

# Time scheduling I.

Building Project Management

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## Scheduling in construction

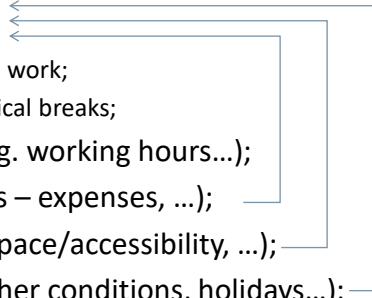
Aims and purposes of time planning

- To forecast the events/activities in the project
- To expose likely difficulties of the future, and help to solve them
- To forecast the requirements of money and other resources
- To minimize the unproductive time of men and machines
- To lay down deadlines
- To use as a control tool

# Scheduling in construction

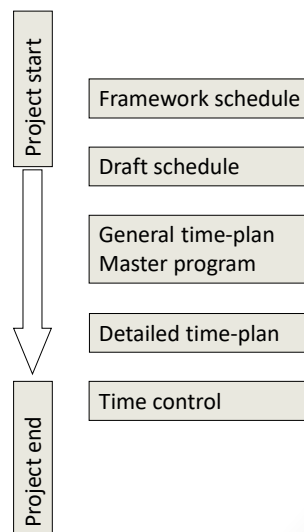
Affecting factors:

- Technology:
  - Time span of actual work;
  - Time span of technical breaks;
- Law, regulation (e.g. working hours...);
- Financing (incomes – expenses, ...);
- Location (limited space/accessibility, ...);
- Time period (weather conditions, holidays...);
- ...



# Scheduling in construction

- Types of schedules (during a building project)
  - It has to be detailed (and accurate) enough for the actual use – project manager, construction manager, general foreman, skilled workers, etc. → contents, time unit
  - The later it is made, the more accurate and detailed it can be



# Scheduling in construction

- Information in a schedule
  - The **time needed** for each construction process ( in some cases the available time span)
  - **Technical content** to each construction process
  - **Connections** between processes in time, in space
  - Chronological order (**sequence**) depending on technology
  - **Time span** of the project/construction
  - Starting/finishing **date**
  - **Resources** needed during the construction processes → during the whole construction
  - Together with the cost calculation: **costs** of each activity → costs during the construction

# Scheduling in PM

## Project time management (PMBOK)

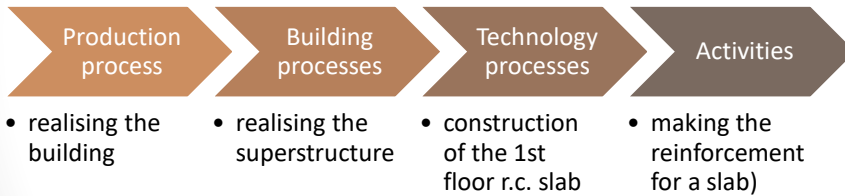
- Activity definition
- Activity sequencing
- Activity duration estimating
- Schedule development
- Schedule control



## „Time planning”

Activity?

- Determine what is to be done: **OUTCOMES** (plan)
- Work Breakdown Structure (WBS)
- List of activities (tasks)



- **Activities:** processes made in **one time**, at **one place**, by **one group of workers**

## „Time planning”

Sequence?

### Relations between activities

- **Technological** conditions: order of activities based on technological reasons
  - Formworking and pouring of concrete
  - Ceramic tile on wall and floor
- **Organisational** conditions: one worker-one job-one place-one time
  - The number of skilled workers – one job at the same time
  - Size and location of the place of work - allowing adequate working space

## „Time planning”

Duration?

- Quantities for each task
- Assigning resources
  - Material (construction material, auxiliary structures, ...)
  - Human (management, skilled workers – labour)
  - Equipment (machines, heavy equipment, power tools, ...)
  - Area
  - Money
- Estimating the time required for the processes:
 

Standards

  - Performance standard [time/unit] (h/m<sup>3</sup>, h/m<sup>2</sup>...)
  - Standard output [unit/time] (m<sup>3</sup>/h, pcs/h)

## „Time planning”

Duration?

