



Aalto University  
School of Engineering

# Operation Management in Construction

## Lecture #1 - Introduction

**Olli Seppänen**  
Associate professor

# Short Bio

- **Operations management experience 2000-**
  - 3 start-ups related to software
  - Dozens of real projects as consultant
  - Especially production planning and control
  - PhD + book + ~50 publications on the topic
- **Professor at Aalto 2015-**
  - Operations management, design management
  - Time-related disputes on the side



# Topics, Lecture #1

- **Course Introduction**
  - Learning Objectives
  - Lectures and assignments
  - Workload
  - Readings
  - MyCourses discussions
  - Grading
- **What kind of production is construction?**
- **Overview of planning methods**

# Intended Learning Objectives

- ILO 1: **Students can explain** the nature of production in construction
- ILO 2: **Students can compare and contrast** the similarities and differences of different production planning and control methods (Drawing Gantt Charts, CPM, LBMS, Takt planning, Last Planner System)
- ILO 3: **Students can calculate** the production system cost of a schedule
- ILO 4: **Students can explain** the factors related to production system risk of a schedule
- ILO 5: **Students can explain** the significance of work and labor flow and how flow can be achieved in construction
- ILO 6: **Students can discuss** how digitalization can be used to guide production planning and control decisions
- ILO 7: **Students can** plan a location-based schedule of a real project using the Location Based Management System
- ILO 8: **Students can** make production control decisions based on the schedule using the Location Based Management System
- ILO 9: **Students can analyze** the quality of a location-based schedule
- ILO 10: **Students can collaborate** in multi-disciplinary teams

# Lectures and assignments

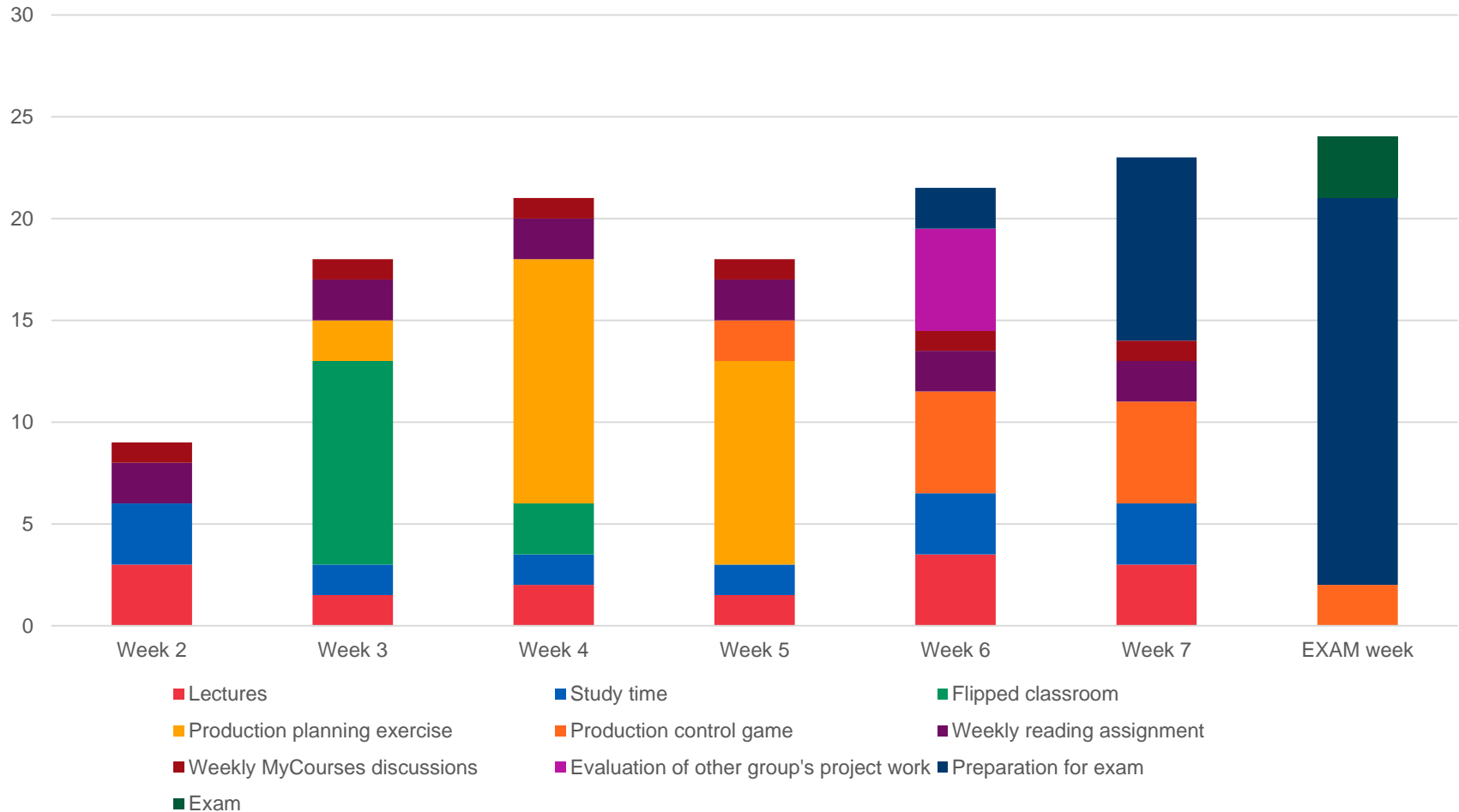
|                    | Week 2  |   | Week 3  |   | Week 4                  |   | Week 5   |                                   | Week 6                                  |                                | Week 7   |                                   |  |
|--------------------|---|---|---|---|-------------------------|---|--|-----------------------------------|---|--------------------------------|--|-----------------------------------|--|
|                    | 13.1  | 15.1                                      | 20.1  | 22.1  | 27.1                    | 29.1                                    | 3.2  | 5.2                               | 10.2                                    | 12.2                           | 17.2   | 19.2                              |  |
| Lectures (ILOs)    | Intro (1,2)                                       | Location-based planning Intro (2,3,4,5,9) | Location-based production control intro (2,5,8) | Software tutorial for group assignment (7,10) | Flipped classroom (2,5) | Mid-assignment software tutorial (7,10) | Guest lecture - takt planning and control case studies | Controlling software tutorial (8) | Lean production simulation game (1,2,5) | Lean Construction intro (1, 5) | Integrating LBMS and Last Planner System (5,8) | Digital situational awareness (6) |  |
| Assignments (ILOs) |   |   | PRODUCTION PLANNING GROUP ASSIGNMENT (3,7,10)   |   |                         |   | PEER REVIEW OF ASSIGNMENT (9)                          |                                   |   |                                |  |                                   |  |
|                    |   |   | FLIPPED CLASSROOM PREP (2,5)                    |   |                         |   | PRODUCTION CONTROL GAME (5,8)                          |                                   |   |                                |  |                                   |  |
|                    | Continuous MyCourses forum discussions (all ILOs) |   |   |   |                         |   |  |                                   |   |                                |  |                                   |  |
|                    | Readings for every lecture                        |   |   |   |                         |   |  |                                   |   |                                |  |                                   |  |

