PRIMAVERA 25th ANNUAL CONFERENCE

2008 WORLD CHAMPIONSHIP PROJECTS AND PORTFOLIOS

CENTERED ON CUSTOMER SUCCESS

Introduction of

Relationship Diagramming Method (RDM)

Variant of the Critical Path Method of Planning & Scheduling Analysis

to

Primavera Pertmaster

Fredric L. Plotnick, Ph.D., Esq., P.E.

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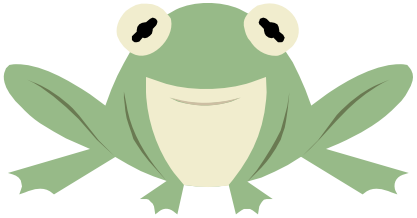
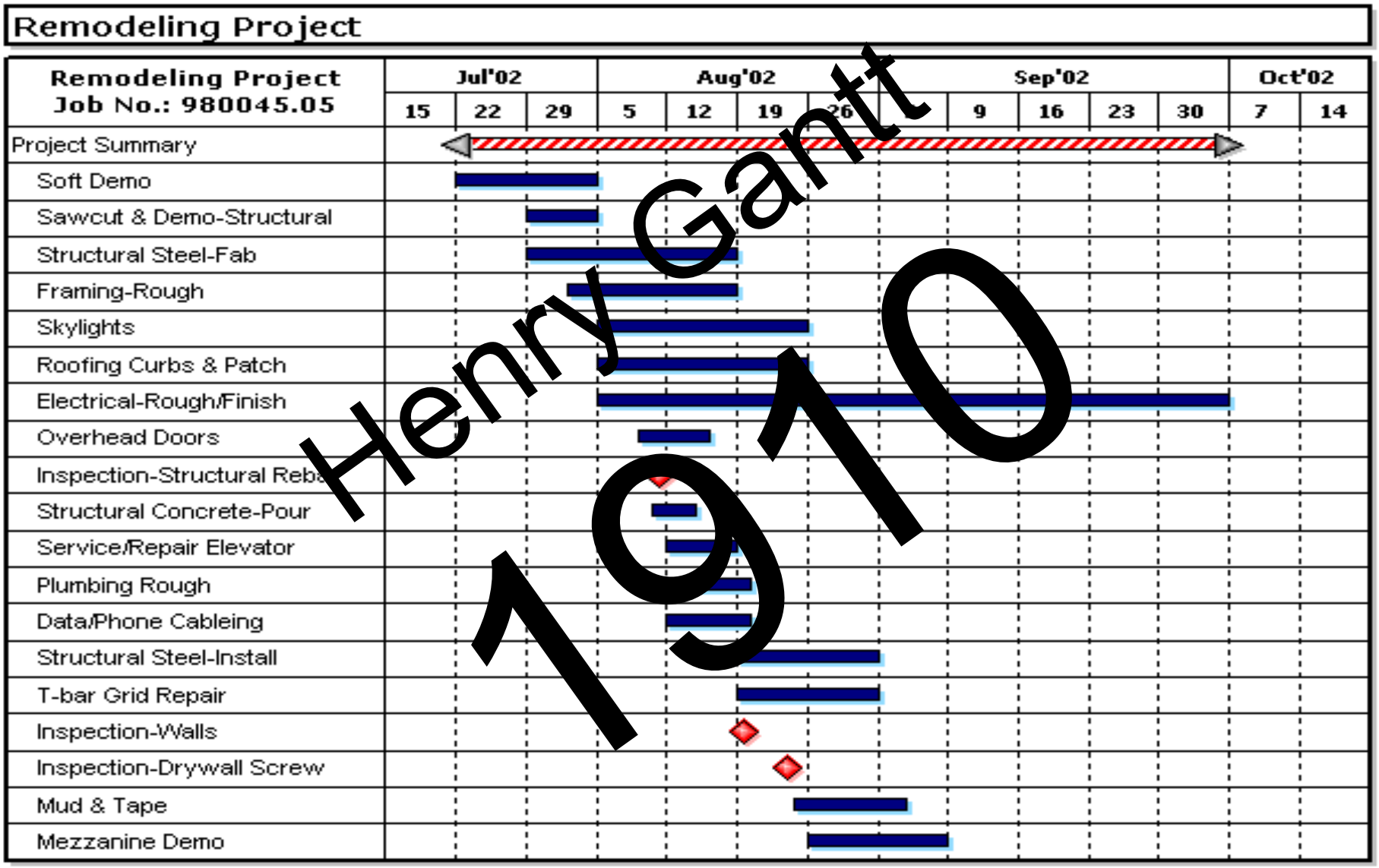
Origin of the Problem