Estimating time: the duration of the processes

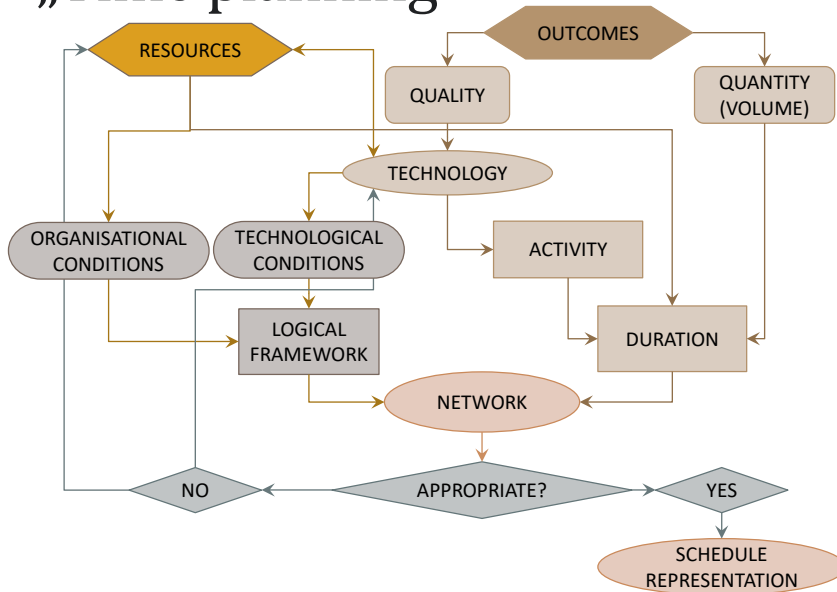
$$\text{Work [time]} = \frac{\text{Volume [unit]}}{\text{Standard output [unit/time]}}$$

$$\text{Work [time]} = \text{Volume [unit]} \times \text{Performance standard [time/unit]}$$

$$\text{Duration [time]} = \frac{\text{Work [time]}}{\text{Allocated resource [unit]}}$$

- Work: time of process for one unit of resource
- Duration: time of process for the allocated units of resource

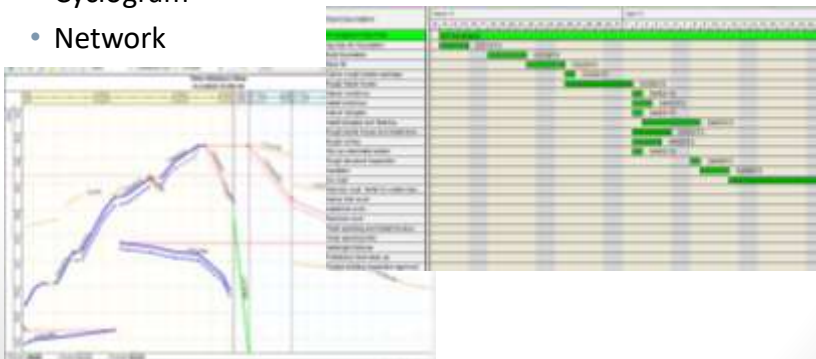
# „Time planning”



## Schedule representations

Schedule?

- Timetable (tabular or alpha-numerical schedule)
- Bar chart, Gantt chart
- Cyclogram
- Network



## Schedule representations

- Timetable (tabular or alpha-numerical schedule)
  - It is accurate
  - Hard to see the current status at the first sight

Example: a retaining wall

ID	Activity	Time	Start	Finish	Labour	Machine	Cost	Remark
1	Demolish top soil	2 d	02-04-10	03-04-10		1 bulld.	€...	
2	Excavating trench	2 d	04-04-10	05-04-10	3 labr.	1 backh.	€...	15% labr.
3	Blinding	3 d	06-04-10	08-04-10	5 labr.		€...	
4	Formwork (foundation slab)	3 d	08-04-10	10-04-10	2 carp.		€...	
5	Reinforcement (foundation slab)	5 d	08-04-10	12-04-10	4 steel.		€...	35% prefabr.

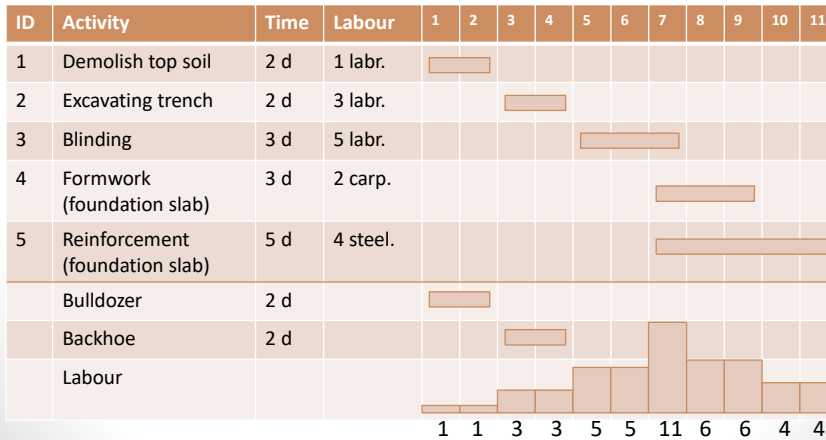
## Schedule representations

- Bar chart – Gantt chart
  - Most widely used technique
  - It consists of a scale – units of time (e. g. days, weeks,...) and a list of project elements (+other information)
  - Easy to see the current status – „today”

