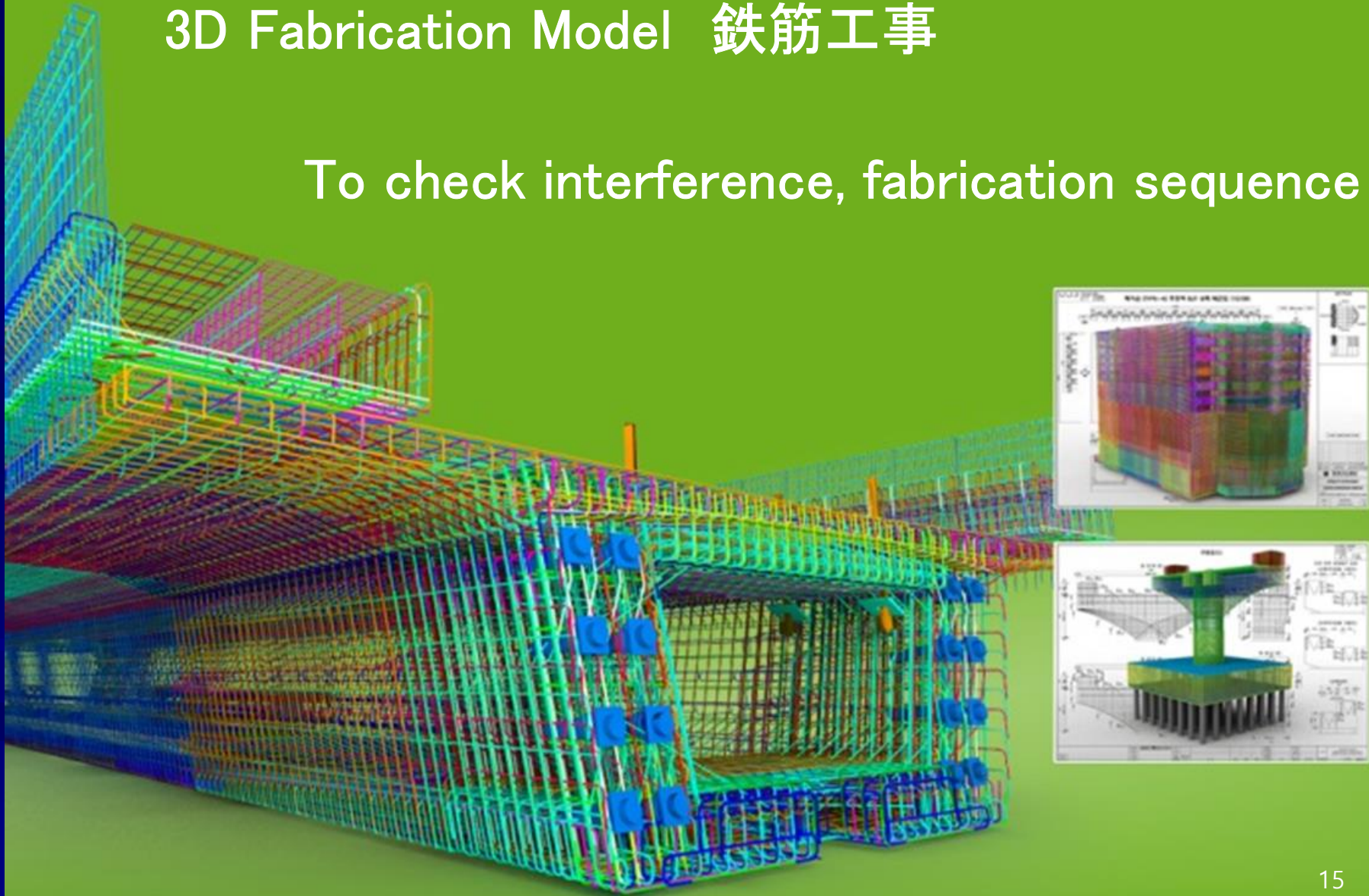
**Planning & investigation cost & Design cost is not big
in LCC :life cycle cost**

BIM for construction

韓国TAESUNG社の
プレゼンテーションより。

3D Fabrication Model 鉄筋工事

To check interference, fabrication sequence



Process of 3D Fabrication Model & Shop Drawings

2D rebar drawings

3D 鉄筋立体図

Rebar work data

Mark No	Type	Length
RD-01	02	H25
RD-02	01	H25
RD-03	02	H25
RD-05	01	H25
RD-07	01	H25
RD-09	01	H25
RD-09	02	H25

鉄筋計画ツール
Rebar Authoring Tools

自動数量計算
Automatic Quantities Calculation

図面精度検証
Drawing Accuracy Review

施工性審査
Constructability Review

加工図作成
Shop Drawings

数量算出
Quantities Calculation

鉄筋の最適使用化
Optimization of Rebar Arrangement

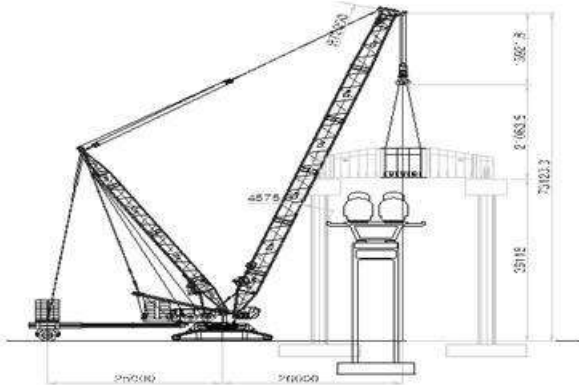
経済的施工法の検討
Economical Mock-up Test

鉄筋のロス削減
Minimization of Rebar loss

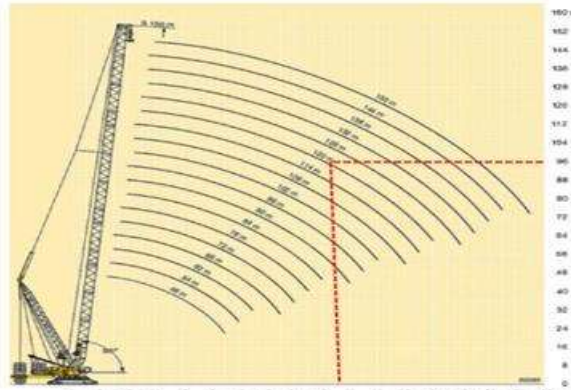
Cost Down

Why do we need virtual construction technology ?

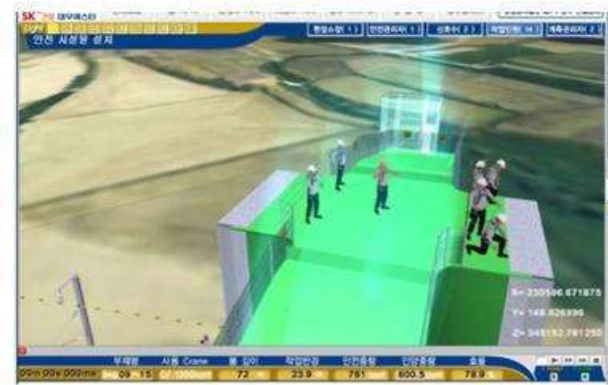
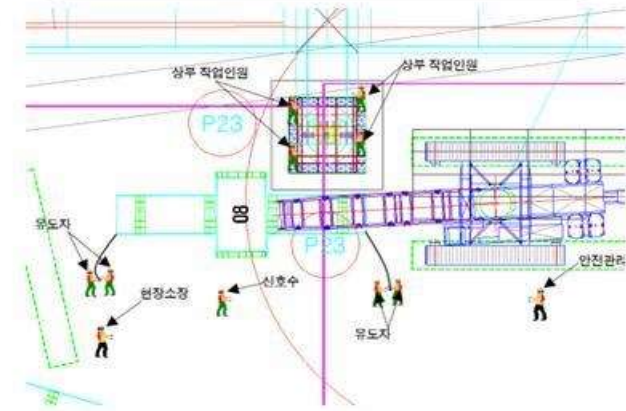
Construction Plan



