

CONSTRUCTION SCHEDULING

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Schedule - planned dates of **activities** and planned **milestones** of the schedule (significant events in the project, e.g. end of a stage, acceptance).

Scheduling - finding such start dates for all activities that meet the constraints related to the relationships between them and the availability of resources, with the simultaneous optimization of the objective function (it may be, for example, minimizing the duration of the project or maximizing NPV).

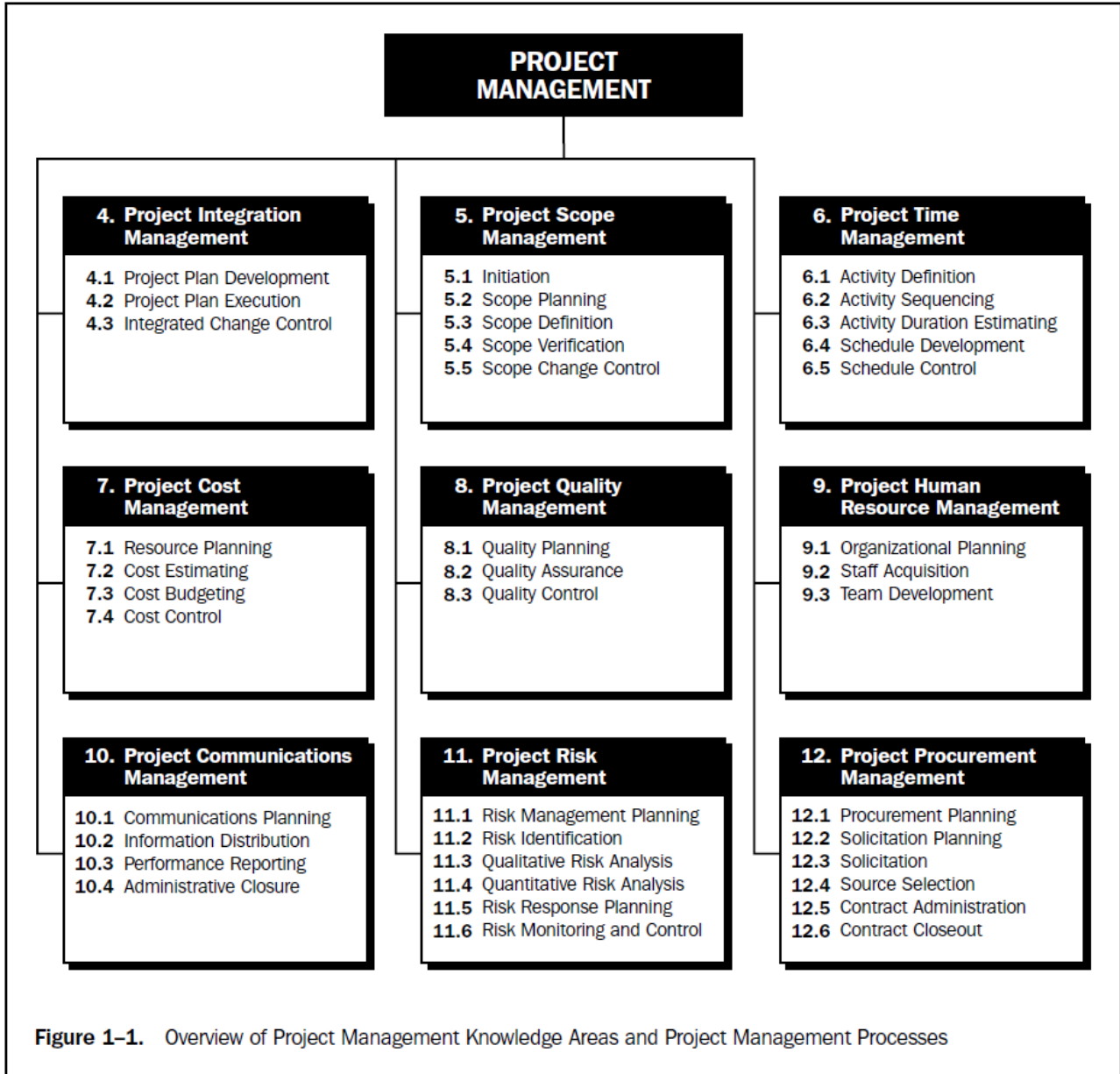
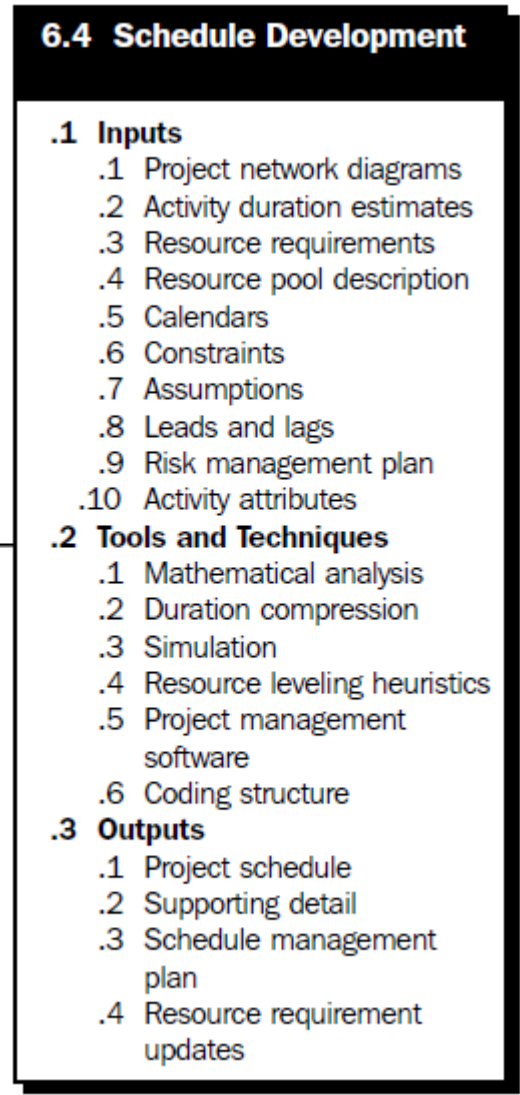
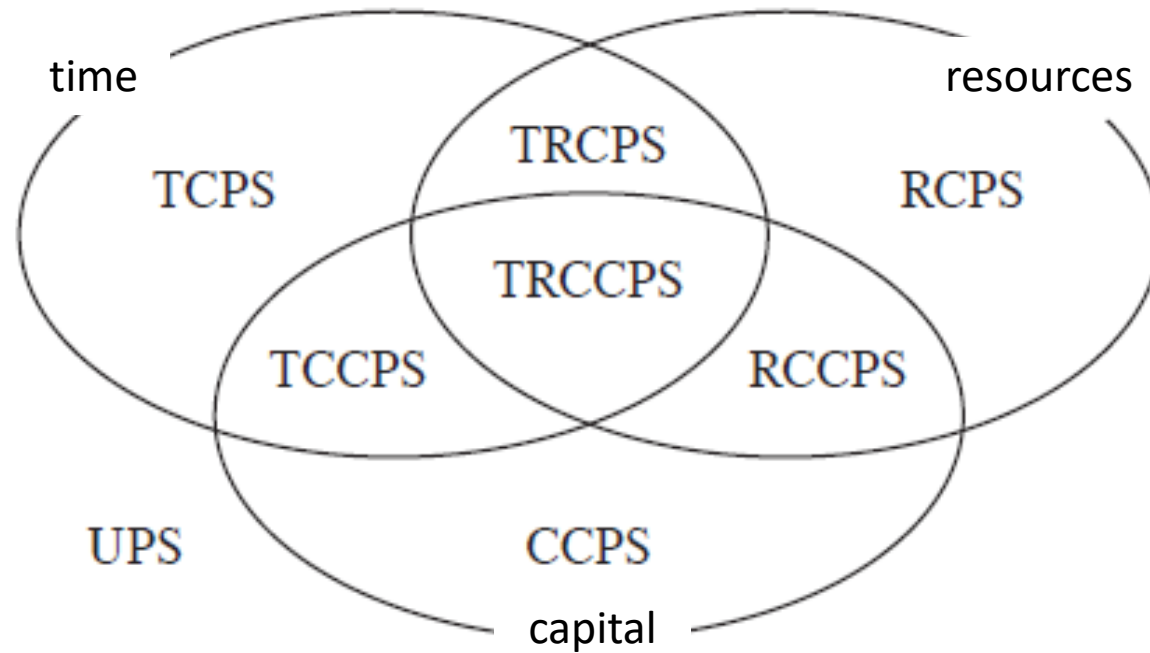


Figure 1-1. Overview of Project Management Knowledge Areas and Project Management Processes



Project Management Institute. (2004). A Guide to the Project Management Body of Knowledge, Third Edition, PMI, USA.