## Intended Learning Objectives

- 1 **Students can explain** the nature of production in construction
- 2 **Students can compare and contrast** the similarities and differences of different production planning and control methods (Drawing Gantt Charts, CPM, LBMS, Takt planning, Last Planner System)
- 3 **Students can calculate** the production system cost of a schedule
- 4 **Students can explain** the factors related to production system risk of a schedule
- 5 **Students can explain** the significance of work and labor flow and how flow can be achieved in construction
- 6 **Students can discuss** how digitalization can be used to guide production planning and control decisions
- 7 **Students can** plan a location-based schedule of a real project using the Location Based Management System
- 8 **Students can** make production control decisions based on the schedule using the Location Based Management System
- 9 **Students can analyze** the quality of a location-based schedule
- 10 **Students can collaborate** in multi-disciplinary teams

# Intended workload (5 credits = 135 hr)

Study time allocation



# Evaluation 1-5 based on:

- **Final exam 50% (mandatory to pass)**
  - Open books MyCourses exam
  - One question per ILO 1-9 + one extra question
- **Assignments 25 % (all three mandatory)**
  - Production planning assignment – team assignment 40 %
  - Peer evaluation report – individual assignment 20 %
  - Production controlling assignment 40 %
- **Participation 25% (optional)**
  - Attending lectures
  - Participating in MyCourses discussions
  - Self-assessment of lecture participation (readings and activity)

# Participation / MyCourses Discussions

- **Max 30 points total**
    - 1 point per attended lecture (except Flipped Classroom and production control simulation 27.1, 10.2. are worth 2 points) – enter in Mycourses after each lecture
    - Good preparation for lecture AND/OR active participation during lecture (self-evaluated, max 2 bonus points per attended lecture, max 10 extra points) - enter in MyCourses for each lecture
    - Good MyCourses forum posts – initiating or continuing discussions (1 point / post)
  - **MyCourses: Discussions between lectures on lecture topics, assignments, readings**
  - **Comment on:**
    - What remained unclear? What was not realistic? Does this work in practice? What is important?
    - Add your own work experience and examples and try to apply the theory
-



# Bonus points for participation

- **Readings/ preparation:**

0: I did not watch the videos or read the readings of the lecture

1: I watched the videos AND I read the readings AND prepared a list of key points and questions related to the reading topics AND made sure that those key points and questions were addressed during the contact session

- **Participation**

0: I participated in small group discussions / class activities

1: I actively participated in small group discussions and listened to what others had to say and was ready to change my opinion when necessary. At the end of small group discussions, I made sure that the ideas of the group were shared with others, for example by using Presemo or sharing the ideas with the class.

# Assignments (25 % of total grade)

- **Assignment #1: Planning assignment (40%)**
    - Groups of 3 (up to 20 groups)
    - Choose from 2 projects (Medical office building or a road construction project)
    - Watch the tutorial movie + mid-assignment movie
    - Join the tutorial session + mid-assignment feedback session
    - Complete a schedule and report based on starting data
    - Evaluate other group members' teamwork skills and participation
    - Scores of Assignment #1 are divided to team members in relation to teamwork score (free riders will get a poor score)
  - **Assignment #2: Peer review of planning assignment (20%)**
    - Evaluation report of someone else's assignment
    - Write a report + score the assignment based on evaluation rubric
    - Score of assignment #1 is determined by average of peer evaluation report scores (assignment #2). Each group will get three evaluations.
    - Peer evaluation reports are evaluated by the teacher
-

# Assignments (25 % of grade)

- **Production control assignment (40%)**
  - Watch the tutorial movie + join the tutorial session
  - Status data is given 2 x / day for two weeks and is entered to the controlling software
  - Possible actions are discussed on MyCourses, actions impact the outcome of the next round
  - Complete the simulation and report
  - Evaluated by the teacher

# Readings

- **Assigned readings before each lecture**
- **Read through the material, note any questions (extra point for doing this)**
- **Pair / group discussions related to readings and videos in the beginning of each lecture**
- **All lecture readings will be part of the final exam**

# Exam

- **10 essay questions in 3 hours**
  - **Computerized exam**
  - **Open books – you can bring all readings, all books, surf the internet but you cannot communicate with others**
  
  - **Material includes everything learned during the course**
    - Readings, lectures, class discussions, MyCourses discussions, assignments
  - **Demonstrate your learning related to learning objectives!**
    - Theory
    - Practical knowledge gained from your work experience or the various simulations and assignments of the course
    - Cut & paste from readings results in a low score – no answer can be found in one source
-

# Video 2

# Learning objectives for this lecture

- **ILO 1: Students can explain** the nature of production in construction
  - *ILO emphasized*
- **ILO 2: Students can compare and contrast** the similarities and differences of different production planning and control methods
  - *ILO initiated*

# Empire State Building

- Location-based planning and control
- Levels as the unit of control
- Production methods from manufacturing
- Performance we still cannot match today