Equipment Capacity Review



Worker Position Review



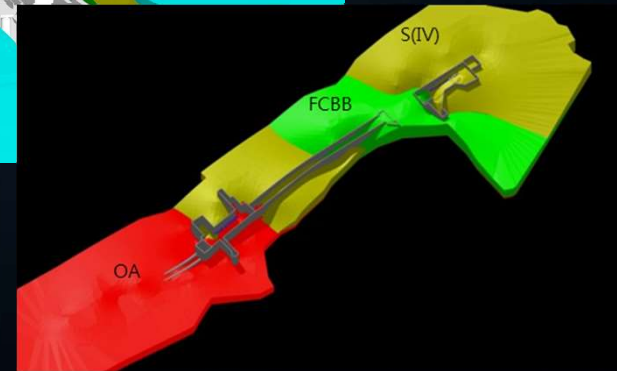
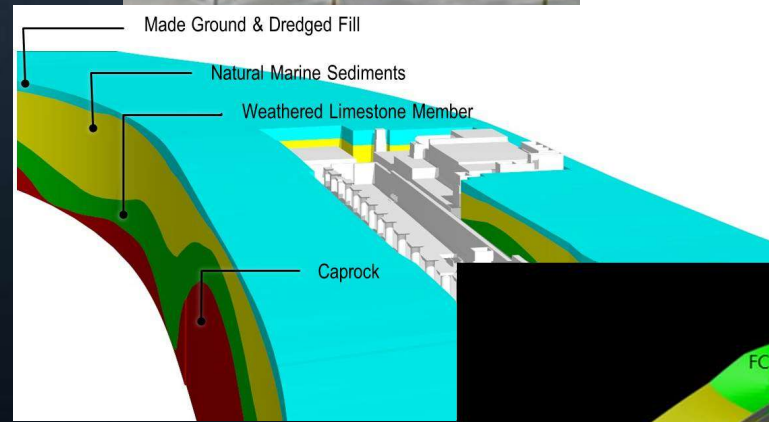
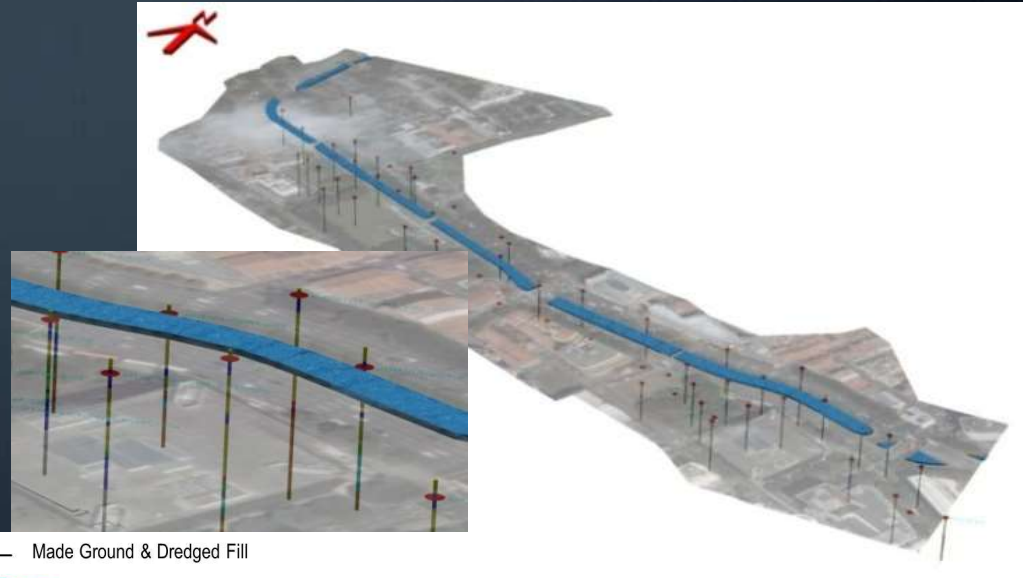
Terrain and Stratum Model

韓国TAESUNG社の
プレゼンテーションスライド.



APPENDIX B Borehole Logs and Borehole Coordinate List

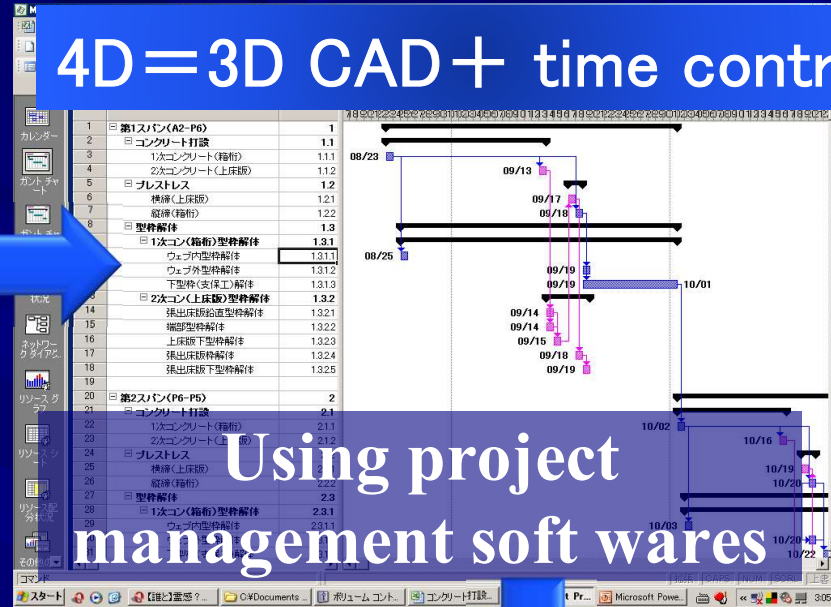
GULF LABORATORIES Co.										Project		Borehole	
Date - Date of Date										Geotechnical Investigation-Phase I		Doh, MW1006	
Borehole Number (prev): 1217150										Ground Level (GN10)		747	
Fluid: Water										Client		Schlumberger Overseas SA	
Core Dia (mm): 83										Casing Diameter (mm): 150		3 of 4	
Method: Hand excavation and rotary coring										Location: At State E-27ng, Chongae-Si 15704 134		Sheet	
Coordinates: 280653.0 (N), 387864.0 (E)										Start Date: 2017/11		End Date: 2017/11	
Station	Depth (m)	Rock	Core	Size	Remarks	Level	Depth (m)	Description	Legend				
100	100	100	2	17		100.00	100.00	All particles weak light greyish brown to light green brown fine grained crystalline dolomitic LIMESTONE with pockets of very weak light grey to yellowish brown silts (15-25%). (Ductility weak/soft).					
101	101	101	2	17		101.00	101.00						
102	102	102	2	17		102.00	102.00						
103	103	103	2	17		103.00	103.00						
104	104	104	2	17		104.00	104.00						
105	105	105	2	17		105.00	105.00						
106	106	106	2	17		106.00	106.00						
107	107	107	2	17		107.00	107.00						
108	108	108	2	17		108.00	108.00						
109	109	109	2	17		109.00	109.00						
110	110	110	2	17		110.00	110.00						
111	111	111	2	17		111.00	111.00						
112	112	112	2	17		112.00	112.00						
113	113	113	2	17		113.00	113.00						
114	114	114	2	17		114.00	114.00						
115	115	115	2	17		115.00	115.00						
116	116	116	2	17		116.00	116.00						
117	117	117	2	17		117.00	117.00						
118	118	118	2	17		118.00	118.00						
119	119	119	2	17		119.00	119.00						
120	120	120	2	17		120.00	120.00						
121	121	121	2	17		121.00	121.00						
122	122	122	2	17		122.00	122.00						
123	123	123	2	17		123.00	123.00						
124	124	124	2	17		124.00	124.00						
125	125	125	2	17		125.00	125.00						
126	126	126	2	17		126.00	126.00						
127	127	127	2	17		127.00	127.00						
128	128	128	2	17		128.00	128.00						
129	129	129	2	17		129.00	129.00						
130	130	130	2	17		130.00	130.00						
131	131	131	2	17		131.00	131.00						
132	132	132	2	17		132.00	132.00						
133	133	133	2	17		133.00	133.00						
134	134	134	2	17		134.00	134.00						
135	135	135	2	17		135.00	135.00						
136	136	136	2	17		136.00	136.00						
137	137	137	2	17		137.00	137.00						
138	138	138	2	17		138.00	138.00						
139	139	139	2	17		139.00	139.00						
140	140	140	2	17		140.00	140.00						
141	141	141	2	17		141.00	141.00						
142	142	142	2	17		142.00	142.00						
143	143	143	2	17		143.00	143.00						
144	144	144	2	17		144.00	144.00						
145	145	145	2	17		145.00	145.00						
146	146	146	2	17		146.00	146.00						
147	147	147	2	17		147.00	147.00						
148	148	148	2	17		148.00	148.00						
149	149	149	2	17		149.00	149.00						
150	150	150	2	17		150.00	150.00						
151	151	151	2	17		151.00	151.00						
152	152	152	2	17		152.00	152.00						
153	153	153	2	17		153.00	153.00						
154	154	154	2	17		154.00	154.00						
155	155	155	2	17		155.00	155.00						
156	156	156	2	17		156.00	156.00						
157	157	157	2	17		157.00	157.00						
158	158	158	2	17		158.00	158.00						
159	159	159	2	17		159.00	159.00						
160	160	160	2	17		160.00	160.00						
161	161	161	2	17		161.00	161.00						
162	162	162	2	17		162.00	162.00						
163	163	163	2	17		163.00	163.00						
164	164	164	2	17		164.00	164.00						
165	165	165	2	17		165.00	165.00						
166	166	166	2	17		166.00	166.00						
167	167	167	2	17		167.00	167.00						
168	168	168	2	17		168.00	168.00						
169	169	169	2	17		169.00	169.00						
170	170	170	2	17		170.00	170.00						
171	171	171	2	17		171.00	171.00						
172	172	172	2	17		172.00	172.00						
173	173	173	2	17		173.00	173.00						
174	174	174	2	17		174.00	174.00						
175	175	175	2	17		175.00	175.00						
176	176	176	2	17		176.00	176.00						
177	177	177	2	17		177.00	177.00						
178	178	178	2	17		178.00	178.00						
179	179	179	2	17		179.00	179.00						
180	180	180	2	17		180.00	180.00						
181	181	181	2	17		181.00	181.00						
182	182	182	2	17		182.00	182.00						
183	183	183	2	17		183.00	183.00						
184	184	184	2	17		184.00	184.00						
185	185	185	2	17		185.00	185.00						
186	186	186	2	17		186.00	186.00						
187	187	187	2	17		187.00	187.00						
188	188	188	2	17		188.00	188.00						
189	189	189	2	17		189.00	189.00						
190	190	190	2	17		190.00	190.00						
191	191	191	2	17		191.00	191.00						
192	192	192	2	17		192.00	192.00						
193	193	193	2	17		193.00	193.00						
194	194	194	2	17		194.00	194.00						
195	195	195	2	17		195.00	195.00						
196	196	196	2	17		196.00	196.00						
197	197	197	2	17		197.00	197.00						
198	198	198	2	17		198.00	198.00						
199	199	199	2	17		199.00	199.00						
200	200	200	2	17		200.00	200.00						