Evolution of CPM



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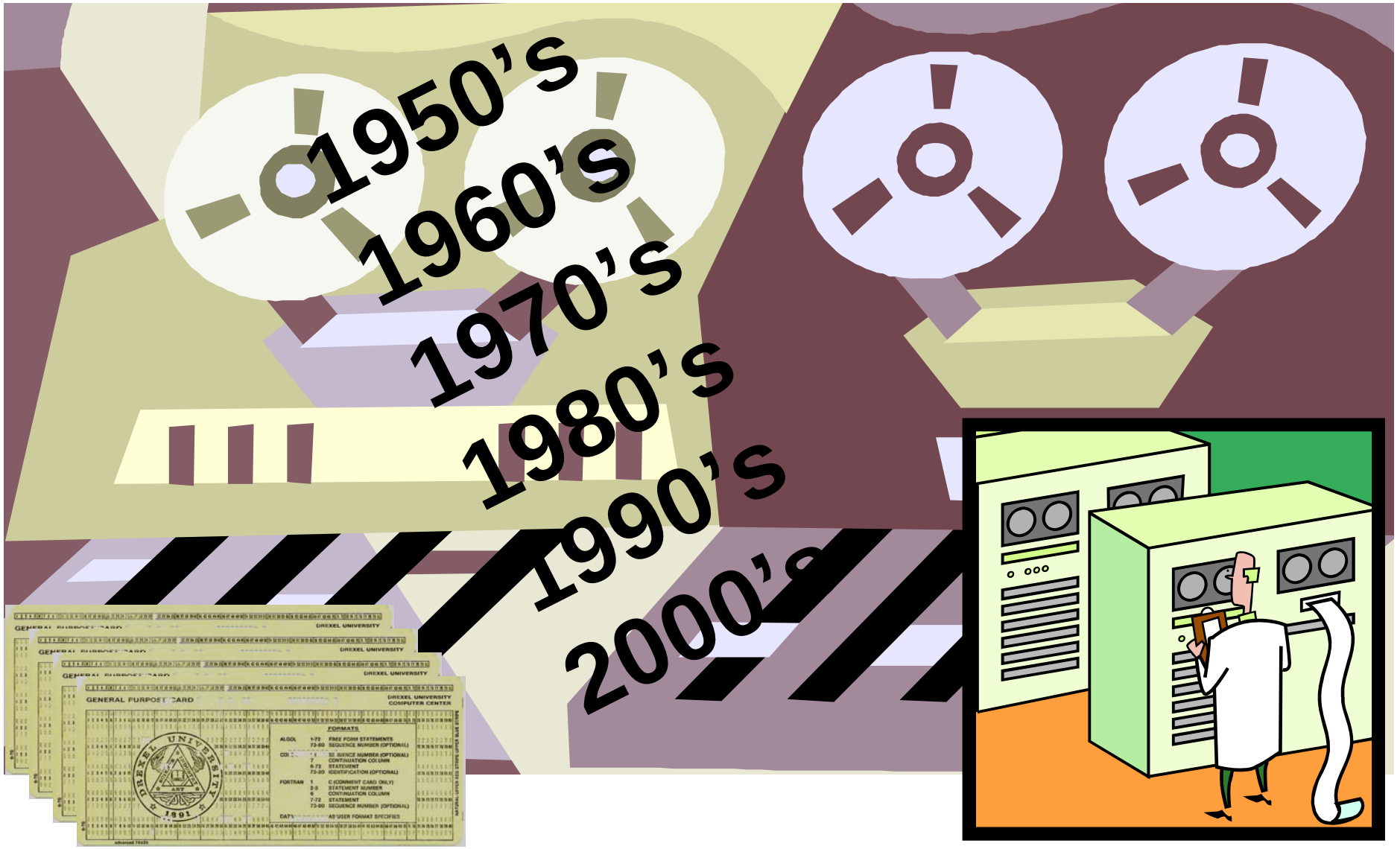