ID	Activity	Time	Labour	1	2	3	4	5	6	7	8	9	10	11
1	Demolish top soil	2 d		█	█									
2	Excavating trench	2 d	3 labr.			█	█							
3	Blinding	3 d	5 labr.					█	█	█				
4	Formwork (foundation slab)	3 d	2 carp.								█	█	█	
5	Reinforcement (foundation slab)	5 d	4 steel.									█	█	█

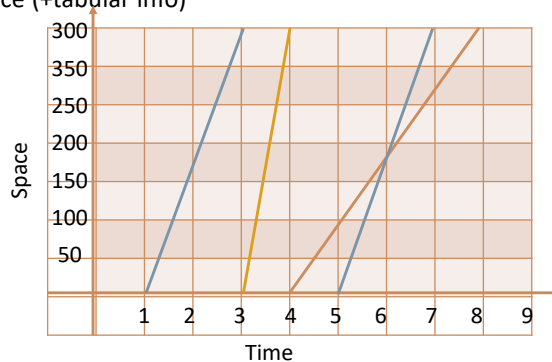
## Schedule representations

- Bar chart – Gantt chart
  - Resource management: workers, equipment



## Schedule representations

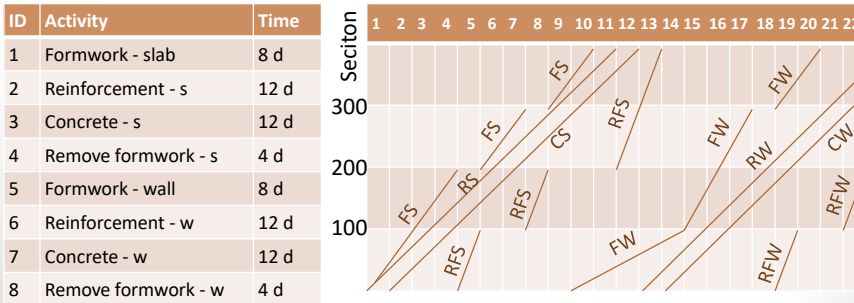
- Linear schedule – Cyclogram
  - Used usually by construction of linear objects or repeating tasks
  - It shows spatial progress
  - It consists of two scales – one for time (e. g. days, weeks,...) and one for space (+tabular info)





# Schedule representations

- Linear schedule – Cyclogram
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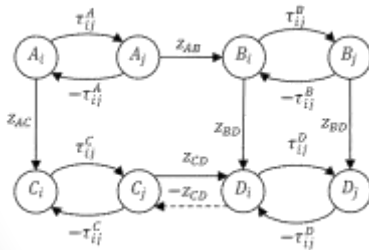


# Schedule representations

## Network diagrams

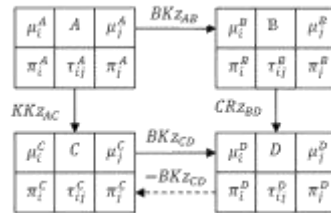
### Activity on arrow network

- 1957. Kelley and Walker – CPM
- (1958. NASA – PERT)



### Activity on node network

- 1959. B. Roy - MPM



# Characteristics of networks

- Models
  - Networks contain information about relations between activities

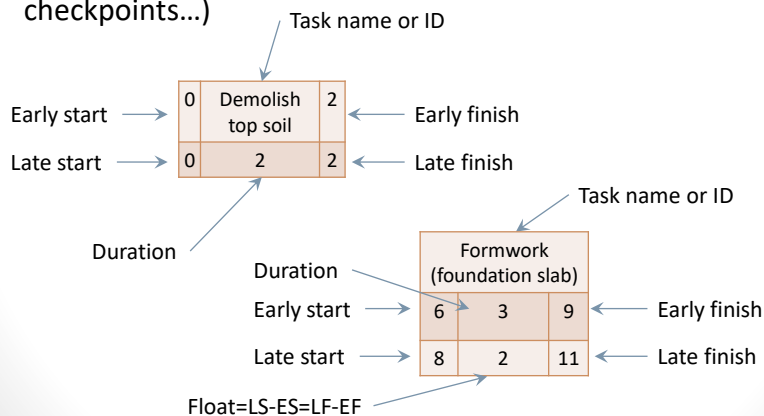
Network	Node	Arrow
Activity	Activity on node (MPM)	Activity on arrow (CPM)
Event	Event on node (PERT)	

- Basic elements:
  - Durations: time of processes, time of operations
  - Events (milestones): Project start, project end, activity start, activity end, deadlines, etc.