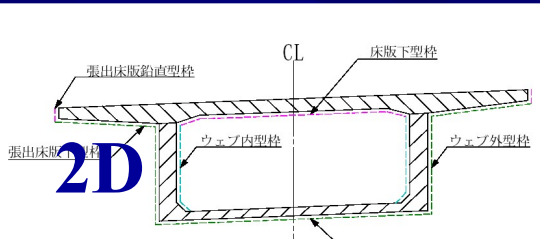
Project management using BIM



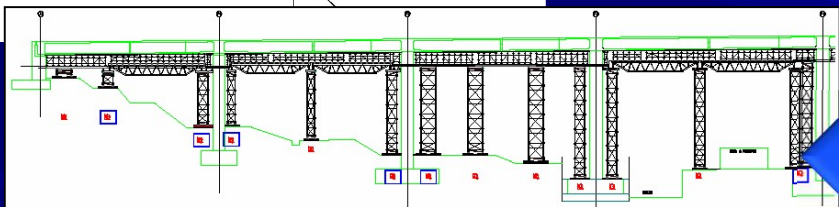
4D = 3D CAD + time control



Using project management soft wares



5D = 3D CAD + 計算 + time control + Cost control



TARGET BUDGET VS. FORECASTED COST (1995.07.3)

PROJECT DIVISION (1): DIRECT WORK

COST ITEM	実施予算	出来高	残工事	実施	差額
	(BQ対応)	対応原価	対応原価	予定原価	
	Target Budget	Cost To Date	Cost To Completion	Forecasted Const. Cost	Balance
OUNT (M) =					
OUNT (N) =					
OUNT (O) =					
OUNT (P) =					
OUNT (Q) =					
OUNT (R) =					
OUNT (S) =					
OUNT (T) =					
OUNT (U) =					
OUNT (V) =					
OUNT (W) =					
OUNT (X) =					
OUNT (Y) =					
OUNT (Z) =					
OUNT (*) =					

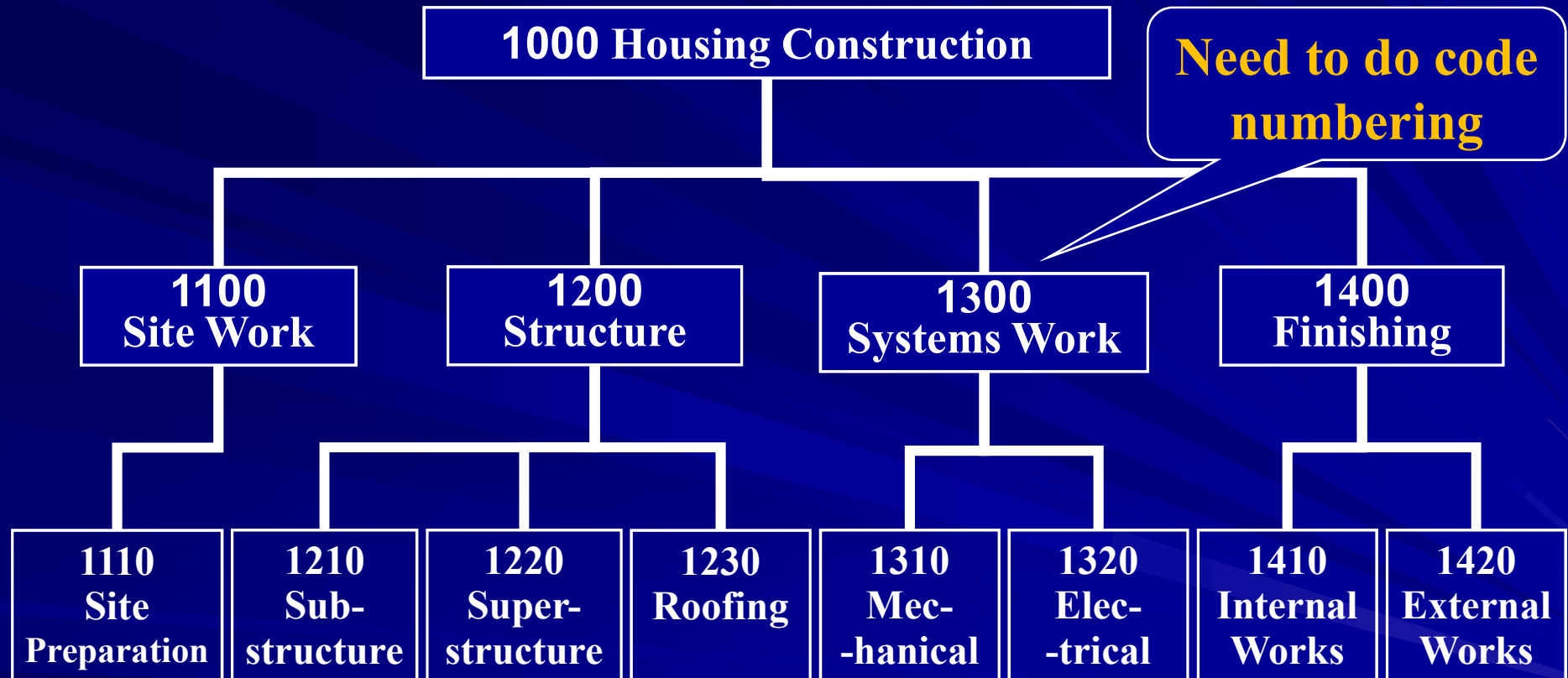
OUNT = * 1000

Virtual Construction
仮想施工
(施工性・安全性検証)

Verify the entitlement of claim for additional cost and/or time extension

Basic technique for schedule control

WBS: Work Breakdown Structure



WBS is essential for clarifying whole required activities of the project.