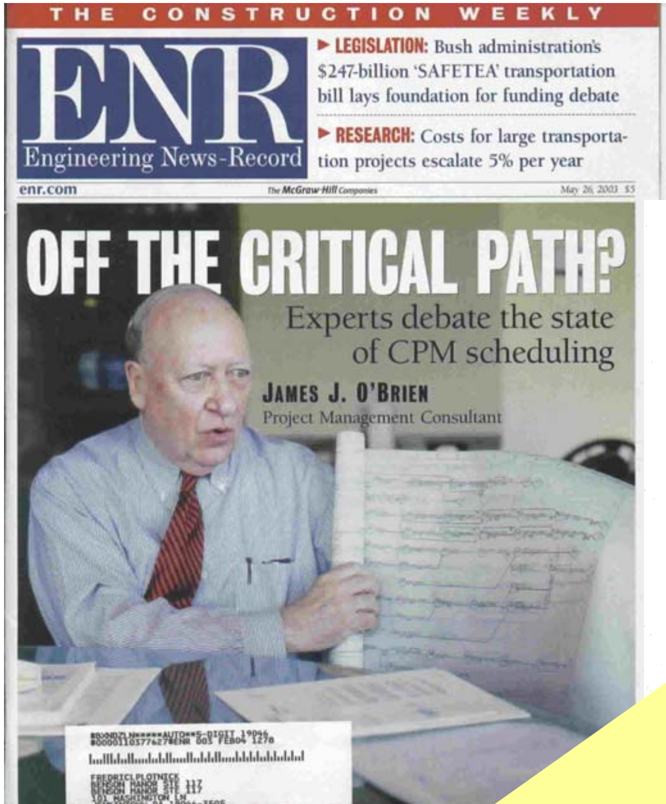

In the early days of CPM, computing capability was at a premium. Rooting out inconsistencies in scheduling data had to be left completely to the planner. In practice, this meant deliberately limiting the use of the "flexibility" features. Today, the desktop computer I'm using to compose this letter has far more capability than the UNIVAC we used for our first CPM calculations. Thus, there is no reason why the computer cannot be programmed to tell me that my scheduling input is inconsistent and why.

ENR Engineering News-Record
enr.com
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Letters

The State of CPM Schedules

Your cover story, Critics Can't Find the Logic in *Many* of Today's CPM Schedules, paints a disheartening picture of the current state of CPM schedules (ENR 5/26 p. 30). It's only 46 years since Morgan Walker and I first worked out CPM for duPont and yet project people are still falling into some of the same scheduling traps warned against during CPM's childhood. The use of features like "leads and lags," "multiple calendars" and "assigned constraints" do provide some levels of schedule flexibility. In practice, their use too often leads to inconsistent schedules and misleading views of project condition.

In the early days of CPM, computing capability was at a premium. Rooting out inconsistencies in scheduling data had to be left completely to the planner. In practice, this meant deliberately limiting the use of the "flexibility" features. Today, the desktop computer I'm using to compose this letter has far more capability than the UNIVAC we used for our first CPM calculations. Thus, there is no reason why the computer cannot be programmed to tell me that my scheduling input is inconsistent and why.