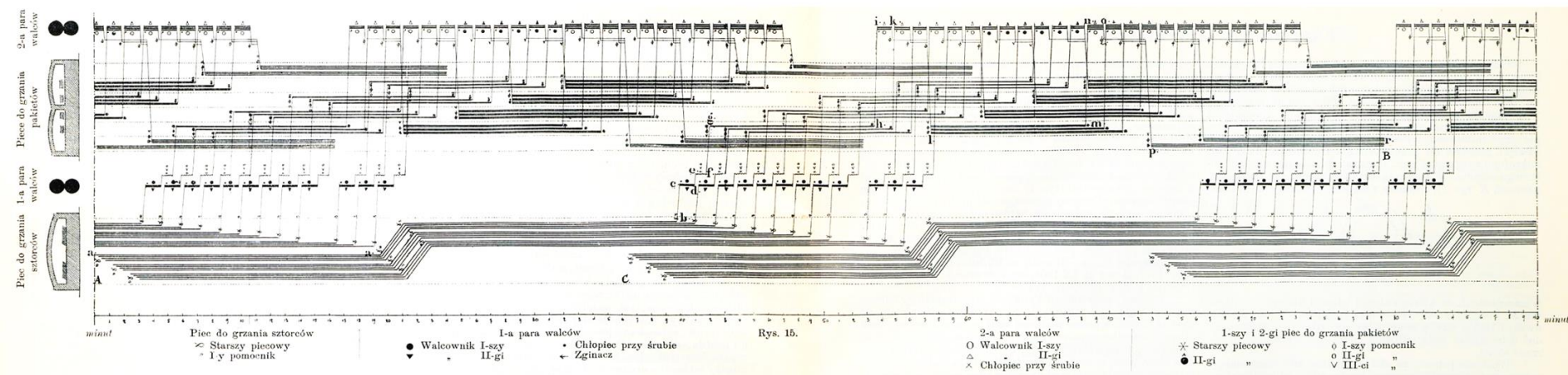
- UPS - *unconstrained project scheduling*
- TCPS - *time constrained project scheduling*
- RCPS - *resource constrained project scheduling*
- CCPS - *capital constrained project scheduling*
- TRCPS - *time and resource constrained project scheduling*
- TCCPS - *time and capital constrained project scheduling*
- RCCPS - *resource and capital constrained project scheduling*
- TRCCPS - *time, resource and capital constrained project scheduling*

Kostrubiec, A. (2003). Harmonogramowanie realizacji projektów-przegląd modeli. W: Inżynieria zarządzania przedsiębiorstwami. Red. L. Zawadzka. Gdańsk, 2003.

other examples:

- Deterministic vs. Non-deterministic
- Master project schedule vs. Milestone schedule / summary schedule vs. Detailed project schedule
- *Multi-Mode Resource-Constrained Project Scheduling - **MRCPS**,*
- *Multi-Mode Resource-Constrained Time-Cost Trade-off, **MRC-TCT** or **RC-TCT**),*
- *Time, Resource & Capital Constrained Project Scheduling Problem - **TRCCPSP**,*
- **P-MRCPSP** - *preemptive scheduling,*
- *MRCPSP with Discounted Cash Flows – **MRCPSPDCF**,*
.....and many, many more....

Karol Adamiecki and Henry Gantt



MILL, Textile June

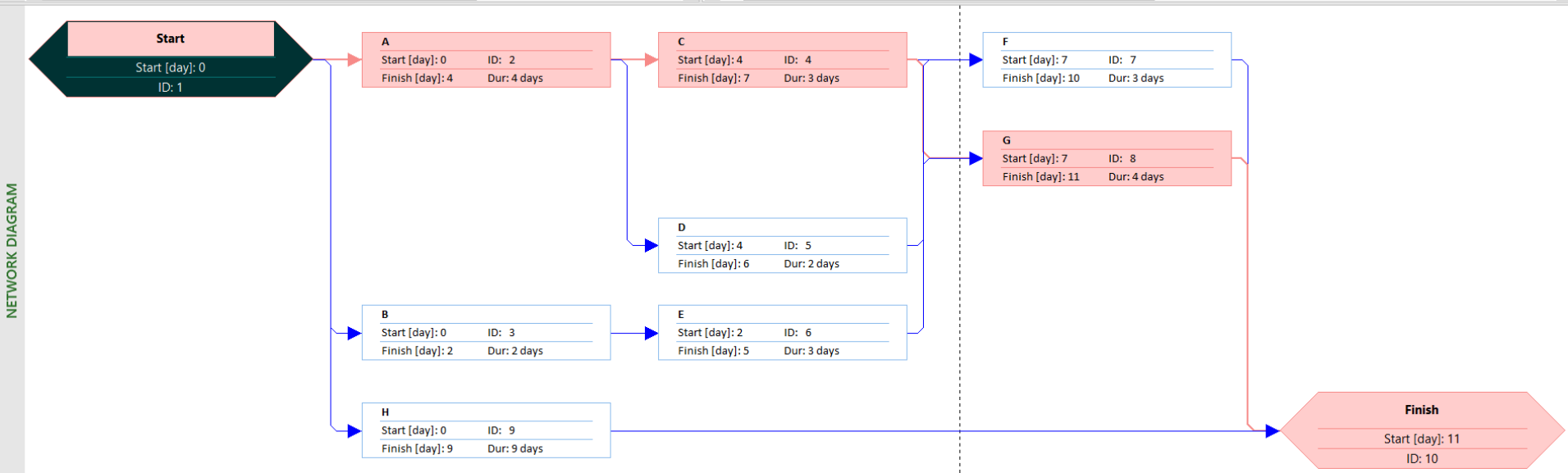
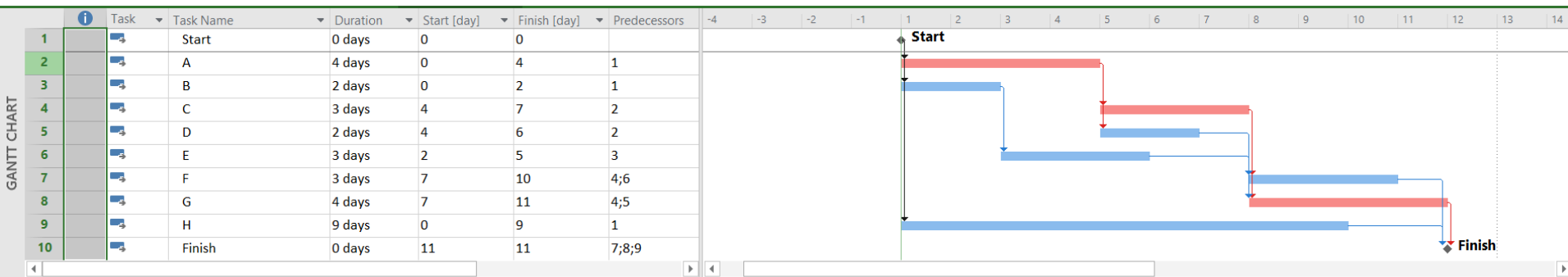
SYMBOL	DEPARTMENT OR MACH. CLASS	% OF CAPACITY USED ON Day TURN							TOTAL EXPENSE OF IDLENESS	DETAILS OF IDLENESS EXPENSE DUE TO						
		10	20	30	40	50	60	70		80	90	LACK OF WORK	LACK OF HELP	LACK OF AND POOR MATERIAL	REPAIRS	POOR PLANNING
	Spinning	[Bar chart showing capacity usage]							18 70	18 70						
	Winding	[Bar chart showing capacity usage]							118 74		103 74				15 00	
	Doubling	[Bar chart showing capacity usage]							10 61	10 61						
	Twisting	[Bar chart showing capacity usage]							17 95	17 95						
	Quilling	[Bar chart showing capacity usage]							70 67	10 67	10 00					
	Warping	[Bar chart showing capacity usage]							390 75			390 75				
	Weaving	[Bar chart showing capacity usage]							915 25	75 00		840 25				
	Finishing	[Bar chart showing capacity usage]							210 72			210 72				
	Inspecting	[Bar chart showing capacity usage]							49 70		10 70	39 00				
	Shipping	[Bar chart showing capacity usage]							216 17	66 00		150 17				
	Total	[Bar chart showing capacity usage]							1969 26	298 93	124 44	1630 89				

Karol Adamiecki, 1909, Metoda wykreślna organizowania pracy zbiorowej w walcowniach, w: Przegląd Techniczny 19 (47)

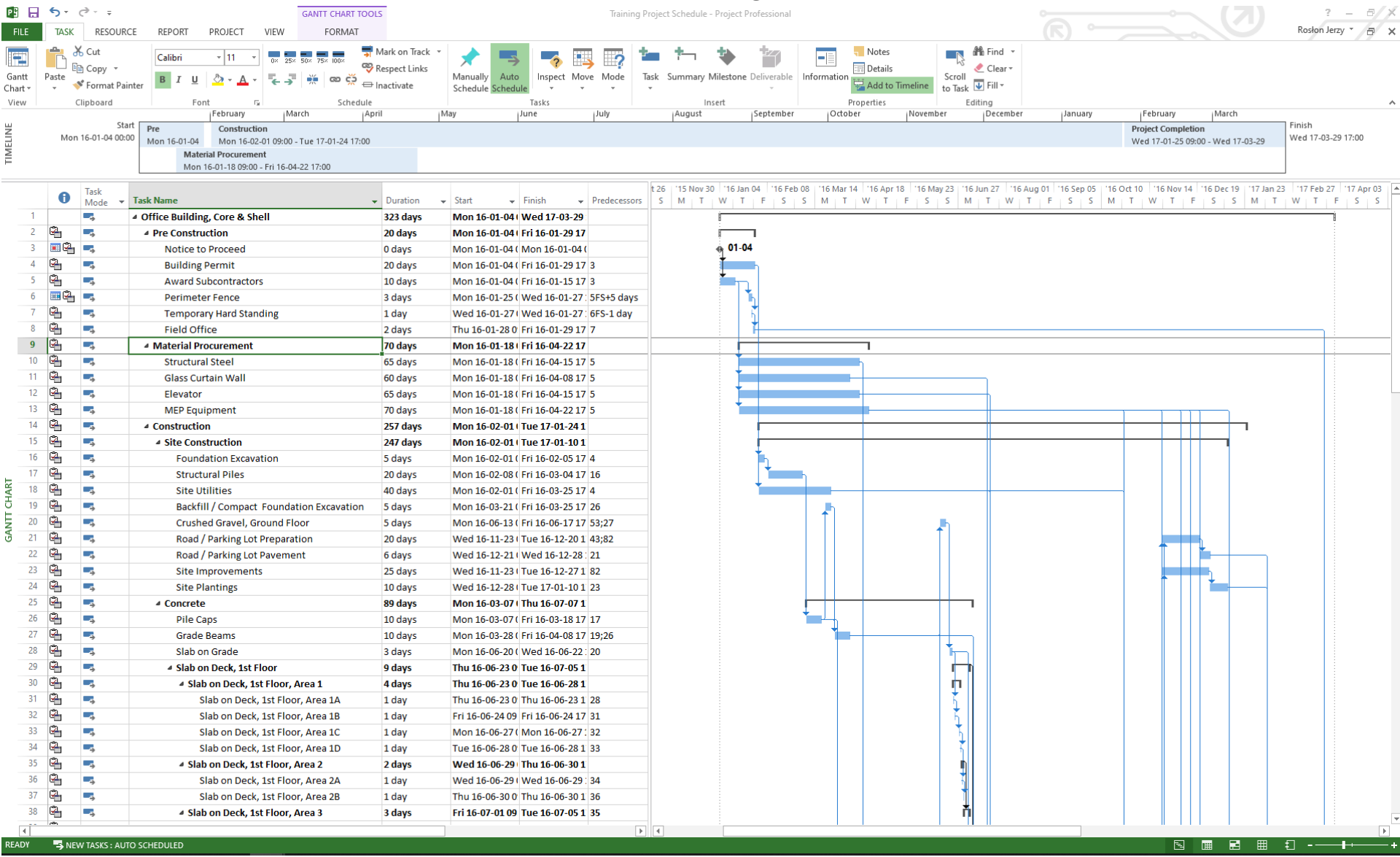
Crank Handles	Order Number	January					February					March									
		14	17	21	24	28	31	4	7	11	14	18	21	25	28	3	6	10	13	17	20
No. 14-F-Spec.	90 59031	[Gantt chart showing task duration from Jan 14 to Feb 2]																			
No. 12-F-Spec.	60 59032	[Gantt chart showing task duration from Jan 14 to Feb 5]																			
No. 14-F	100 59043	[Gantt chart showing task duration from Jan 14 to Feb 14]																			
No. 8-F-Spec	10 59063	[Gantt chart showing task duration from Jan 14 to Feb 14]																			
No. 10-F-Spec.	10 59064	[Gantt chart showing task duration from Jan 14 to Feb 14]																			
No. 8-F-Spec.	100 59066	[Gantt chart showing task duration from Jan 14 to Feb 14]																			
No. 14-F-Spec.	100 59067	[Gantt chart showing task duration from Jan 14 to Feb 14]																			