# Empire State: 1929

- **A 102 story building**
  - *18 months*
  - *one floor per day*
  - *structure finished in 4.5 months*
- **assembly line production**
  - *continuous and aligned*
- **emphasis on controlling the work**
  - *actual quantities in locations were monitored daily*
  - *the work crews were checked to ensure they were working in the correct location three times per day*

# Olkiluoto 3 nuclear plant



- **Started 2005, planned completion 2009**
- **Latest estimate (November 2018): completion January 2020.**
- **Original estimate: €3,2B. Current estimate €8,5B. World's second most expensive building! Fixed price, so the Owner pays only €5,5B**
- **In addition, contractor has to pay up to €850M in damages**

# Länsimetro



- **Started 2009, original estimated completion fall 2014**
- **Delay 1: 2015, delay 2: august 2016, delay 3: december 2016, delay 4: early 2017 delay 5: finally opened 18 November 2017**
- **Cost overrun by 28%**
  - **Escalation because of extended duration**

# Kamppi Center Project, Finland

## Project Scope

- 4-year construction project
- €500M.
- Bus terminal, internal parking, six-floor retail, offices, residential units

## Project Challenges

- On-site Communications, Scheduling, Coordination of 800 subcontractors and 5000 construction workers on tight urban site above operational subway (Central Helsinki)



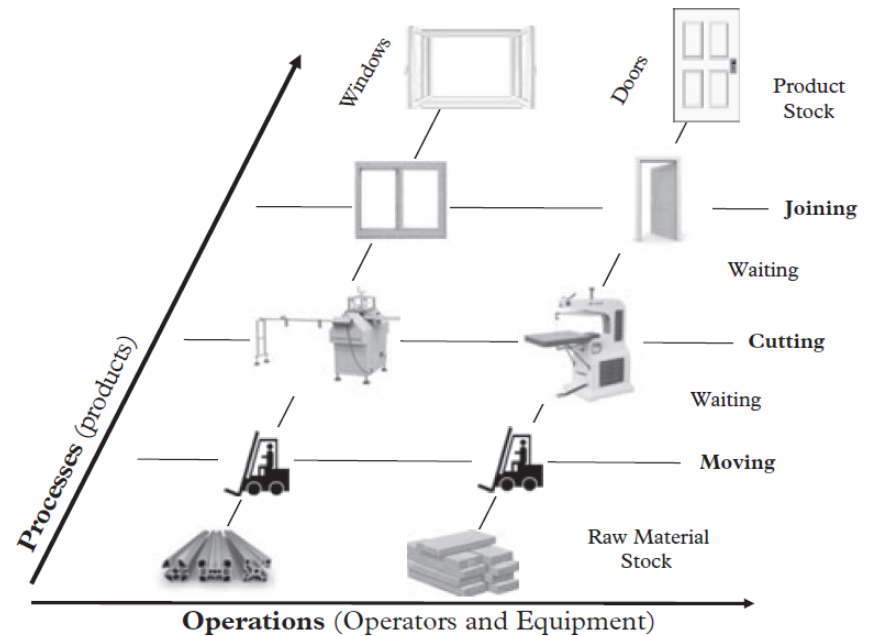
## Cost Savings

- SRV Group delivered this project six months ahead of schedule resulting in:
  - *~12.5% schedule improvement*
  - *6 months faster occupancy (more rent)*
  - *2 million euros savings in General Conditions alone*

# Production in manufacturing

643

- Work flows through work stations
- Product moves, people and machines stay in place
- Work-in-progress can be easily seen (unfinished parts)



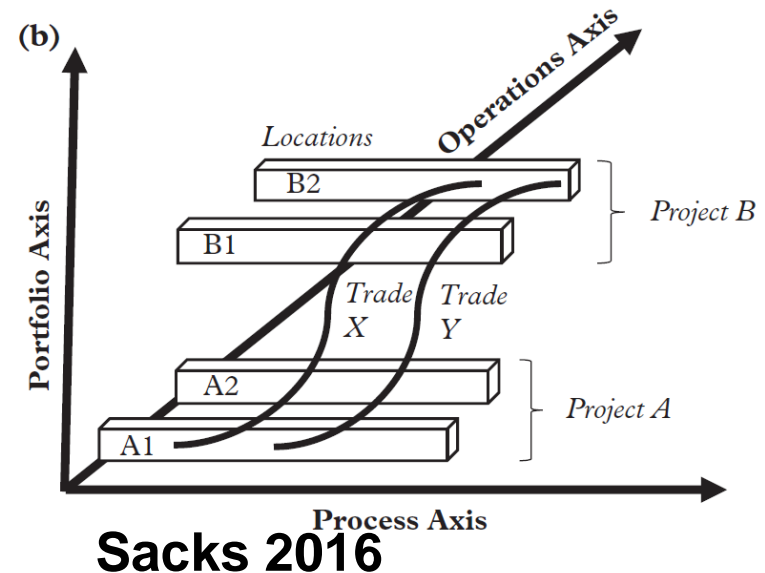
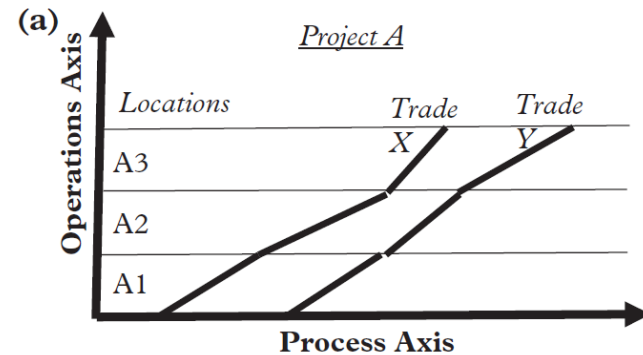
**Figure 1** Operations and processes in manufacturing, based on 'The Structure of Production' by Shingo and Dillon (1989)