Your article seems to imply that Primavera's software is missing an essential data "debugging" feature. Since that software also appears to be an effective monopoly at this time, critics might look to investing in a stand-alone data "debugging" program to test Primavera input data files. The existence of such a program just might convince Primavera to produce their own. Something should be done to elevate the general professional character of today's project schedules.

JAMES E. KELLEY JR.
Elkins Park, Pa.

I have personally been involved with CPM scheduling since the late 1960s and James O'Brien and his activity on arrow technique (ADM) is a good example of someone still holding on to the Model-T technology. It's time to change.

We were arguing with him and his firm as far back as the early 1970s that the days of circles and arrows were passe. I, too, feel that the science of scheduling has changed immensely and the younger generation is leading toward developing instruction sheets rather than project measuring tools. Most users do not understand the forward and backward pass to establish early and late dates.

Times have changed, however, and veteran consultants also need to change. If we cannot accept the new generation of fancy colored schedules and the software that produces them, we need to step aside. The Project Management Institute (PMI) needs to "update" its thinking to the 21st Century.

DAVID F. ARNOLD
Arnold Engineering Co.
Bellingham, Mass.

Your recent cover story focused attention on the need to promote excellence in scheduling, the mission of the new PMI College of Scheduling. Our members and directors are both candid and passionate and the views expressed at the restaurant for your story were our individual views and not those of the college. It will not promote any particular diagramming technique or software design. It will promote better use of the available tools by working with practitioners, software developers, top management, government and academia. Better planning, scheduling and execution of our projects is too important to not get actively involved in trying to improve things. We're holding our first international seminar in Montreal next April 25-27 and we'd like everyone interested in better scheduling to be there.

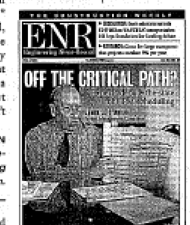
STUART OCKMAN
PMI College of Scheduling
Newtown Square, Pa.

In response to your editorial about critical path scheduling, the real issue here is one of professionalism, morality and ethics. If CPM scheduling is now to be

Letters

regarded as a "college" course of study, then it seems to me that all of the ramifications of professionalism are necessary. It is possible to deceive others without the use of software. Standards may be helpful, and improvements in the various "tools" are always helpful, but this is a people and not a technology issue. It isn't about what a vendor with a dominant market share does or doesn't provide.

MIKE MORRISON
Value Management Consulting
Redmond, Wash.



I understand and agree with most of the complaints of the four "scheduling experts" in your story. However, I find fault with their intentional exclusion of Primavera's president, whose office was only 10 miles away. If ENR was attempting to report a news story within the industry, it failed. What it did was report on the complaints of four people, pining for the good old days, who didn't actually want to debate their position.

I too wish that schedules were not abused and that schedulers were better trained. I've met many "experts" who couldn't schedule themselves out of a paper sack. Usually, it's only after a schedule has become unusable that the manipulation begins. Blaming the software is short-sighted. Comparing scheduling to gun manufacturing is hyperbole. And altering the software to make it idiot-proof will make it less responsive to project needs.

As a professional journal, ENR should not stop at provoking its readers about a topic and should explore the topic, providing equal representation to both sides of an issue and suggesting a path forward.

VERA LOVEJOY
Fluor Corp.
Aliso Viejo, Calif.

True schedulers and planners need training in CPM, ADM or PDM, or all three. Sometimes I think having to put a CPM together on paper with a pencil and straight edge is the best teacher because you think it through before diving in. The one analogy I can think of is, if you don't know what 2 plus 2 equals without a calculator, how do you know if your calculator is functioning correctly? Bottom line: don't blame the software, blame the person at the keyboard and the person buying into the end product.

NANCY S. AQUADRO
Nooter Construction Co.
Bensalem, Pa.