<https://www.onepager.com/community/blog/a-brief-history-of-the-gantt-chart/>

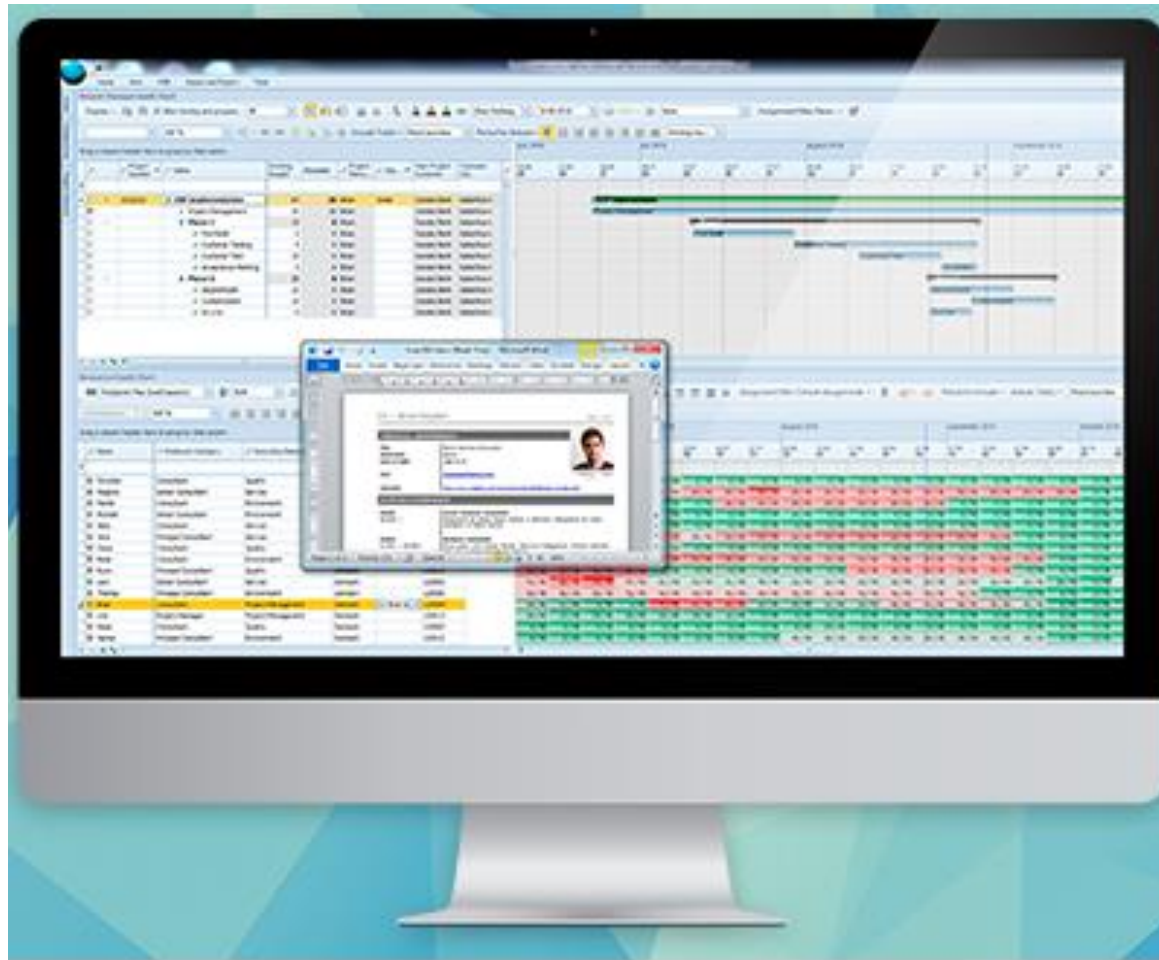
Network vs. Gantt chart



MS Project

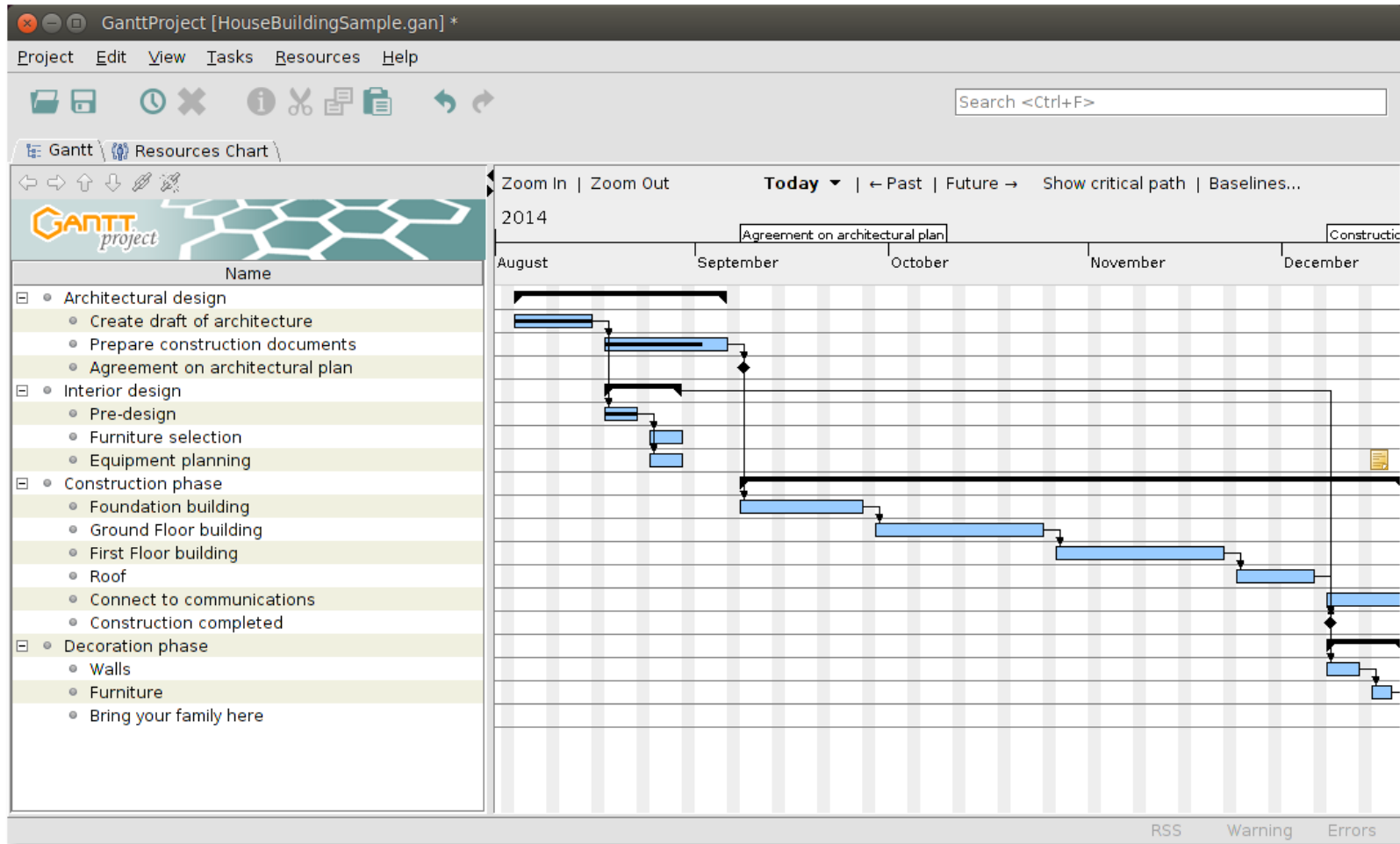


Maconomy People Planner



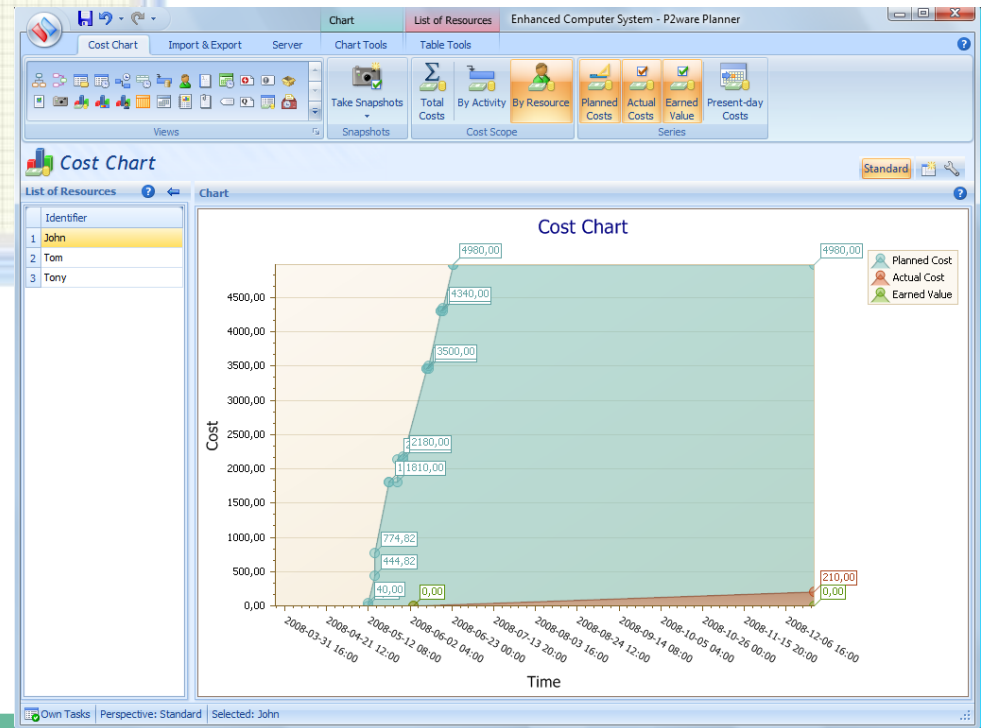
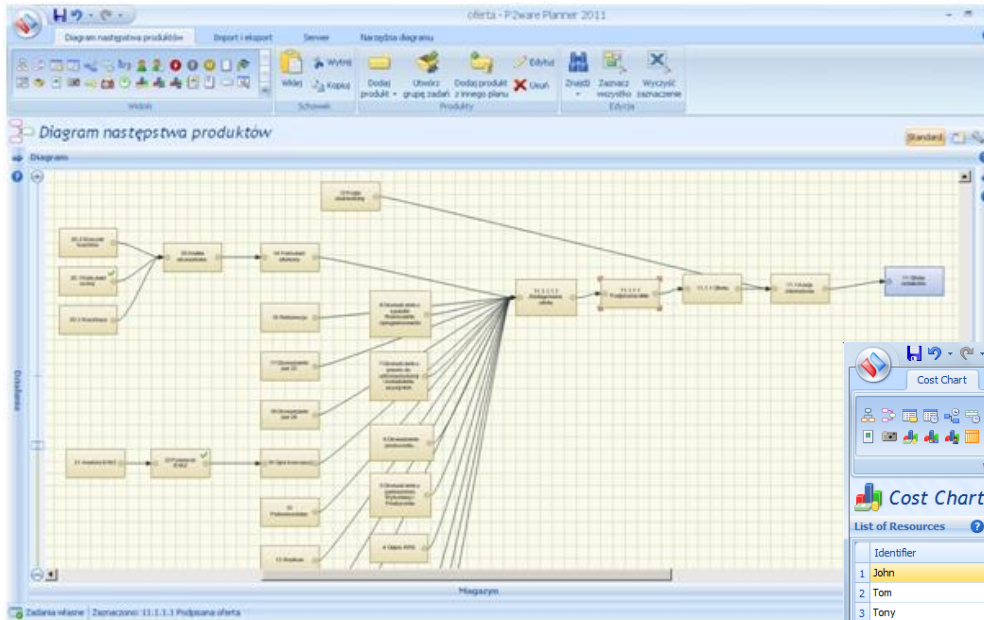