CPM: Critical Path Method

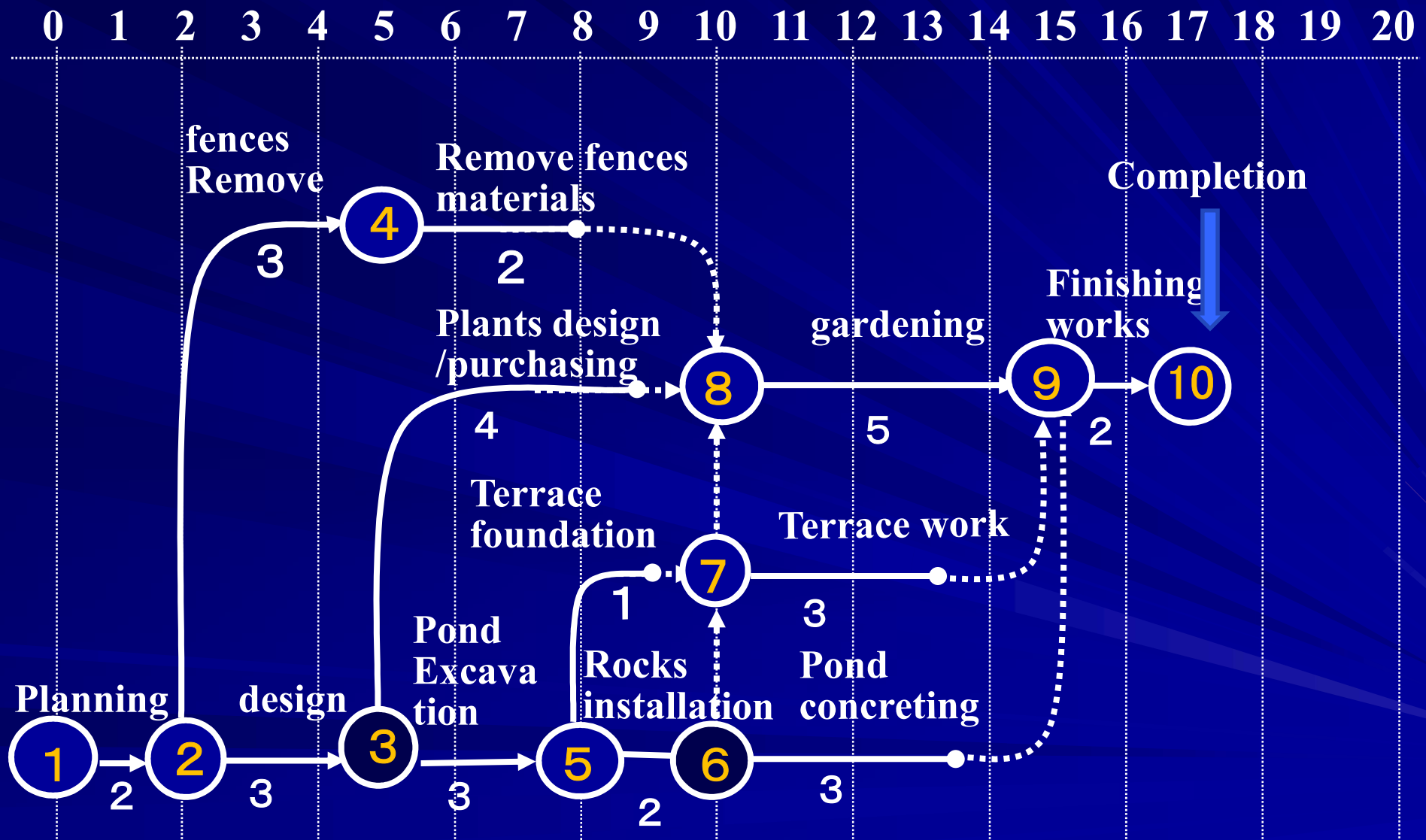
Microsoft Project 2000 Demonstration

The screenshot shows the Microsoft Project 2000 interface. The title bar reads "Microsoft Project - HouseDec2002-06". The menu bar includes "ファイル(F)", "編集(E)", "表示(V)", "挿入(I)", "書式(O)", "ツール(T)", "プロジェクト(P)", "ウィンドウ(W)", and "ヘルプ(H)". The "Format" menu is open, with "バーのスタイル(S)..." highlighted. The task list on the left shows tasks from 1 to 15, including "House", "Start", "Site work", "Structure", "Superstructure", "Roof", "Systems work", "Mechanical", "Electrical", "Finishing", "Internal", "External", and "Finish". The Gantt chart on the right displays a project schedule from January to April, with task bars and resource assignments like "Skill[200%], Unskill[700%]".

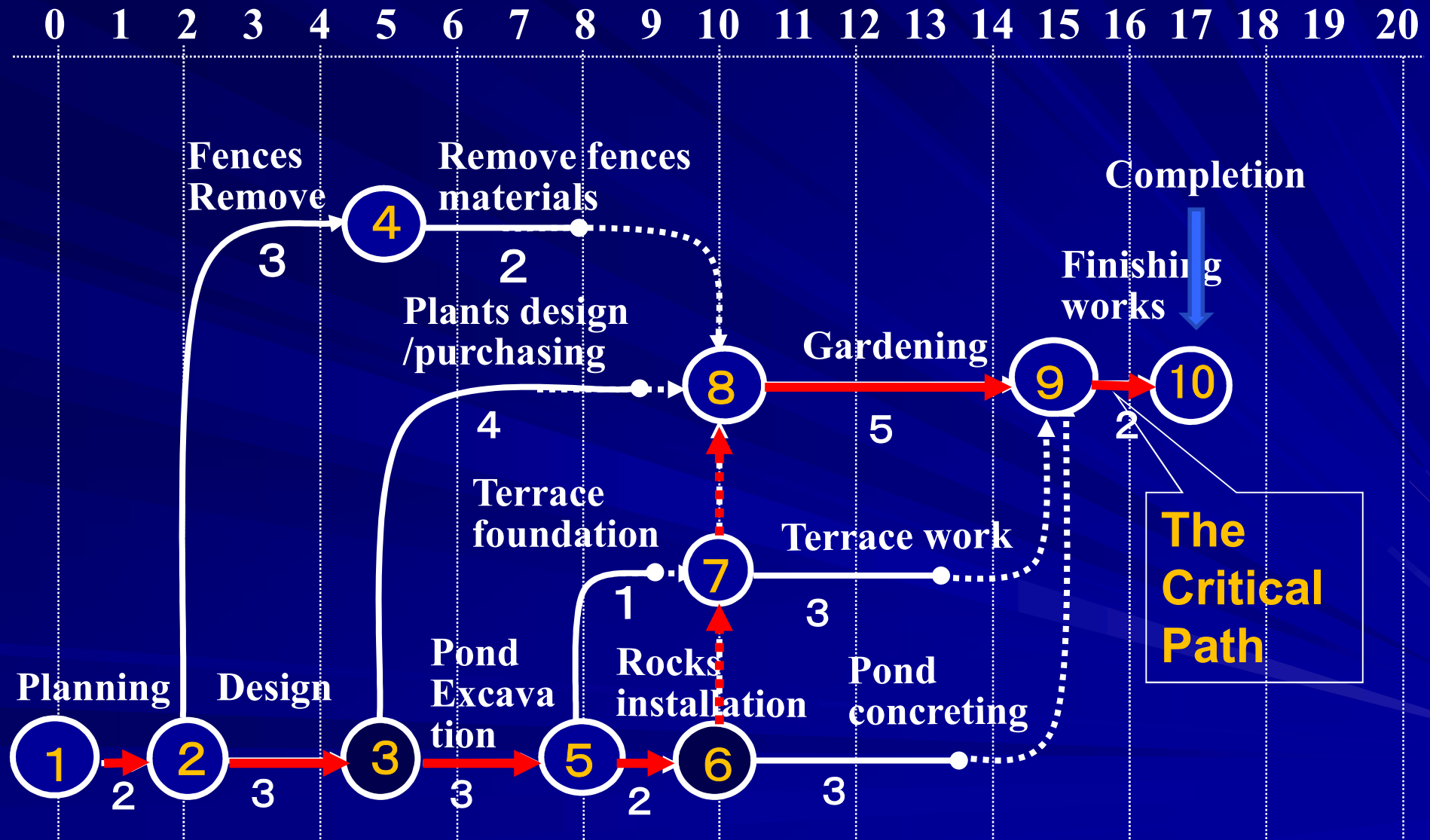
タスク名	開始	終了	日数
1 House			
2 Start			
3 Site work			
4 Site prepara			
5 Structure			
6 Substructure			
7 Superstructure	1.2.02	21日	
8 Roof	1.2.03	14日	
9 Systems work	1.3.00	17日	
10 Mechanical	1.3.01	17日	
11 Electrical	1.3.02	15日	
12 Finishing	1.4.00	15日	
13 Internal	1.4.01	14日	
14 External	1.4.02	10日	
15 Finish	9999	0日	