# Production in construction

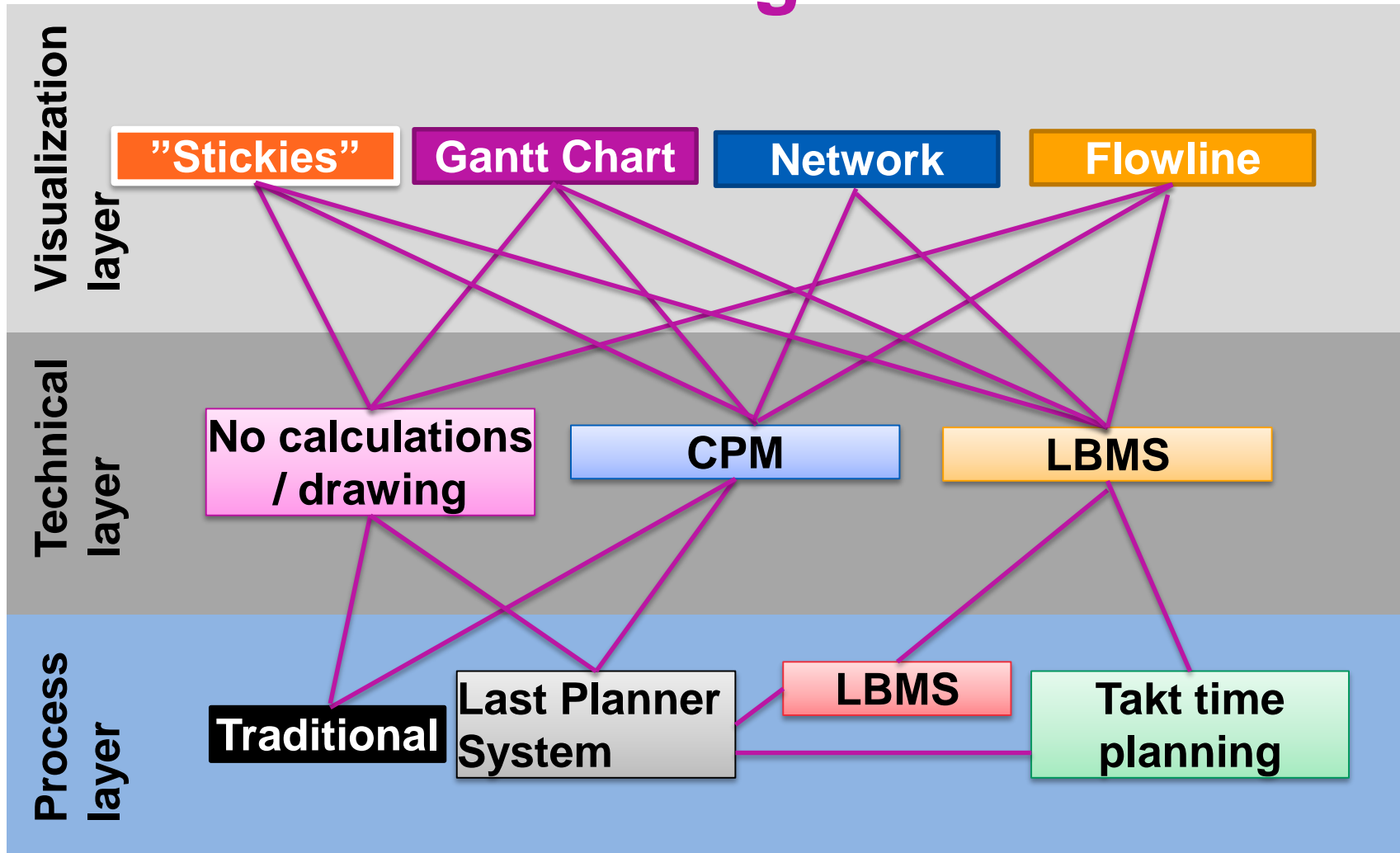
- **Product stays in place**
- **Workers and equipment move through locations**
- **Repetitive processes, non-repetitive locations**
- **Work-in-progress is everywhere**
- **Waste is harder to see**
- **Multi-project environment**

# Three kinds of flow: Portfolio, Process and Operations (PPO model, Sacks 2016)

- **Portfolio Flow:**
  - Resources flow from project to project
- **Process Flow:**
  - Flow of work in location
  - Measure by placing a camera in location
- **Operations Flow:**
  - Flow of workers through locations
  - Measure by placing a camera on helmet of worker