<https://www.deltek.com/en/products/project-erp/maconomy/modules/people-planner>

GanttProject



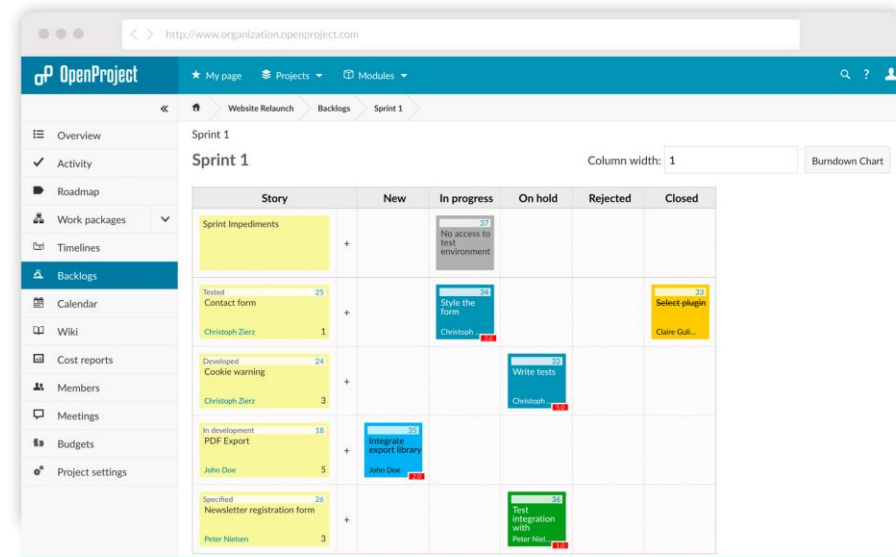
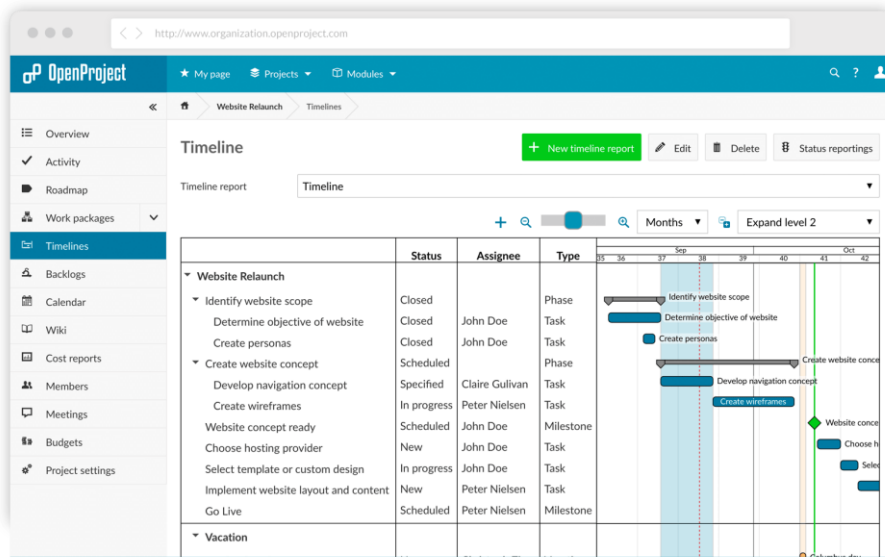
<http://www.ganttproject.biz/>

P2ware Planner Suite



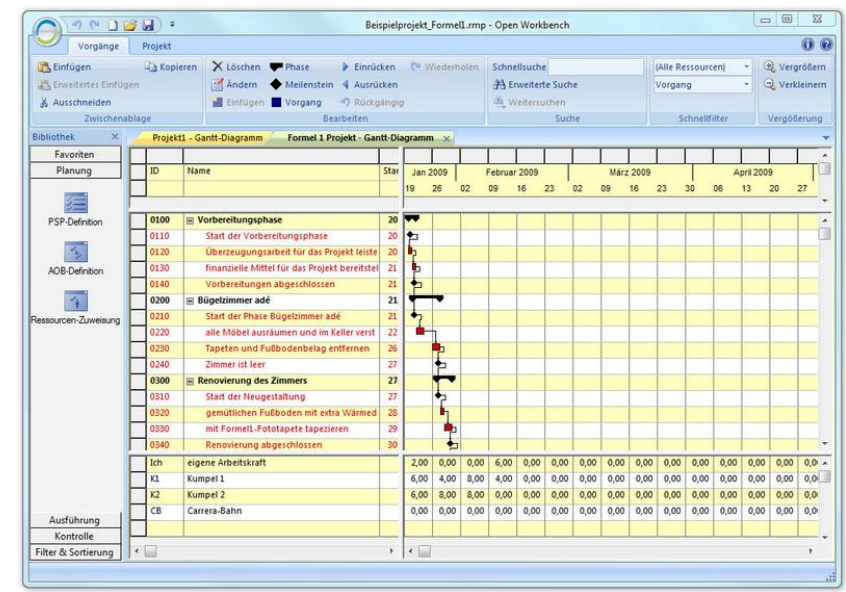
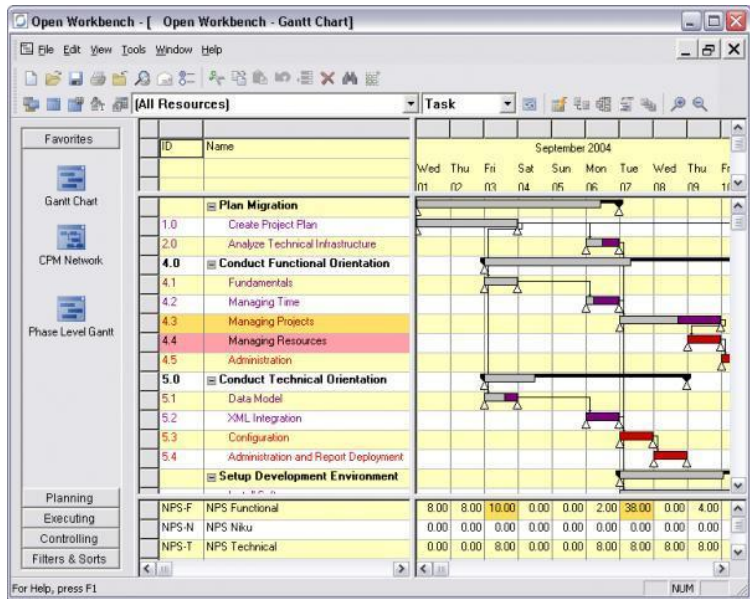
<http://p2ware.com/pl>