Project management software

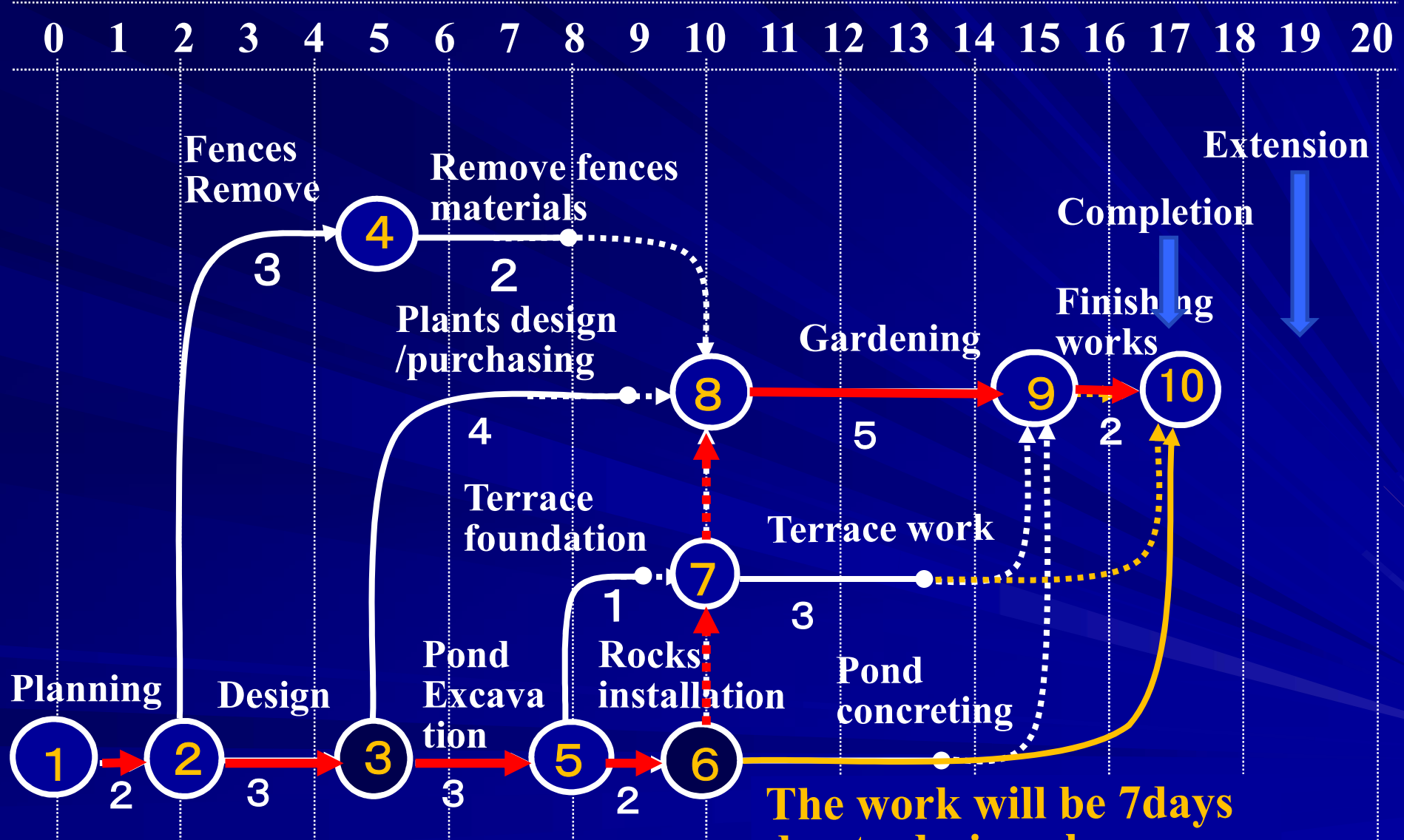
CPM: Critical Path Method



Find out the Critical Path

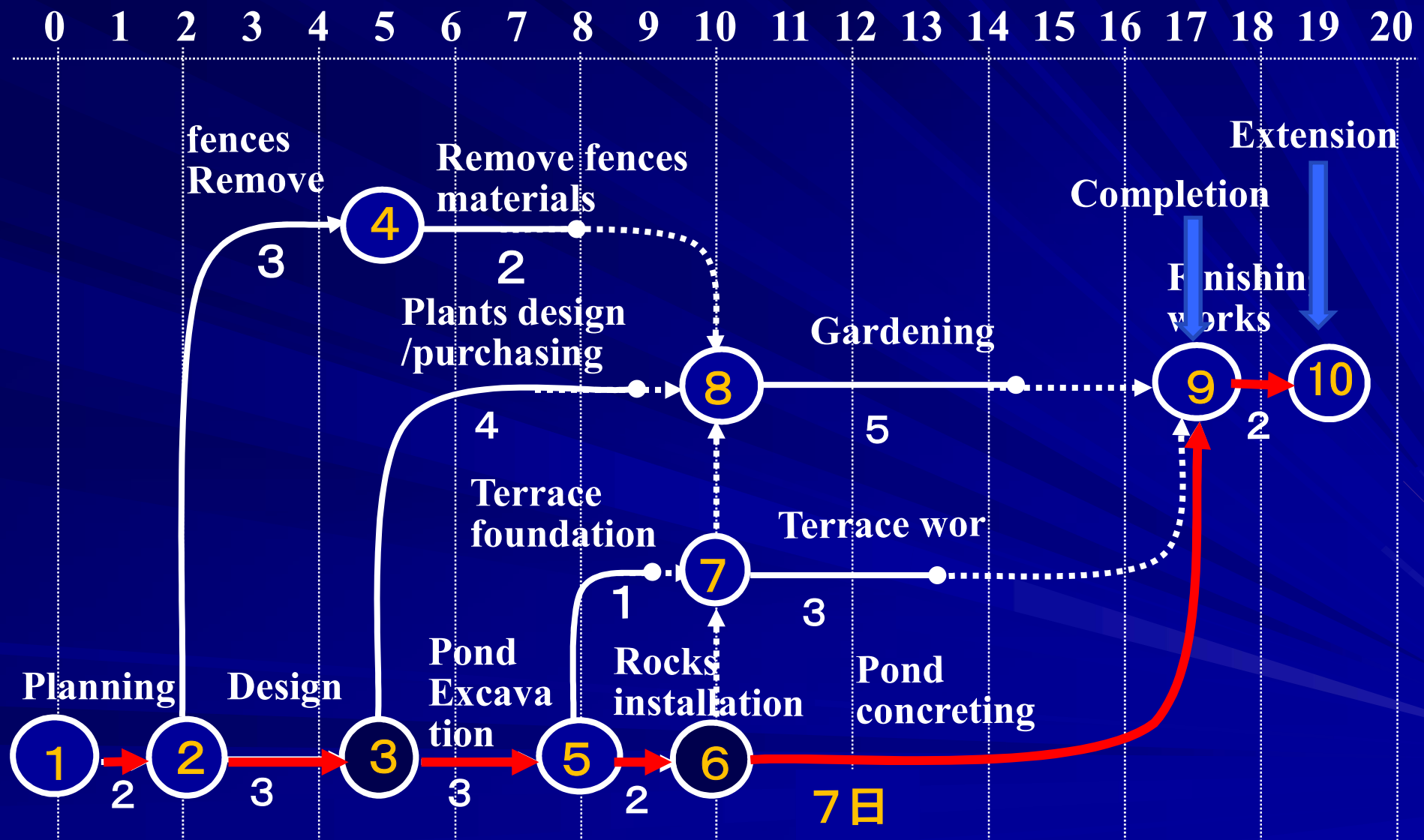


Change of activity duration



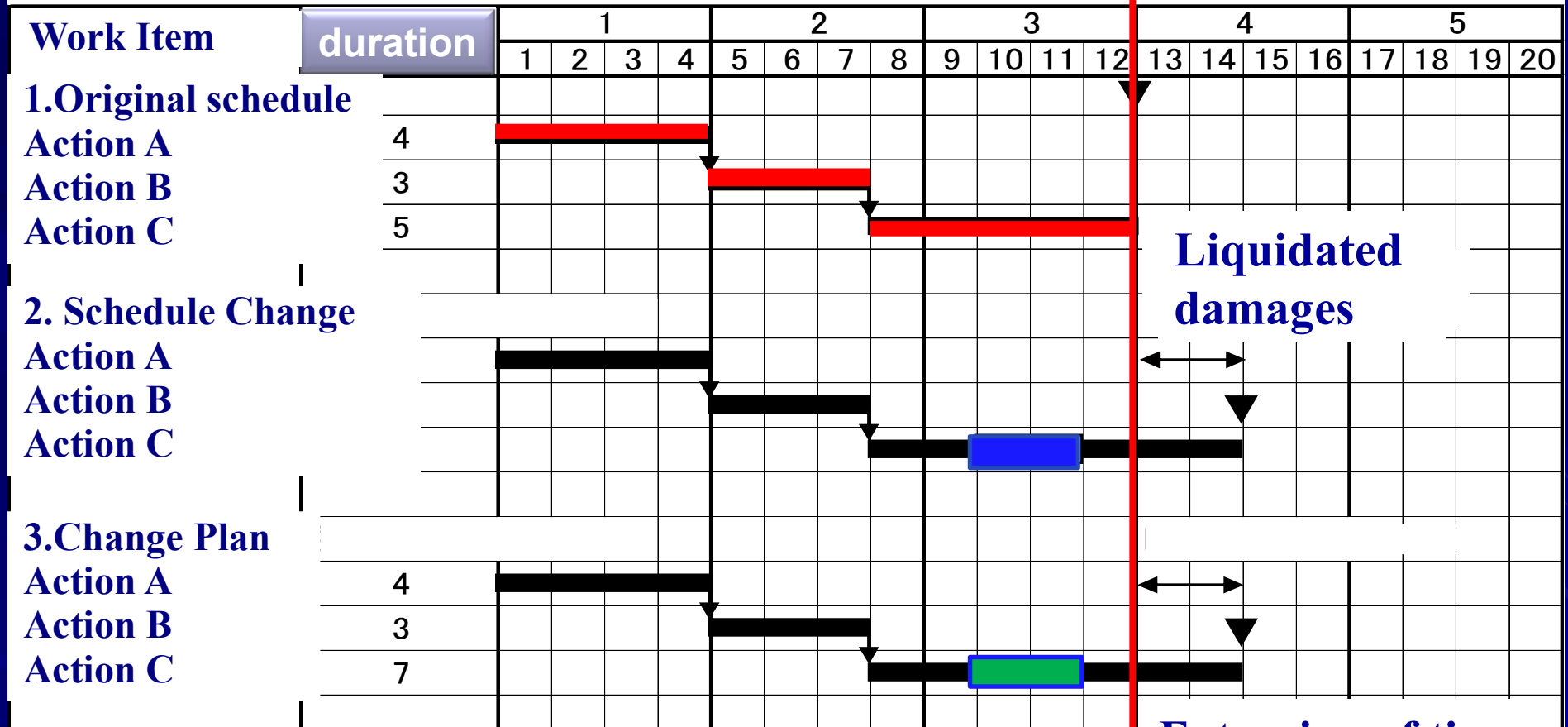
The work will be 7 days due to design change