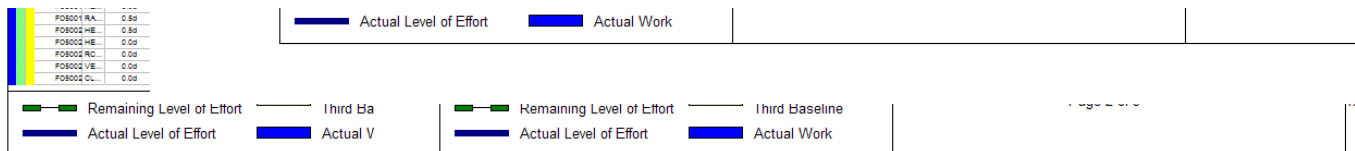
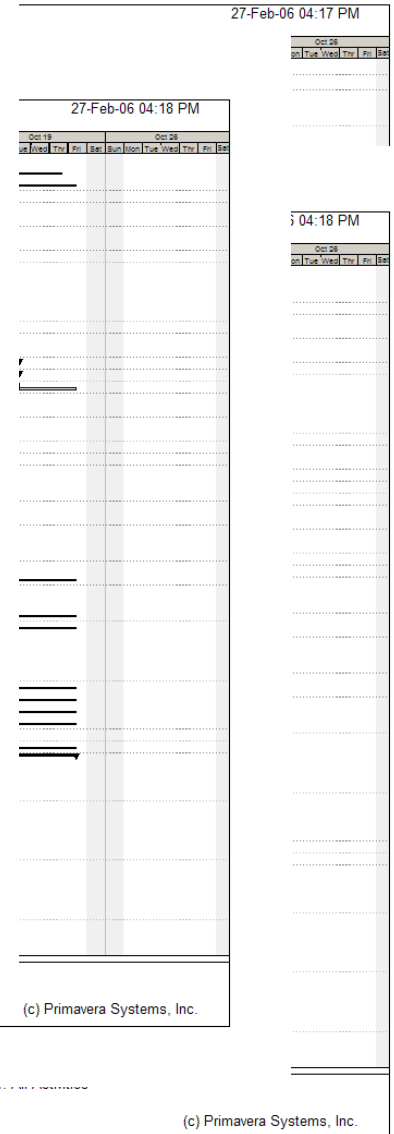
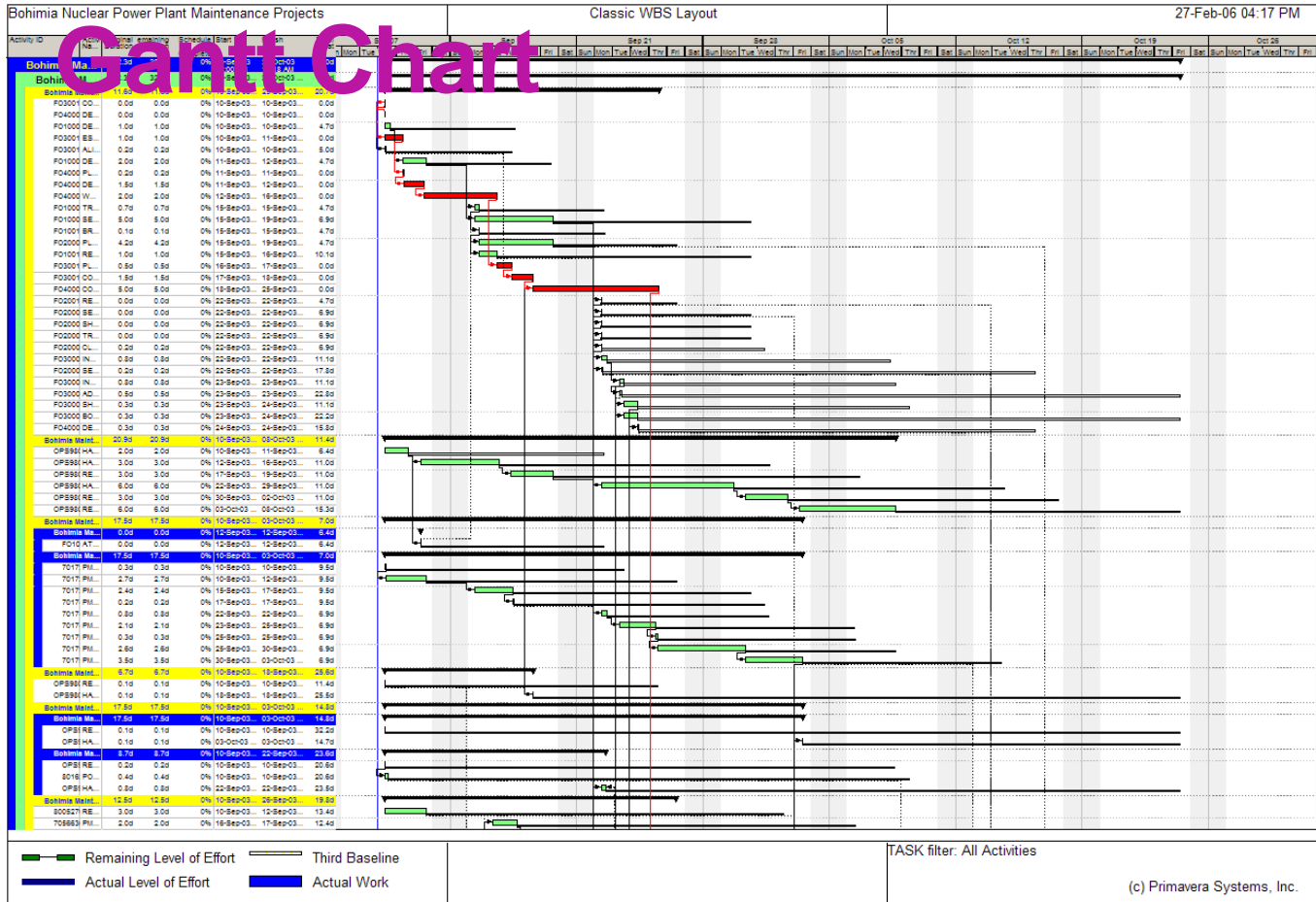
# Alternative Planning methods