Open Project



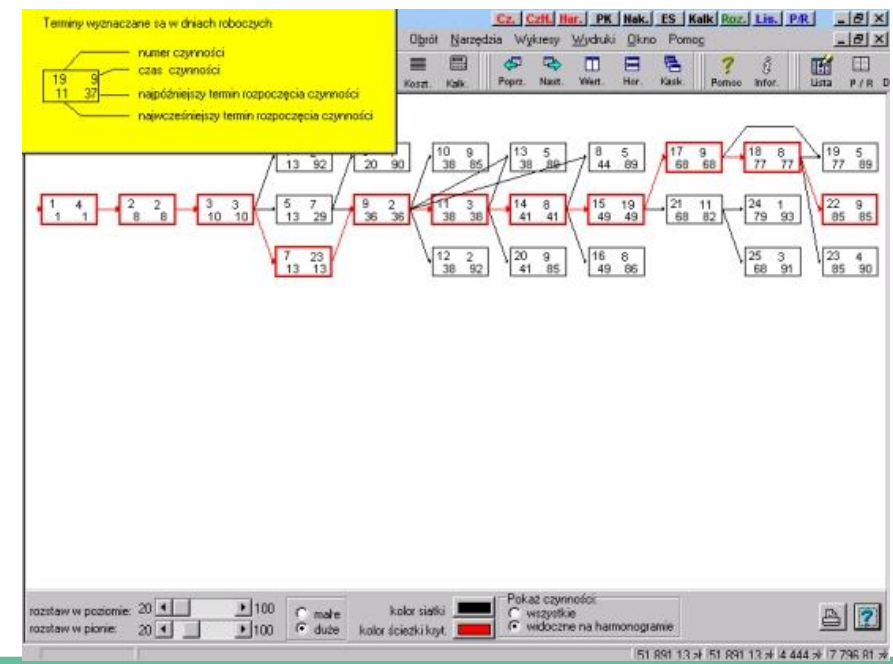
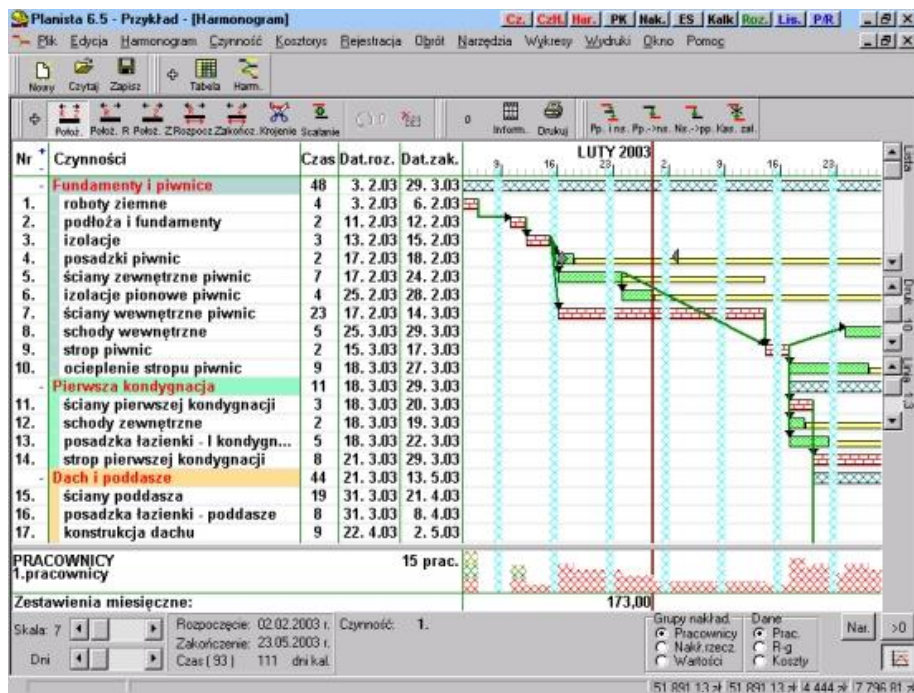
<https://www.openproject.org/>

Open Workbench



https://en.wikipedia.org/wiki/Open_Workbench

Planista



<http://www.planista.com.pl/plan.php>

Primavera



The screenshot displays the Oracle Primavera P6 software interface. The main window shows a Project Gantt Chart for 'Corporate' projects, spanning from 2010 to 2014. A secondary window shows a 'Budget by PM' pie chart with the following data:

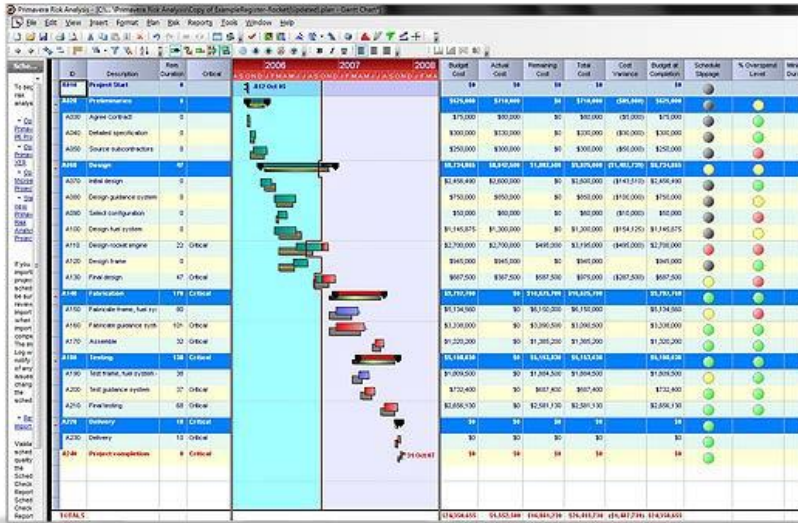
Resource	Percentage	Value
Mary Jones	24%	\$150,000
Thomas Chan	9%	\$575,000
Bob Thomas	6%	\$400,000
Chris Pell	14%	\$85,000
Jorge Cortez	37%	\$4,000,000

Another window shows a 'Layout: Classic Schedule Layout' with a table of activities:

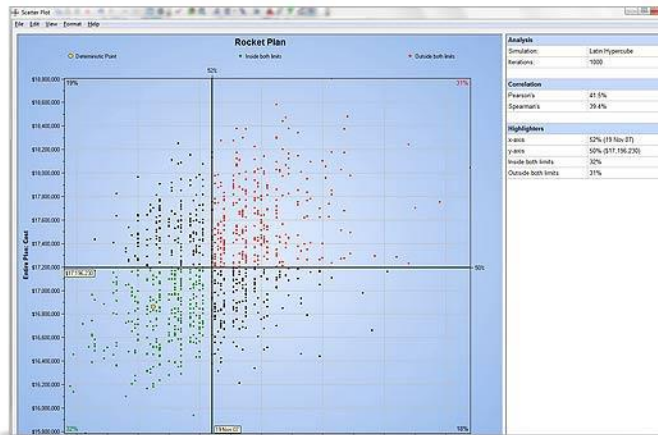
Activity ID	Activity Name	Start	Finish	Original Duration	Remaining Duration	Schedule % Complete
EC00501	Haitang Corporate Park	01-Sep-10A	11-Jan-13	601.5d	432.5d	31.03%
EC00501.D&E	Design and Engineer	01-Sep-10A	07-Jan-11A	92.5d	0.0d	100%
EC1050	Assemble Technical Data for Heat P	06-Dec-10A	15-Dec-10A	6.3d	0.0d	100%
EC1000	Design Building Addition	01-Sep-10A	08-Nov-10A	48.3d	0.0d	100%
EC1030	Review and Approve Design	08-Nov-10A	03-Dec-10A	18.9d	0.0d	100%
EC1150	Review Technical Data on Heat Pul	13-Dec-10A	07-Jan-11A	21.0d	0.0d	100%
EC1010	Start Office Building Addition Proj	01-Sep-10A	01-Sep-10A	0.0d	0.0d	100%
EC00501.Found	Foundation	03-Dec-10A	03-Jun-11	127.0d	23.2d	76.3%
EC1370	Backfill and Compact Walls	27-May-11	03-Jun-11	4.2d	4.2d	0%
EC1090	Begin Building Construction	03-Dec-10A	01-Sep-11	0.0d	0.0d	100%
EC1350	Concrete Foundation Walls	15-Apr-11A	12-May-11	21.0d	8.5d	73.81%
EC1230	Excavation	26-Jan-11A	24-Feb-11A	21.0d	0.0d	100%
EC1360	Form and Pour Slab	12-May-11	27-May-11	10.5d	10.5d	0%
EC1340	Form/Pour Concrete Footings	11-Mar-11	11-Apr-11A	21.0d	0.0d	100%
EC1300	Foundation Phase Complete	02-Jun-11	02-Jun-11	0.0d	0.0d	0%
EC1200	Install Underground Electric Condu	17-Feb-11A	25-Feb-11A	10.5d	0.0d	100%
EC1220	Install Underground Water Lines	22-Feb-11A	20-Feb-11A	10.5d	0.0d	100%
EC13100	Site Preparation	03-Dec-10A	26-Jun-11A	37.0d	0.0d	100%

<https://www.oracle.com/pl/applications/primavera/index.html>

Pertmaster - Oracle's Primavera Risk Analysis

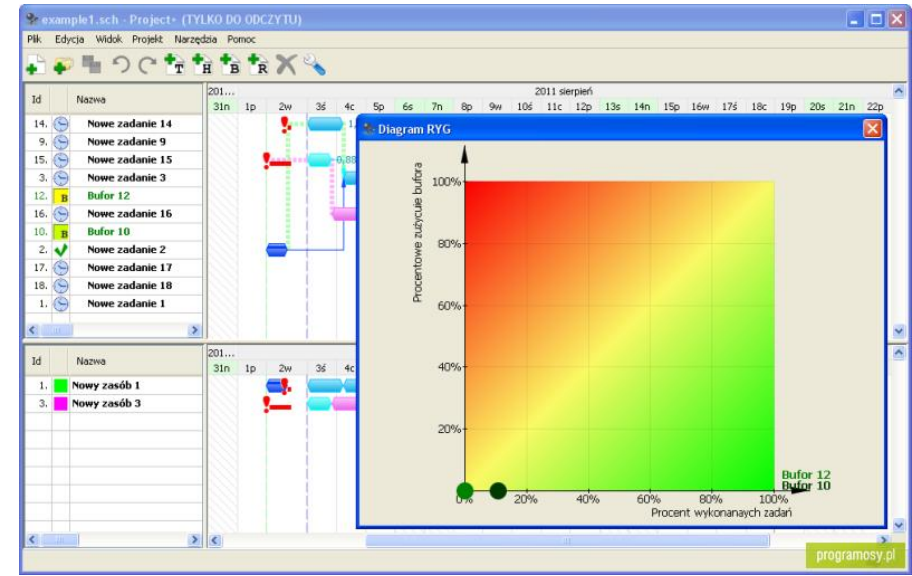
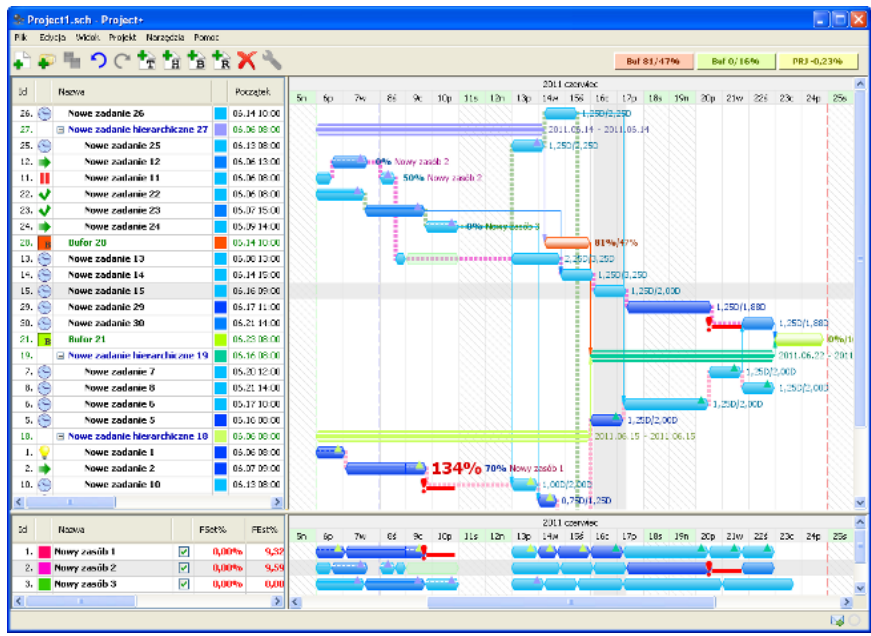