Change of the Critical Path



Delay analysis

工程の遅延



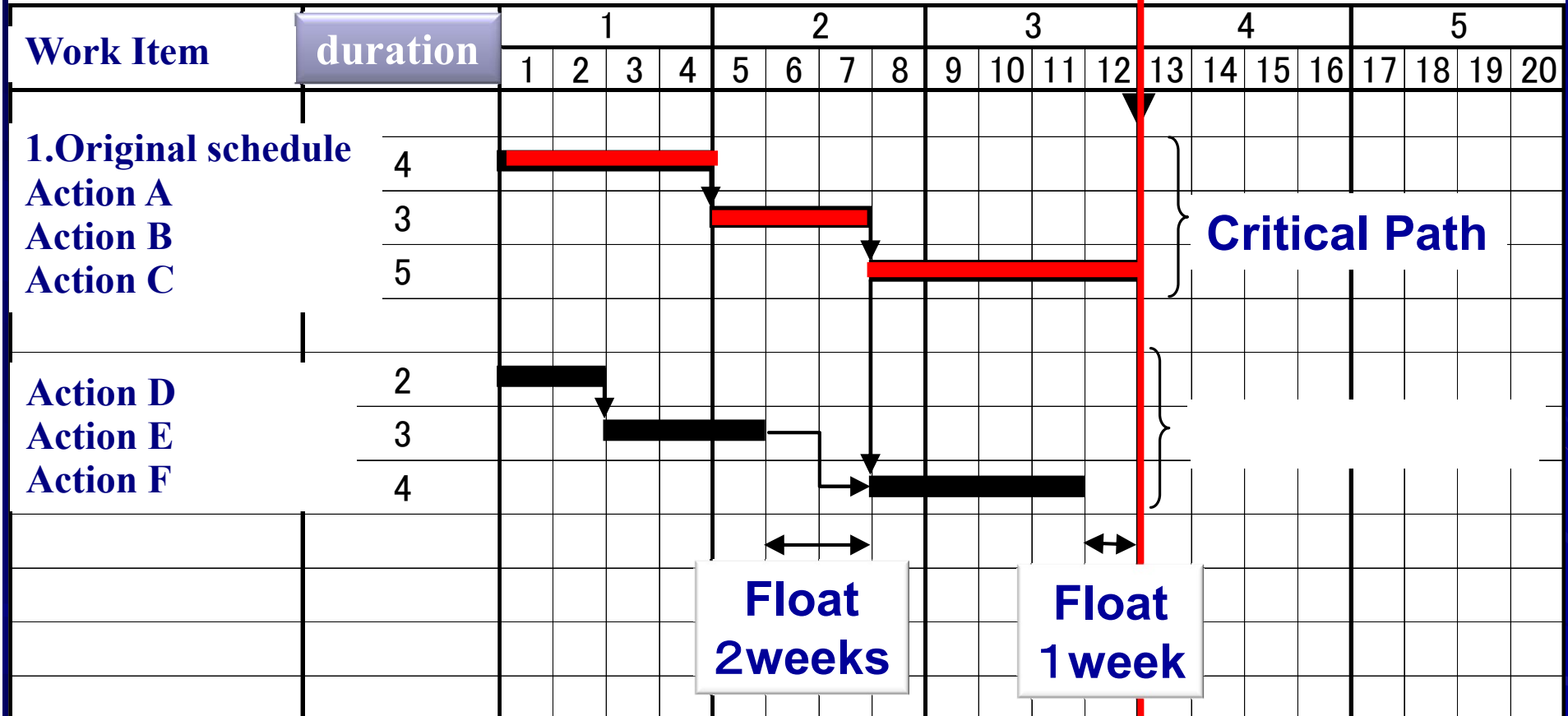
Liquidated damages

Extension of time

- Delay attributable to Contractor
- Delay attributable to Employer

Delay analysis : Critical path and float (1)

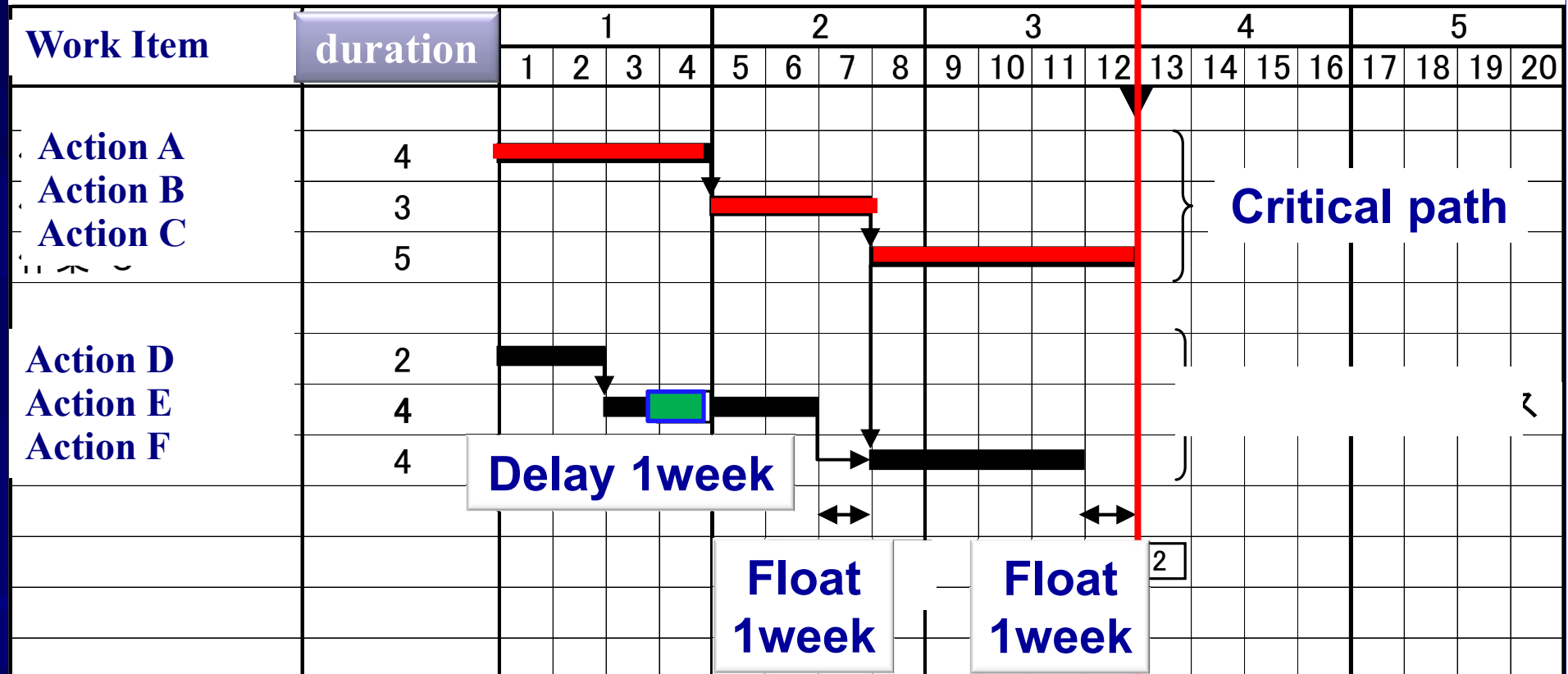
工程のクリティカルパスとフロート



▼ 完工日
↓ リンク

Delay analysis : Critical path and float (2)

ノン・クリティカルパス工程の遅延(1)

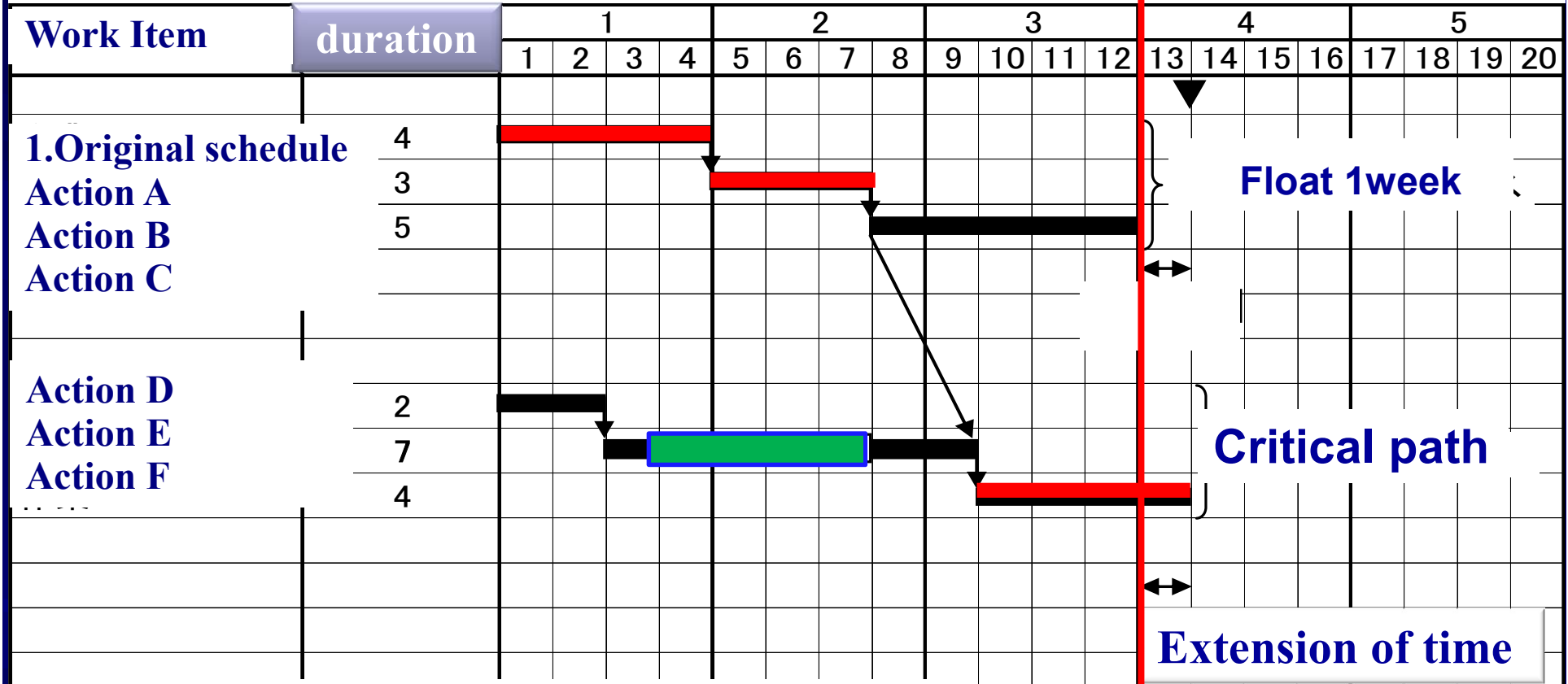


Delay attributable to Contractor

Delay attributable to Employer

Delay analysis : Critical path and float (3)