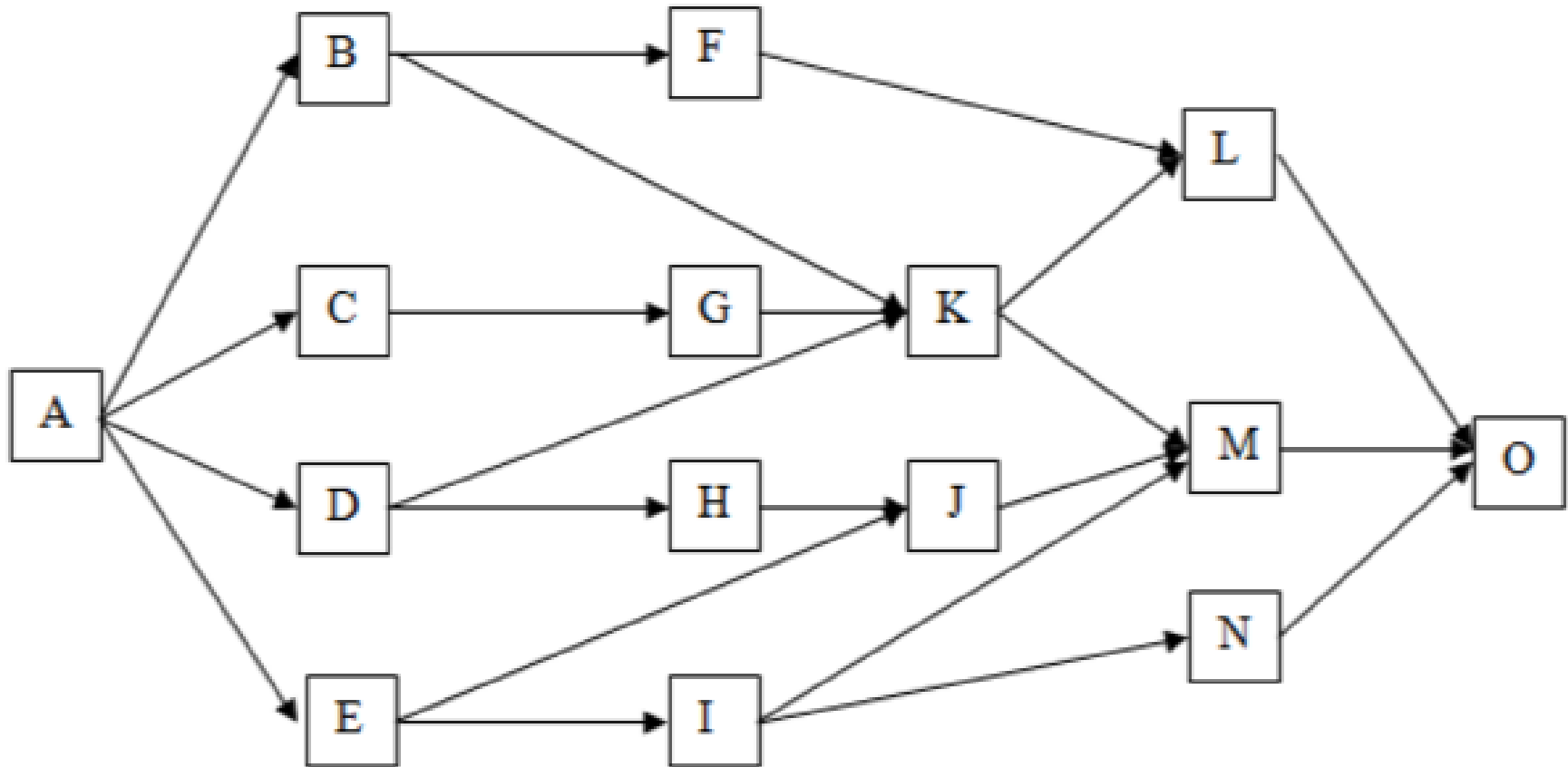


# Stickies



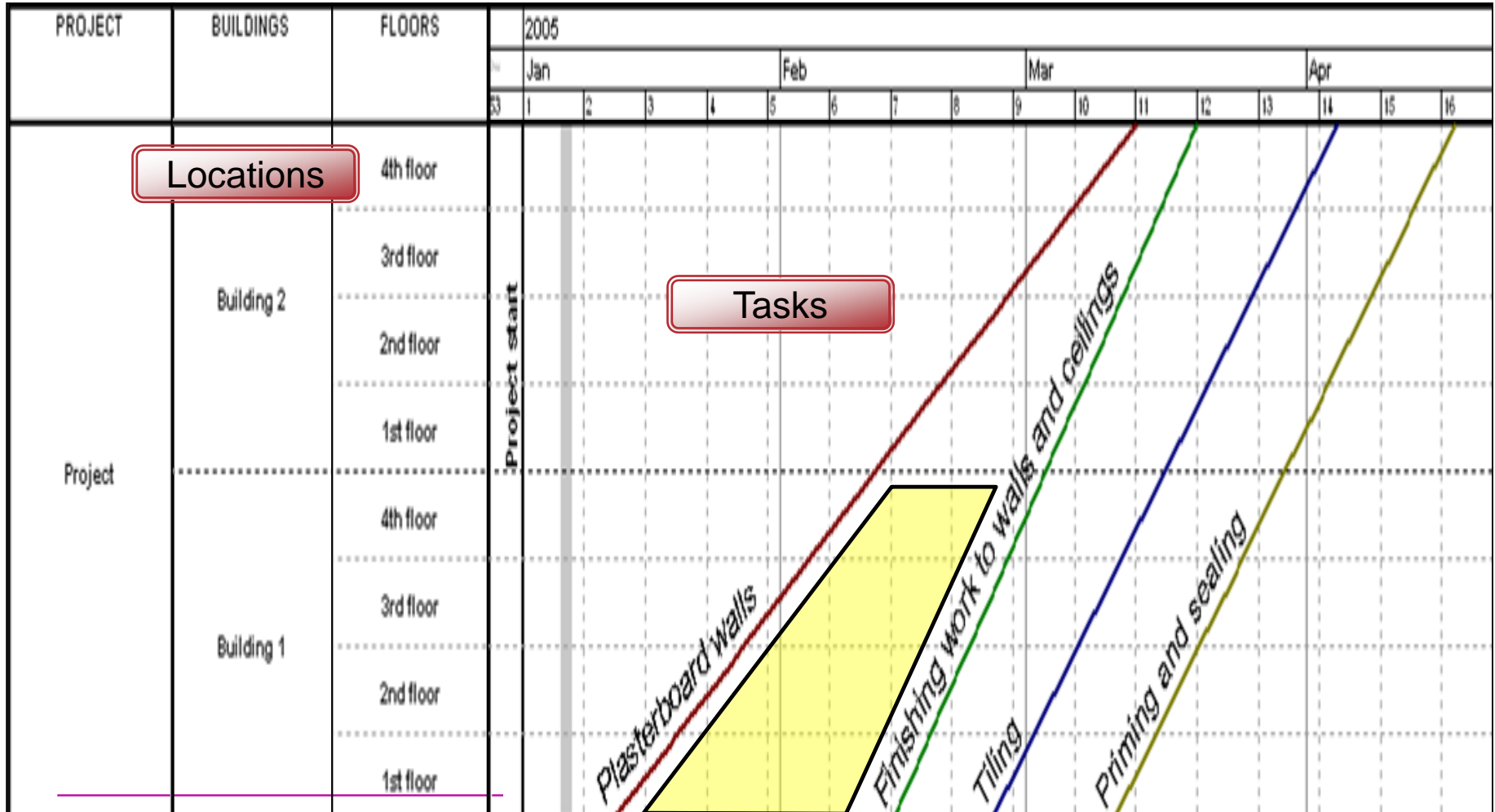


# Network diagram



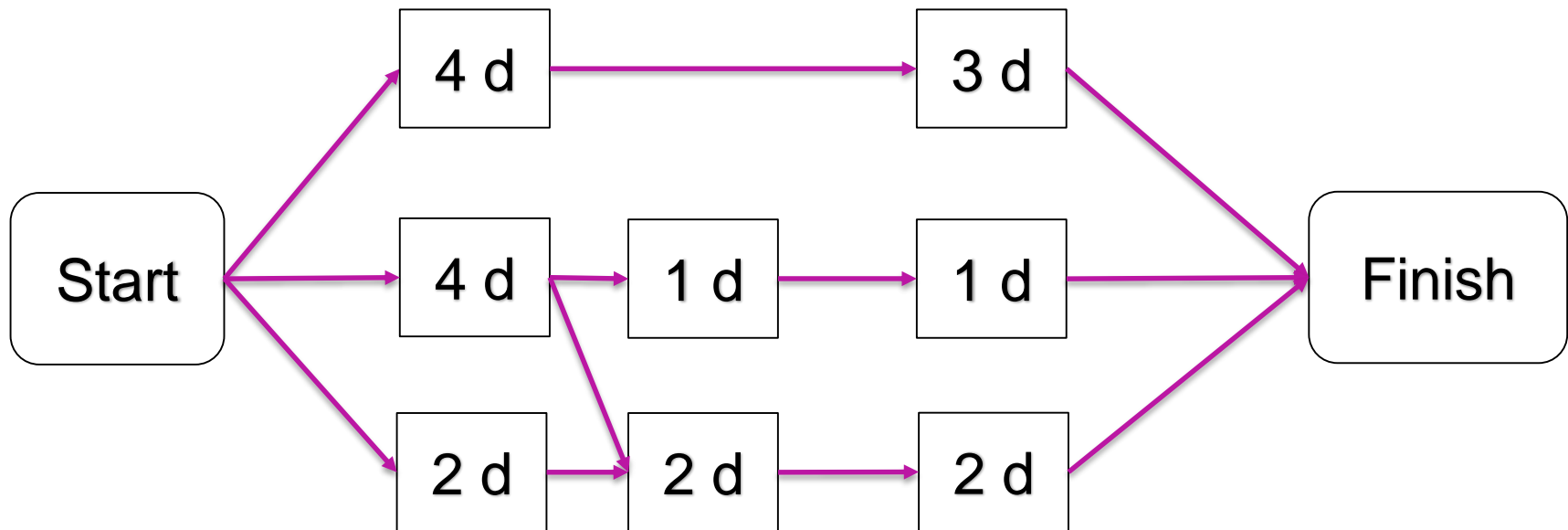
# Flowline

Calendar



# CPM

- How many days to finish the project below?
- What is the critical path?