Risk ID	T/O	Title	Pre-Mitigation Probability	Schedule	C.	Performance	Score	Response	Title	Total Cost	Post-mitigation Probability	Sch
1	T	Poor understanding and detail...	L	H	M	VL	0	Reduce	Introduce pen...	\$10,000	M	L
2	T	Guidance System failure	M	M	MH	VH	10	Reduce	Improve initia...	\$750,000	N	MH
3	T	Contract Delay	H	M	M	H	10	Reduce	Change form...	\$500,000	L	M
4	T	Key resource unavailable	H	L	L	VH	10	Reduce	Change resou...	\$300,000	VL	L
5	T	Delivery overrun	M	L	N	N	0	Reduce	Source alter...	\$50,000	L	L
6	T	Fabrication contractor goes bust	N	L	M	M	0	Reduce		\$0	N	M
7	T	Rework required for assembly...	H	L	M	L	14	Reduce	Check manuf...	\$200,000	N	M
8	T	Testing fails	L	VL	L	N	0	Reduce		\$0	L	L
9	T	Design changes	H	M	M	N	0	Reduce		\$0	H	M
10	O	Reuse previous design work	H	M	H	N	0	Enhance		\$0	H	M



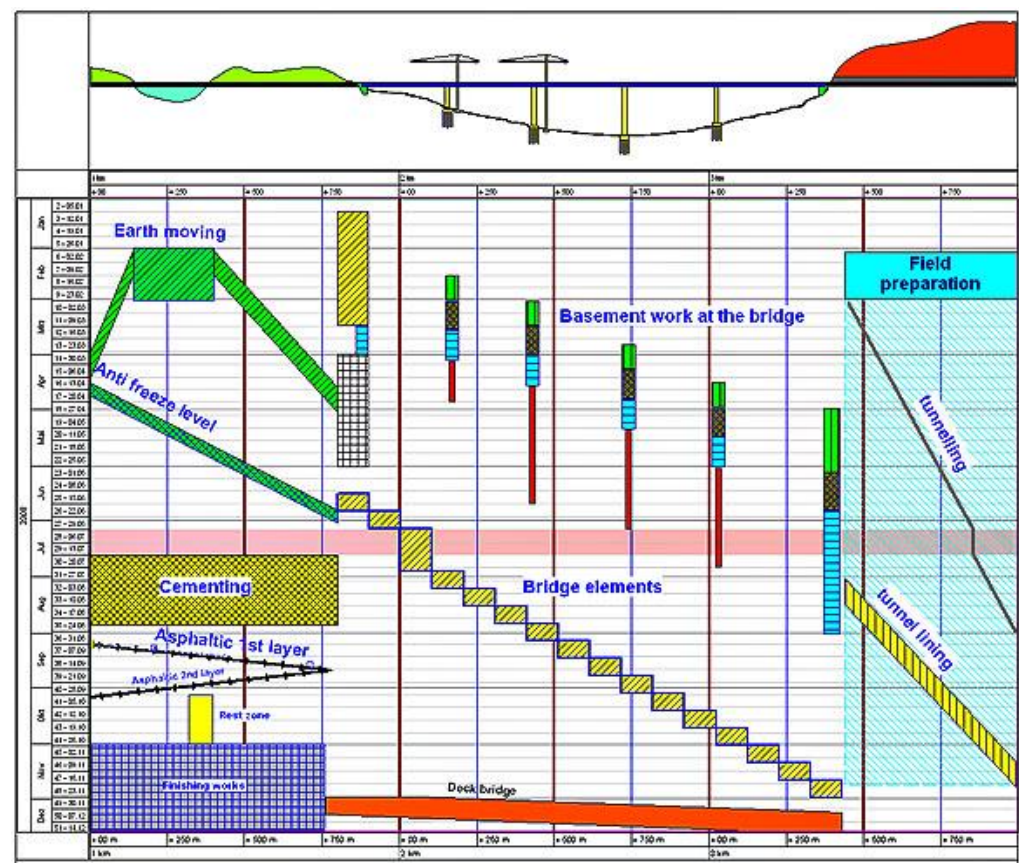
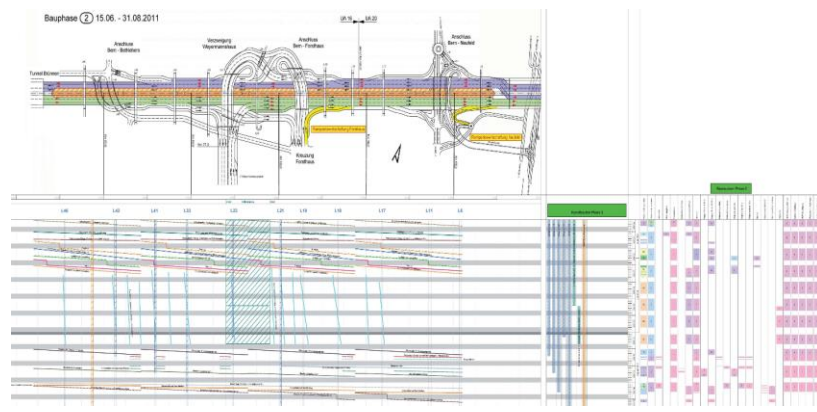
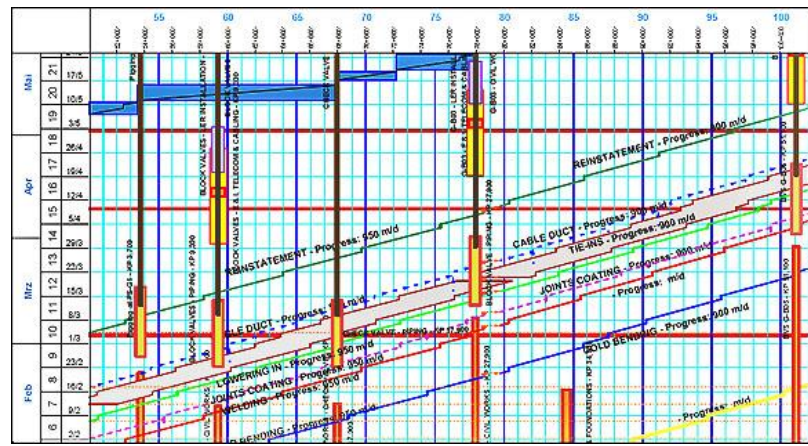
<https://www.oracle.com/pl/applications/primavera/index.html>

Project+



<http://ccpmsoft.home.pl/pl/pobierz-program/35-pobierz-program>

Tilos



<http://www.tilos.org>

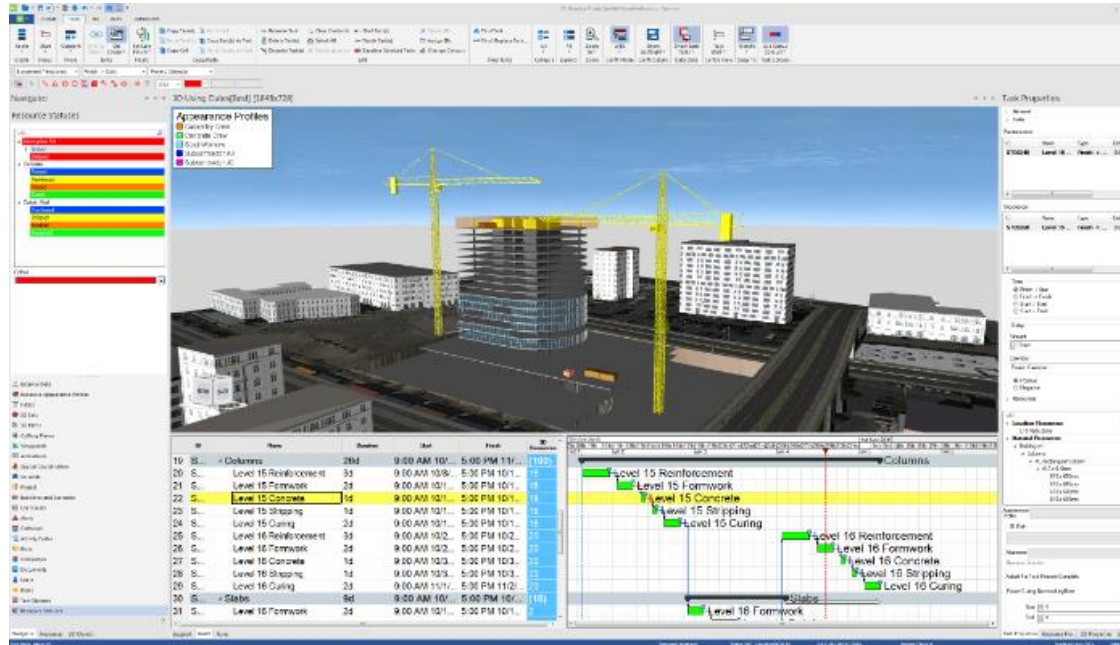
TIME – BIM 4D

- In BIM the 3D models are complemented by 4th dimension – Time
- The model can include whole life cycle of a project
- BIM 4D allows for importing of schedules from other applications, and for rendering visualizations of the construction works
- It also allows for: better supply coordination, analysis of different implementation variants, monitoring, delays reporting