ノン・クリティカルパス工程の遅延(2)

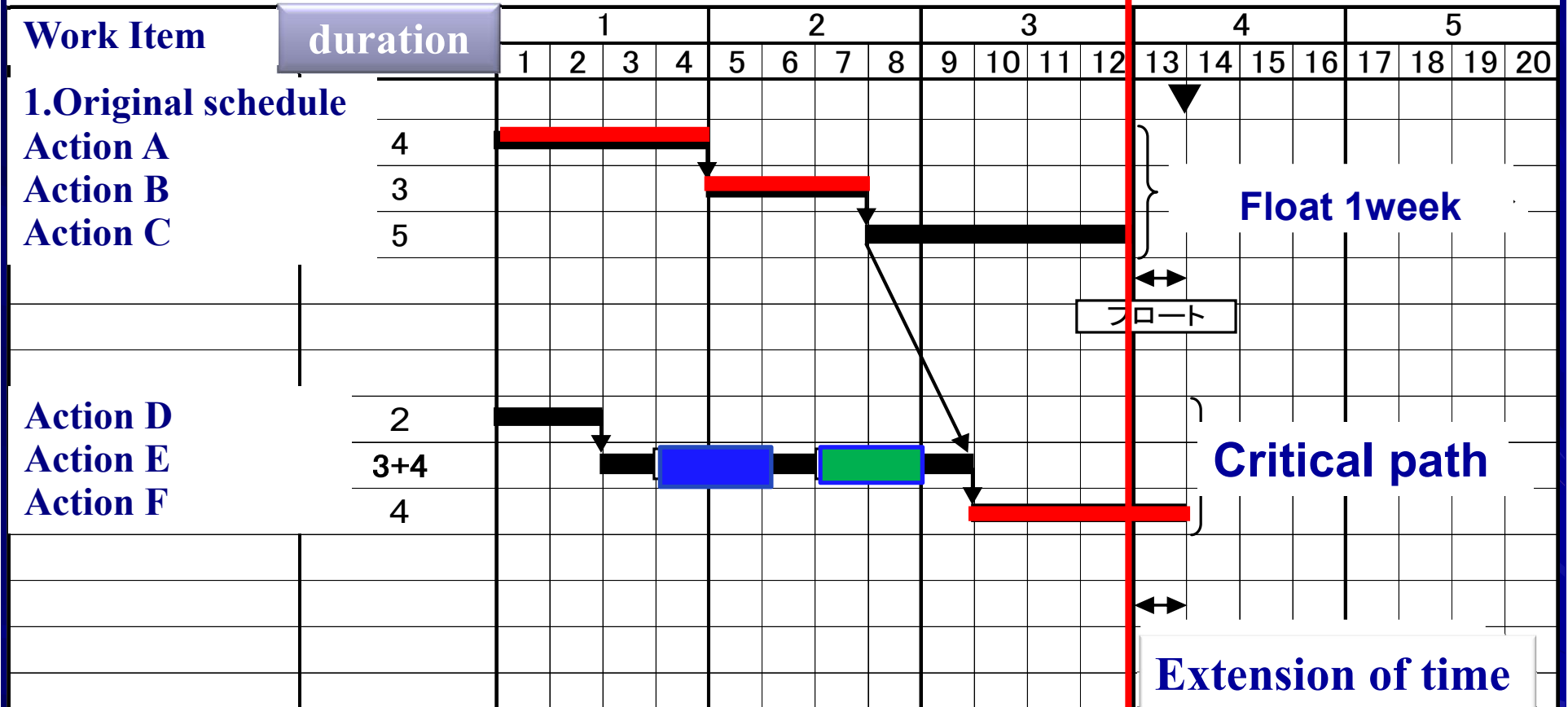


Delay attributable to Contractor

Delay attributable to Employer

Delay analysis : Critical path and float (4)

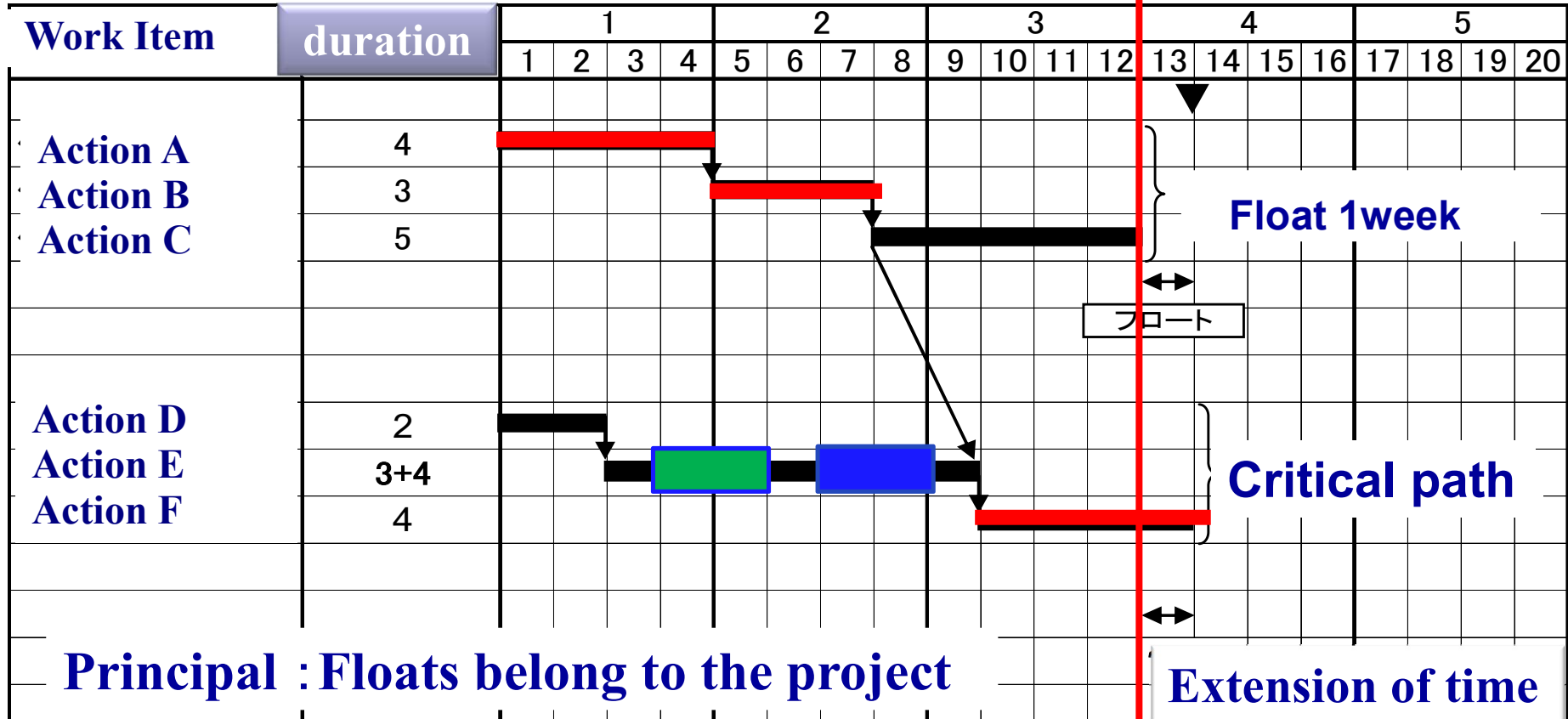
ノン・クリティカルパス工程の遅延(3)



- Delay attributable to Contractor
- Delay attributable to Employer

Delay analysis : Critical path and float (5)

ノン・クリティカルパス工程の遅延(4)