# LBMS = CPM+

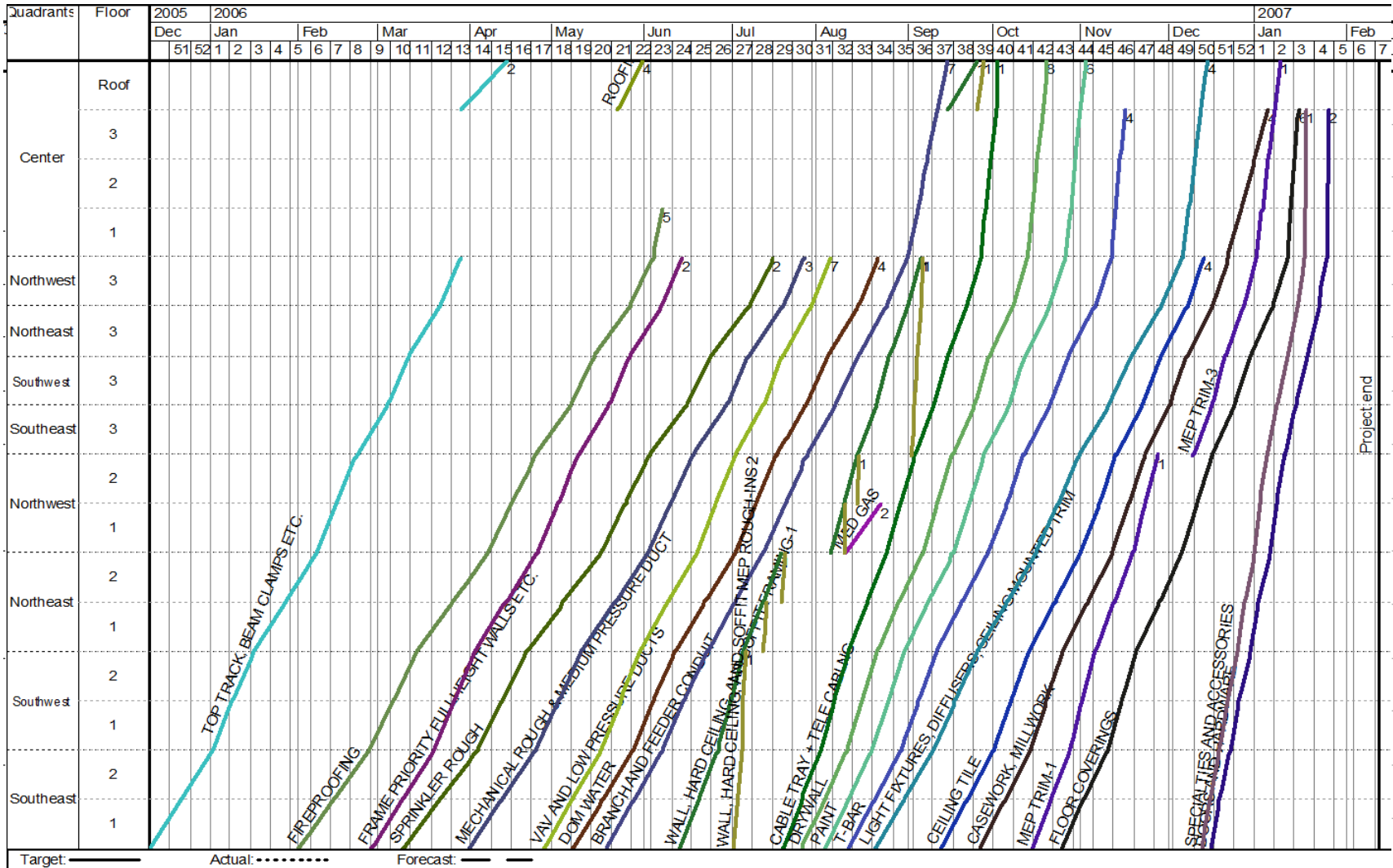
## CPM

- Location is not a planning element (can be coded)
- Durations are an input
- Production is a black box
- No ability to plan continuous flow
- Goal: minimize total duration by focusing on critical path