<https://synchronltd.com/>

Synchro Pro

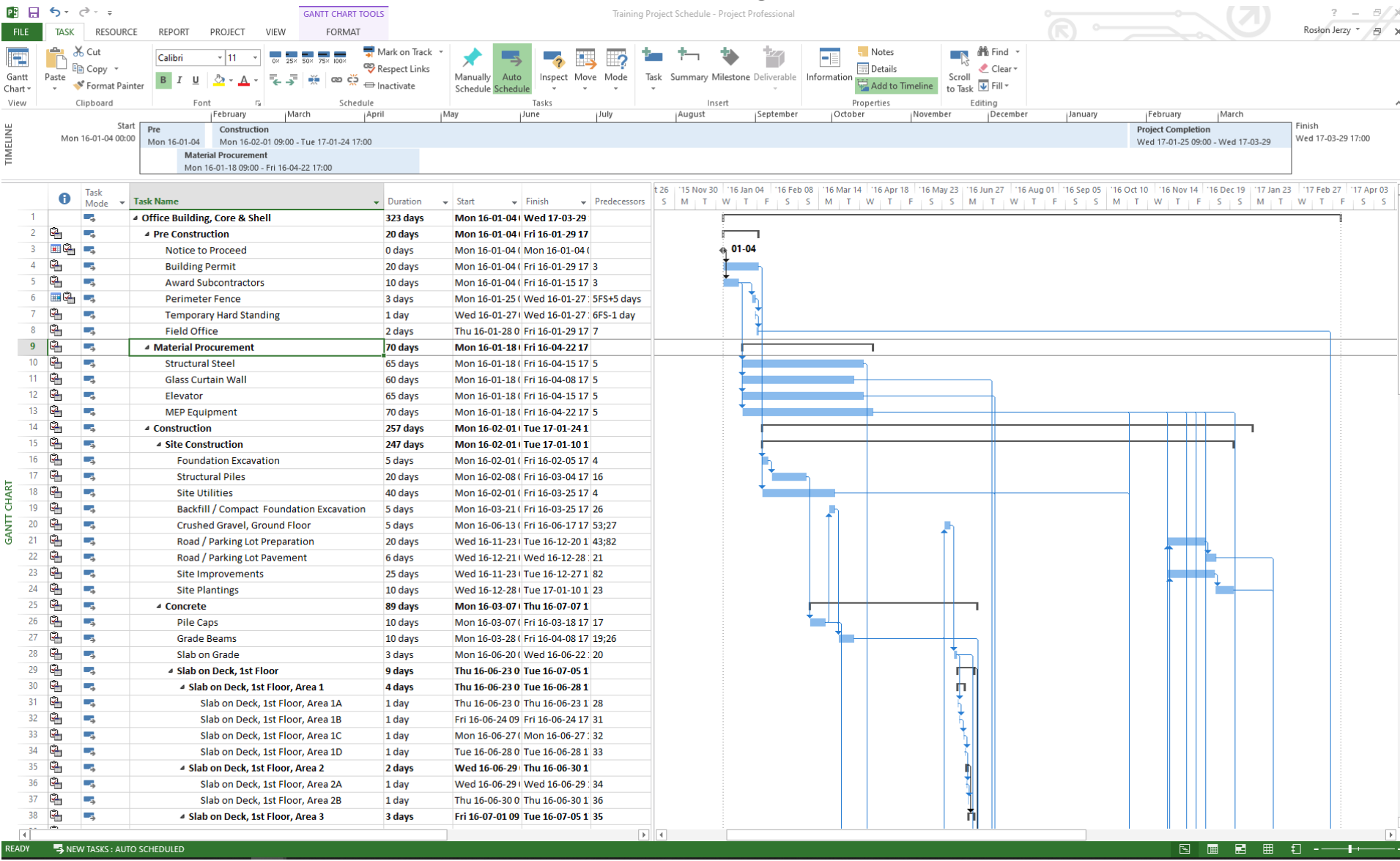


<https://synchro ltd.com/synchro-pro/>

Further reading:

- Project Management Institute. (2004). A Guide to the Project Management Body of Knowledge, Third Edition, PMI, USA.
- CLOEMC - Construction Manager's Library - www.cloemcv.il.pw.edu.pl
- Neumann, K., Schwindt, C., Zimmermann, J. (2012). Project scheduling with time windows and scarce resources: temporal and resource-constrained project scheduling with regular and nonregular objective functions. Springer Science & Business Media.
- Sprecher, A., Kolisch, R., & Drexel, A. (1993). Semi-active, active and non-delay schedules for the resource-constrained project scheduling problem (No. 307). Manuskripte aus den Instituten für Betriebswirtschaftslehre der Universität Kiel.
- Kostrubiec, A. (2003). Harmonogramowanie realizacji projektów-przegląd modeli. W: Inżynieria zarządzania przedsiębiorstwami. Red. L. Zawadzka. Gdańsk, 2003.
- Google scholar

Basics of MS Project - Review



Project Options



- General
- Display
- Schedule
- Proofing
- Save
- Language
- Advanced
- Customize Ribbon
- Quick Access Toolbar
- Add-ins
- Trust Center

Change options related to scheduling, calendars, and calculations.

Calendar options for this project: Project1

Week starts on: Monday

Fiscal year starts in: January

Use starting year for FY numbering

Default start time: 08:00

Default end time: 17:00

Hours per day: 8

Hours per week: 40

Days per month: 20

These times are assigned to tasks when you enter a start or finish date without specifying a time. If you change this setting, consider matching the project calendar using the Change Working Time command on the Project tab in the ribbon.

Schedule

Show scheduling messages

Show assignment units as a: Percentage

Scheduling options for this project: Project1

New tasks created: Manually Scheduled

Auto scheduled tasks scheduled on: Project Start Date

Duration is entered in: Days

Work is entered in: Hours

Default task type: Fixed Units

New tasks are effort driven

Tasks will always honor their constraint dates

Autolink inserted or moved tasks

Show that scheduled tasks have estimated durations

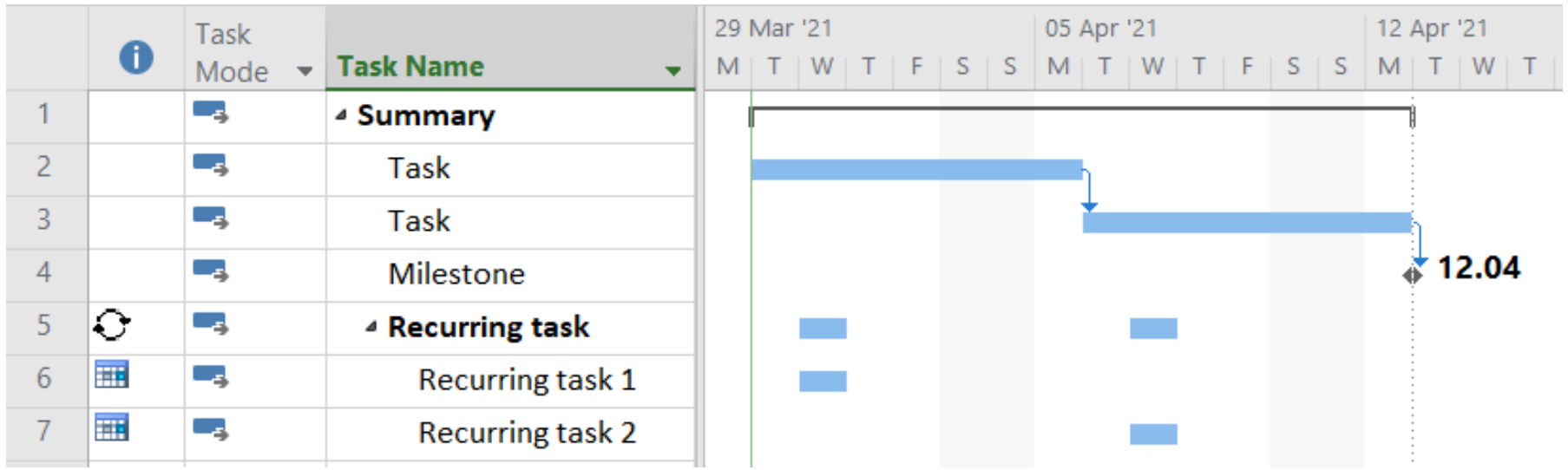
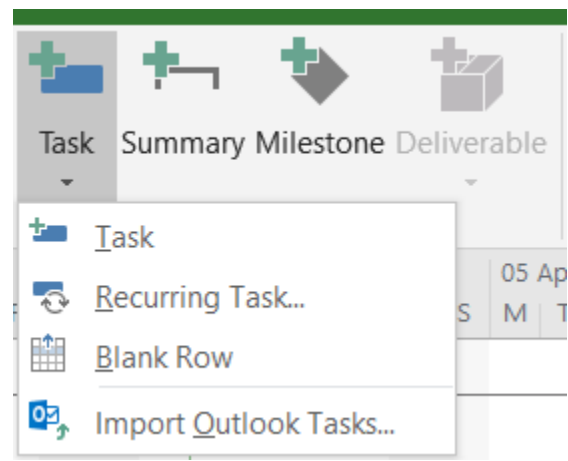
Split in-progress tasks