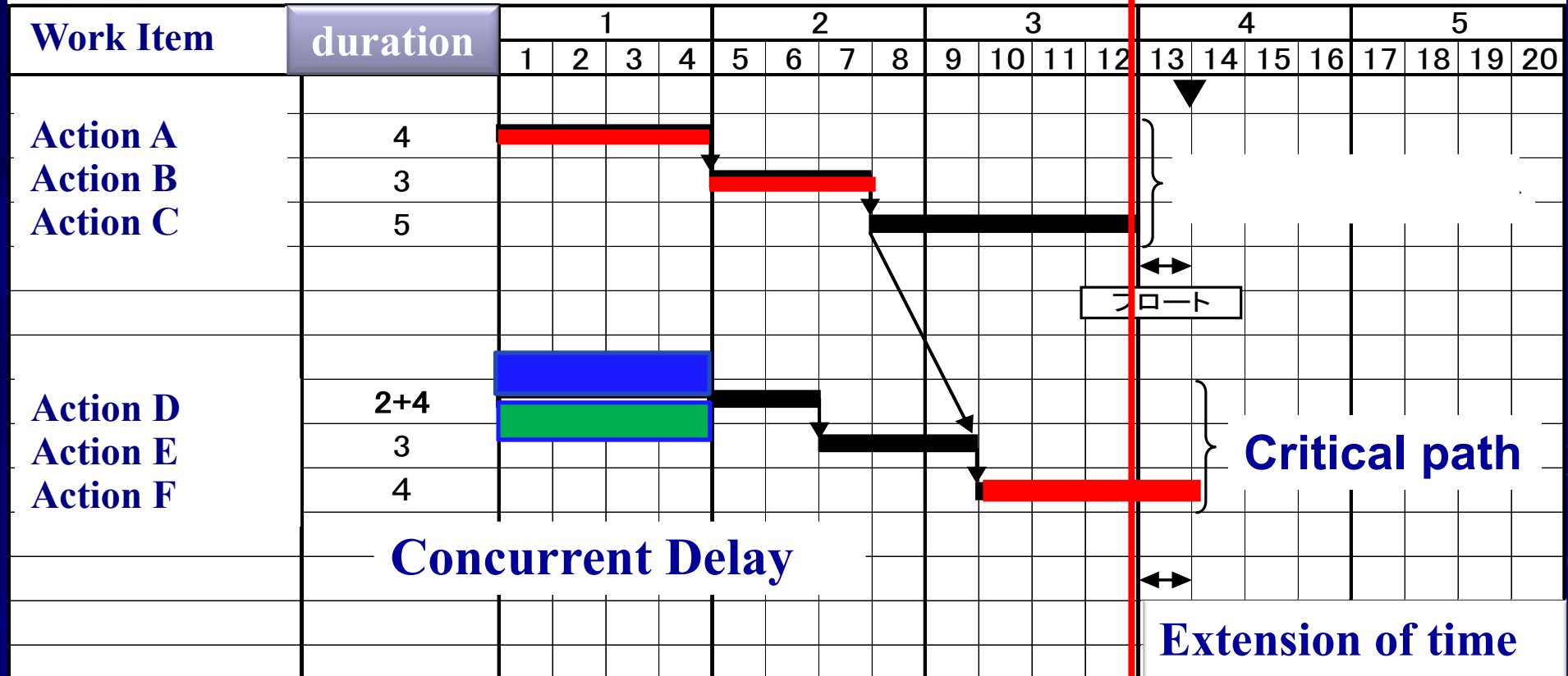
Principal : Floats belong to the project

Extension of time
or Liquidated
damages

- Delay attributable to Contractor
- Delay attributable to Employer

Delay analysis : Critical path and float (6)

ノン・クリティカルパス工程の遅延(5)



Extension of time
or Liquidated
damages

- Delay attributable to Contractor
- Delay attributable to Employer

How do you solve the problems at project sites

On construction project sites, finding solutions to problems involves **not only technical approaches, but also contractual approaches** as well.



Recommended Further study

Interesting words related to contact administration

1. **Contra Proferentem**
2. **Quantum Meruit**
3. **Prevention Principle**
4. **Time at Large**
5. **Estoppel**

What is the reason a project needs to get the Engineer

“Contract” with tax payers or the financier.

◆ The project owner ;
Needs to observe what the Engineer
and the contractor are doing

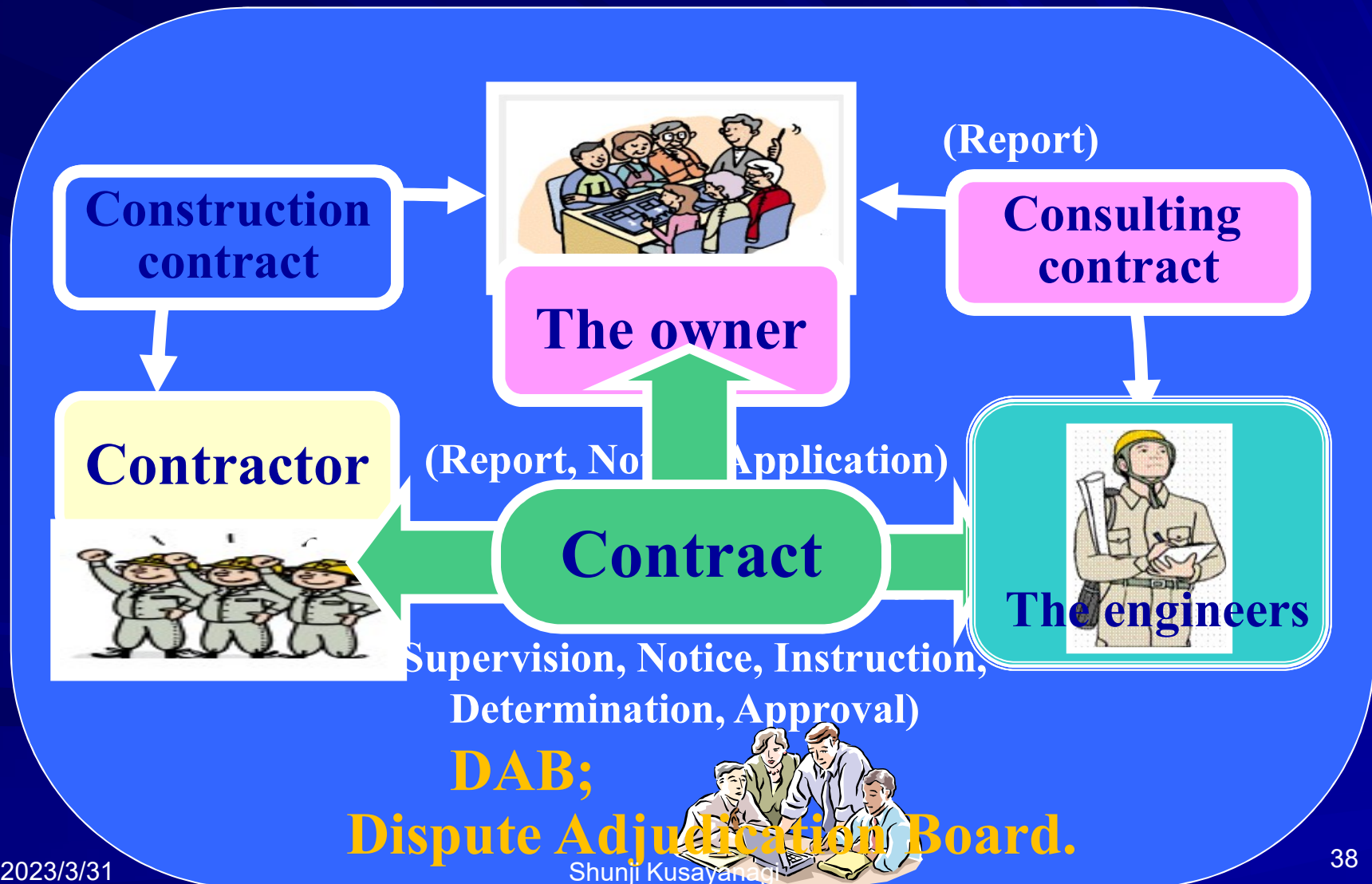
◆ The Engineer Needs to do
supervision, instruction what
the contractor dose.

◆ The contractor ; Needs to shoe what
the process of constructing the
objective structure.

**The process
control**
to keep the transparency

3 Actors Project Execution System

Fundamental concept of the Standard Conditions of Contract of FIDIC



What are “Standards”?

- **There are many so called “standards”.**
 - Design standards
 - Quality standards
 - Site works standards
 - Safety standards
 - Etc.,
- You can not make a proper work if you just following standards.
- Because, what “a standard” telling you is to **need to confirm your work** with it but not telling you **what you have to do.**

Project management and documents

Standards; An acknowledged measure of comparison for quantitative or qualitative value.

-The American Heritage Dictionary of the English Language-

Guideline, telling average value

Specifications; A detailed, exact statement of particulars, especially a statement prescribing materials, dimensions, and quality of work for something to be built, installed, or manufactured.

-The American Heritage Dictionary of the English Language-

Method Statement;

The document is telling you that you have to do your works exactly for the project.

Management of Quality, Safety, etc.,

Project Execution

The capability required for design engineers

The project owner may ask you;

- What is the back ground of your **Design concept**?
- Why do you select this **Industrial Standards**?
- How do you make the **Specifications**?
- Why do you select this **Construction Method**?

Productivity, Safety, liability and Cost performance.



The design engineer need to have following capabilities;

- Knowledge and experiences related to **Industrial standards**.
- To make appropriate **Technical Specifications**.
- Knowledge and experiences related to **Constriction Methods**
- Knowledge and experiences regarding **Contract Administration**

**If you do not have these capabilities, you can not execute
Design & Build contract**