# Characteristics of networks

## Basic elements of AON networks

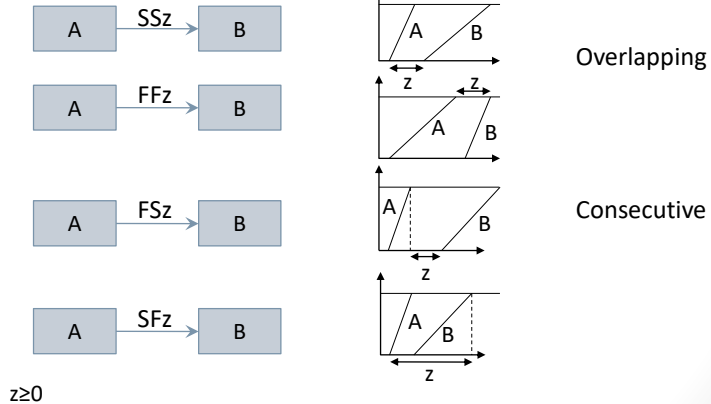
- Nodes: activities, significant events (deadlines, checkpoints...)



# Characteristics of networks

- Arrows: relations between activities

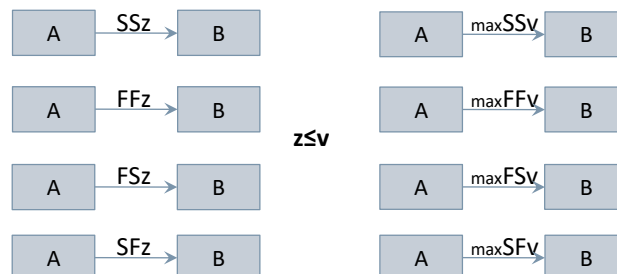
- Single, minimum relations



# Characteristics of networks

- Arrows: relations between activities

- Single, maximum relations

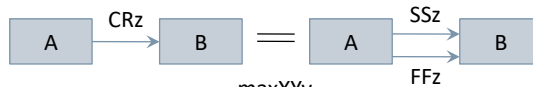


# Characteristics of networks

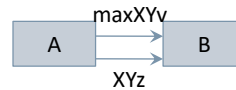
- Arrows: relations between activities

- Combined relations

Critical succession

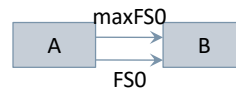


Strict/forced succession ( $z < v$ )



Special case:  $z = v$

Immediate succession

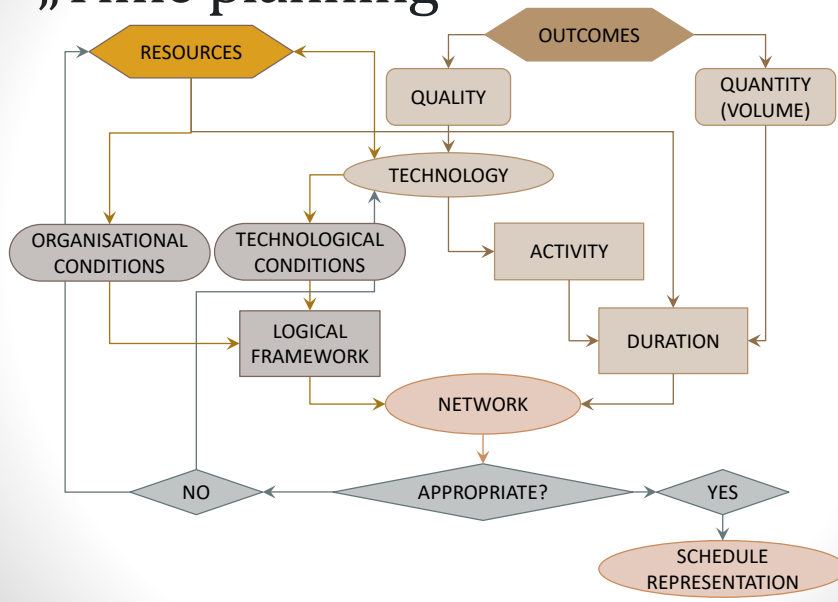


# Characteristics of networks

- Directed edges (arrows)
- Positive durations
- All activities appear only once
- Connected (coherent)
- No **loops** are allowed
- Only one starting node  $\leftarrow$  **Source**
  - A node being origin of at least one arrow, but not terminal point of any arrows.
- Only one end node  $\leftarrow$  **Sink**
  - A node being terminal point of at least one arrow, but not origin of any arrows.

If these conditions are not met, the algorithm can not be used

# „Time planning”



## References

- Lepel Adrienn – *Basics of construction – Basics of scheduling*  
<http://www.ekt.bme.hu/ArchEng/Basics%20of%20scheduling.pdf>
- Dr. Vattai Zoltán – *Construction management – decision support*, Network techniques I-II  
<http://www.ekt.bme.hu/CM-BSC-MSC/CM-BSC-MSC.htm>
- [http://en.wikipedia.org/wiki/Work\\_breakdown\\_structure](http://en.wikipedia.org/wiki/Work_breakdown_structure)