## LBMS

- Locations are used to automate logic and decrease complexity
- Durations are an output
- Production explicitly modeled
- Focused on continuous flow
- Goal: minimize total duration while maximizing productivity and minimizing risk by focusing on flow

# CPM vs. LBMS in flowline



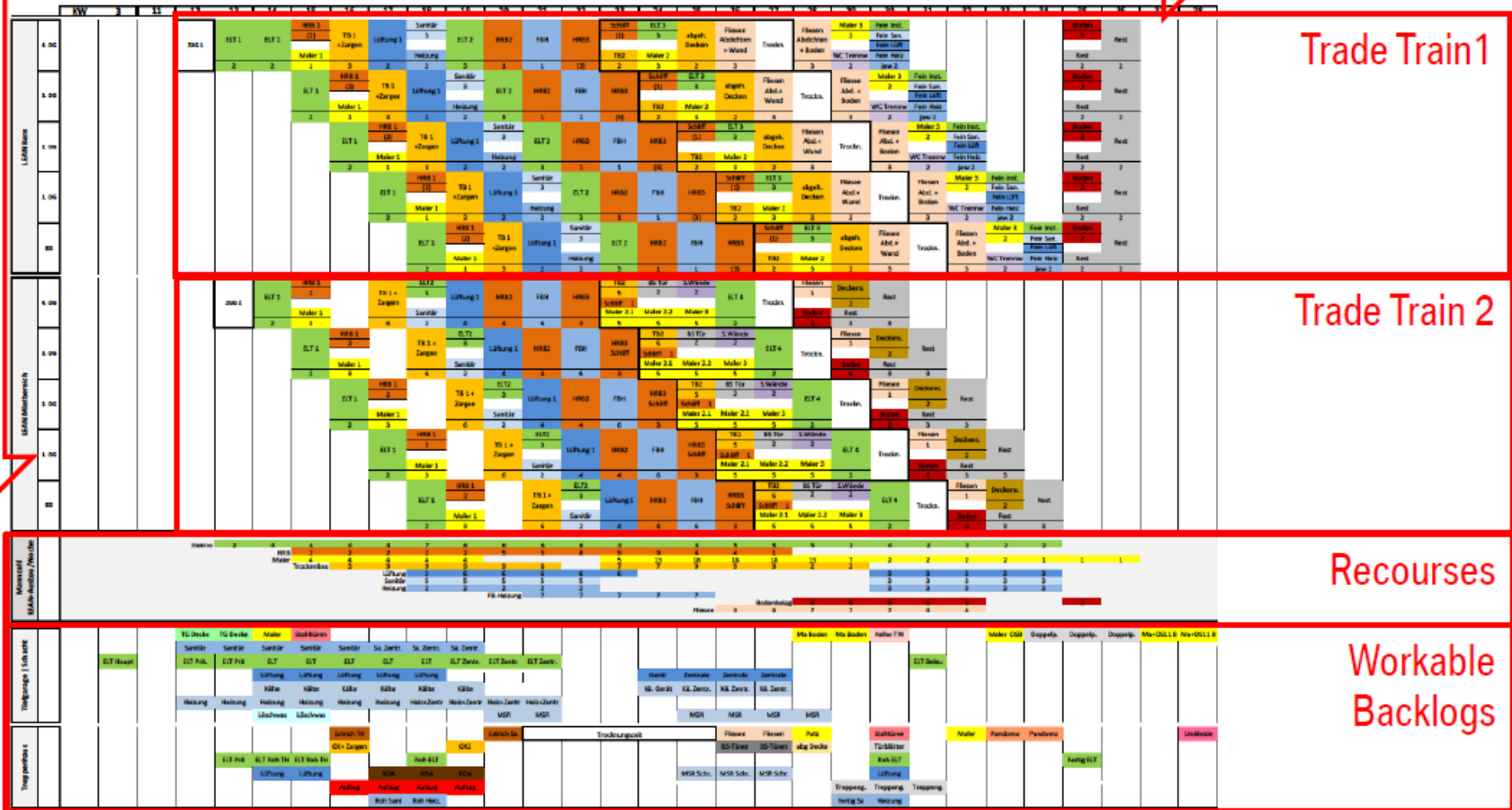
# Takt planning and controlling is a new method in Finland

## Time in Takts

Taktunits

30.11.2015  
15:40

U:\Projects\2015\PE\20014\_Wilka\_Freising\1\_Tehn\AKO\_Termine\_Ausführung\Lean\_Vorbereitung\Ausstattung\0105-11-30\_Ausstattung - Kopie.xlsx





# Thank you Questions & Comments

# Why is Production Planning and Control important?

- [Premo.aalto.fi/opman](https://premo.aalto.fi/opman) 1
- Rate the preset responses 1-5 or add your own responses

# Assignments for next lecture

- **Reading assignment – Location Based Management for Construction white paper (available in MyCourses)**
- **Location Based Management for Construction – Planning, Scheduling and Control - Chapter 5 (e-book / hardcopy from library / Amazon.com)**
- **MyCourses discussion**
  - Initiate discussions on Lecture #1 topics
  - What remained unclear? What was not realistic? Does this work in practice? What is important?

# Self-evaluate participation – record in MyCourses

- **Readings/ preparation:**

N/A

- **Participation**

0: I participated in small group discussions / class activities

1: I actively participated in small group discussions and listened to what others had to say and was ready to change my opinion when necessary. At the end of small group discussions, I made sure that the ideas of the group were shared with others, for example by using Presemo or sharing the ideas with the class.