New scheduled tasks have estimated durations

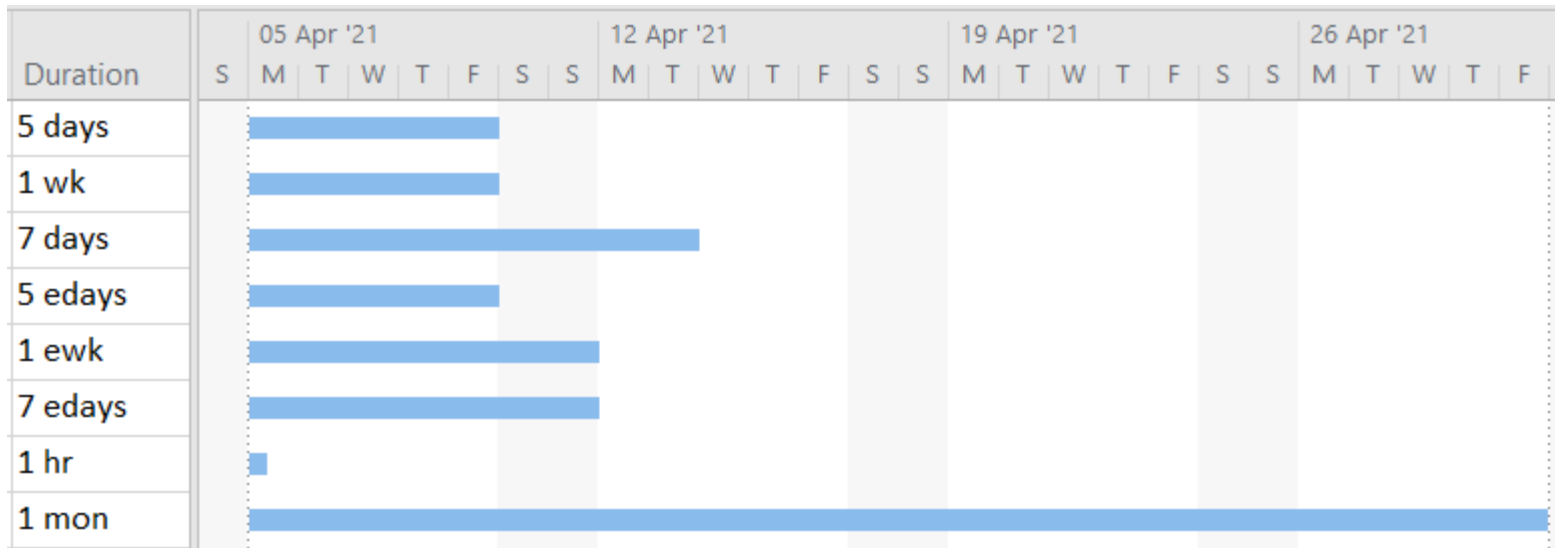
OK

Cancel

Tasks



Duration



Precedence relationships



Finish-to-Start, FS



Finish-to-Finish, FF



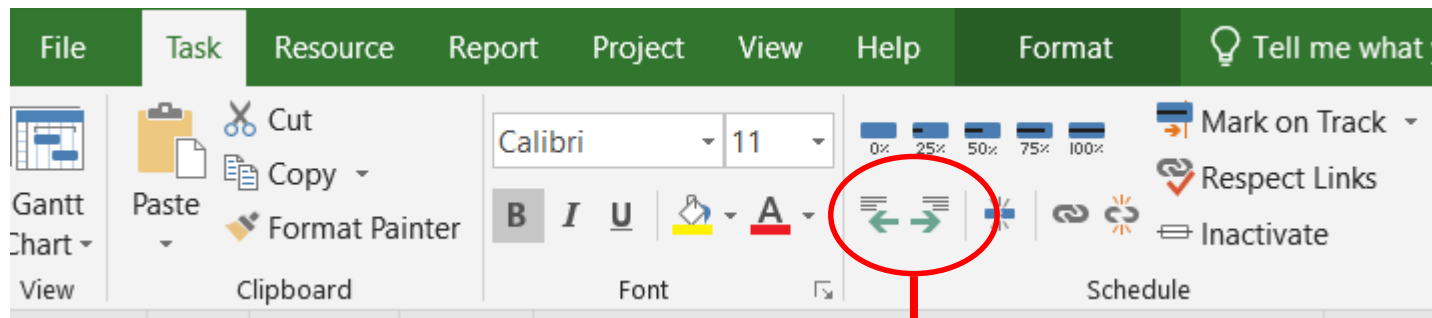
Start-to-Start, SS



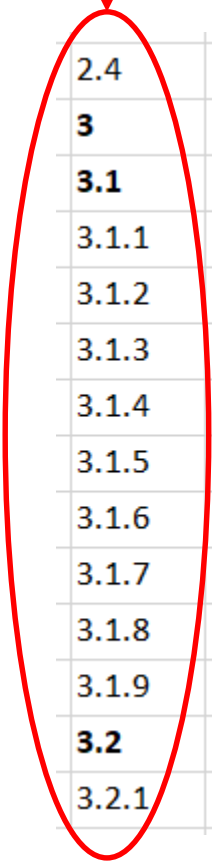
Start-to-Finish, SF

+ lead/lag

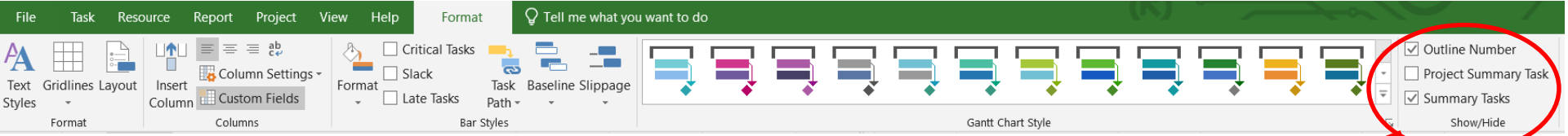
Task Name	Duration	Predecessors	22 Mar '21	29 Mar '21	05 Apr '21	12 Apr '21																					
			M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T
Summary	12 days																										
Task	5 days																										
Task	5 days	2FS+2 days																									



WBS



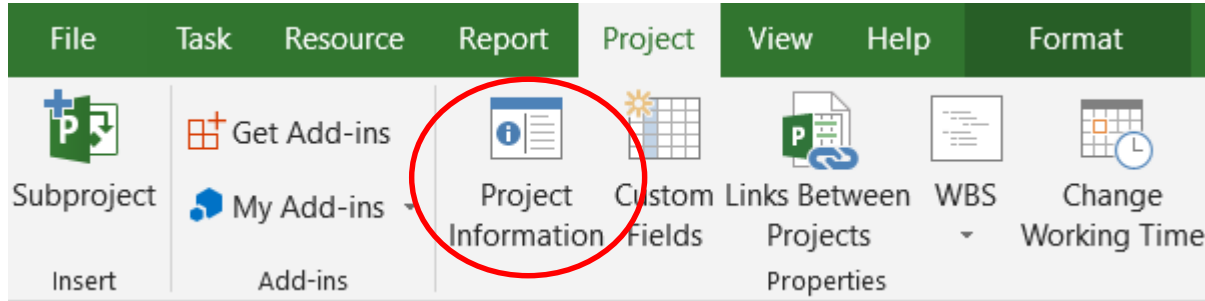
2.4	MEP Equipment
3	Construction
3.1	Site Construction
3.1.1	Foundation Excavation
3.1.2	Structural Piles
3.1.3	Site Utilities
3.1.4	Backfill / Compact Foundation Excavation
3.1.5	Crushed Gravel, Ground Floor
3.1.6	Road / Parking Lot Preparation
3.1.7	Road / Parking Lot Pavement
3.1.8	Site Improvements
3.1.9	Site Plantings
3.2	Concrete
3.2.1	Pile Caps



WBS

1.3 Construction
1.3.1 Site Construction
1.3.1.1 Foundation Excavation
1.3.1.2 Structural Piles
1.3.1.3 Site Utilities
1.3.1.4 Backfill / Compact Foundation Excavation
1.3.1.5 Crushed Gravel, Ground Floor
1.3.1.6 Road / Parking Lot Preparation
1.3.1.7 Road / Parking Lot Pavement
1.3.1.8 Site Improvements
1.3.1.9 Site Plantings
1.3.2 Concrete
1.3.2.1 Pile Caps
1.3.2.2 Grade Beams

Project information



Project Information for 'Project2' ✕

Start date: Current date:

Finish date: Status date:

Schedule from: Calendar:

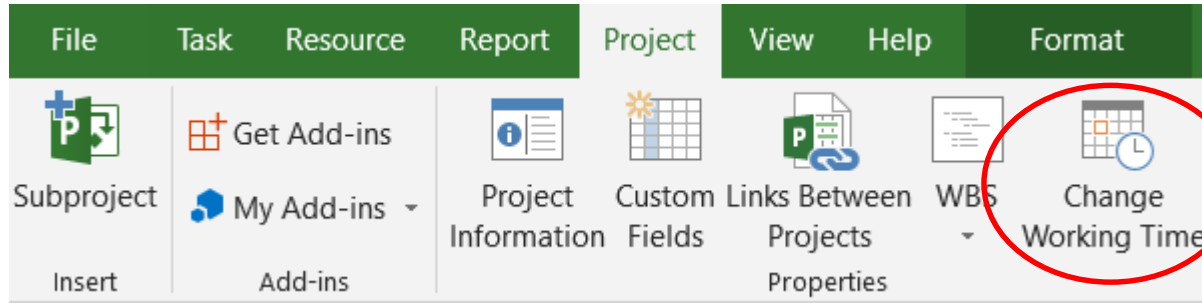
All tasks begin as soon as possible. Priority:

Enterprise Custom Fields

Department:

Custom Field Name	Value

Calendar



Change Working Time

For calendar: Standard (Project Calendar) Create New Calendar ...

Calendar 'Standard' is a base calendar.

Legend:

- Working
- Nonworking
- Edited working hours
- On this calendar:
- Exception day
- Nondefault work week

Click on a day to see its working times: 30 March 2021 is nonworking.

March 2021

M	T	W	Th	F	S	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Based on:
Exception 'Exception 1' on calendar 'Standard'.

Exceptions	Work Weeks
1	Exception 1

Name	Start	Finish
1 Exception 1	30.03.2021	30.03.2021

Details...
Delete

Details for 'Exception 1'

Set working times for these exceptions

Nonworking
 Working times:

	From	To

Recurrence pattern

Daily Every days
 Weekly
 Monthly
 Yearly

Range of recurrence

Start: Tue 30.03.21 End after: occurrences
 End by: Tue 30.03.21

Task

- In response to the ongoing changes on the market,
a construction design firm plans to modernize one of the computer labs and software
- Prepare a schedule based on the provided data
- File: 6_2_Task_-_Design_company_-_computer_office_modernization.docx
- Please send your schedules to:
projekty.ipb@gmail.com