It's not the software, it's the scheduler! Dennis Bryan and Russell Lewton hit it right on the head—the fundamentals of scheduling are being ignored. There is a distinct lack of quality in the preparation of most CPM schedules out there today. Too many alleged schedulers do not rely on the capability of the software, they tailor and fit the schedule to meet their idea of the schedule. Most schedules are a waste of the assets required to put them together. Primavera's P3, and its lower-cost counterpart SureTrack, are powerful tools that enable competent schedulers and project management professionals the ability to plan and perform on a project. I do lament the passing of the ADM and believe it is superior to the Precedence Diagram Method. Will I do an Arrow Diagram by hand? Am I going to boycott PDM? "No" to both counts! I am going to make the best use of my assets and knowledge.

DON L. SHORT II
Tempest Co.
Omaha, Neb.

Correction

Three articles in the June 9 edition of ENR contained editing errors. The amount of Bechtel National Inc.'s contract with U.S. AID for reconstruction in Iraq, as described in "Nation Building Is Hard Work," should be $680 million (p. 14). A photo caption in "With 'Lego Logic,' Army Engineers Wage Peace One Block at a Time," misidentified Army Corps of Engineers Maj. Gen. Carl Strock (p. 17). Finally, the amount of rubble cleared from an overpass that collapsed onto Interstate 80 in western Nebraska, as described in "Nebraska Overpass Will Be Rebuilt with Fewer Piers," should be 650 tons (p. 25).

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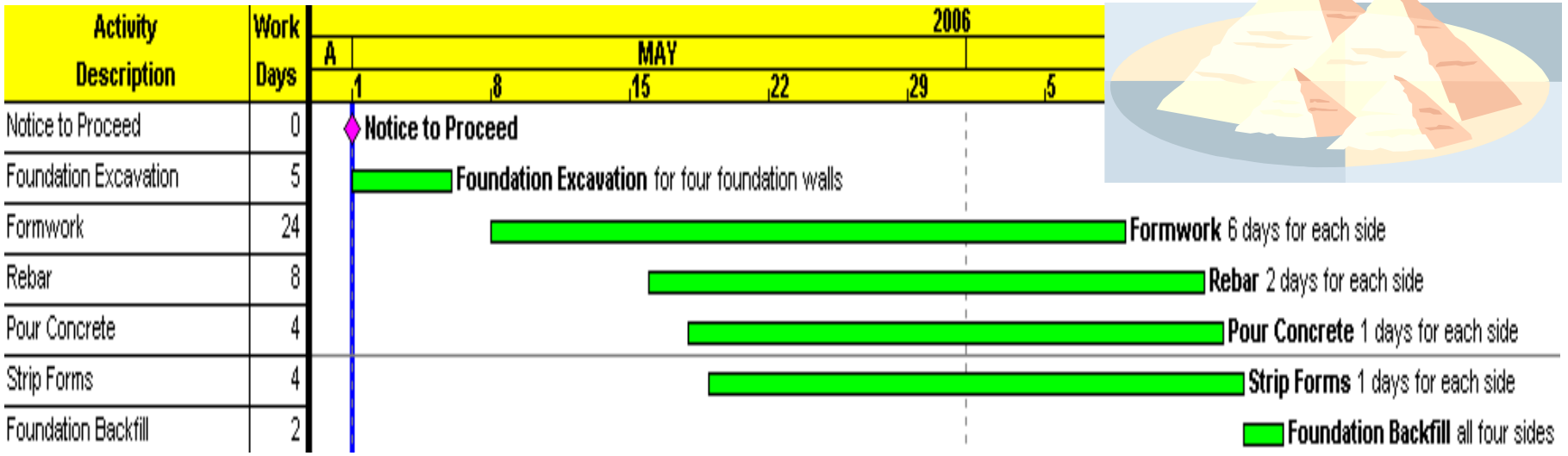
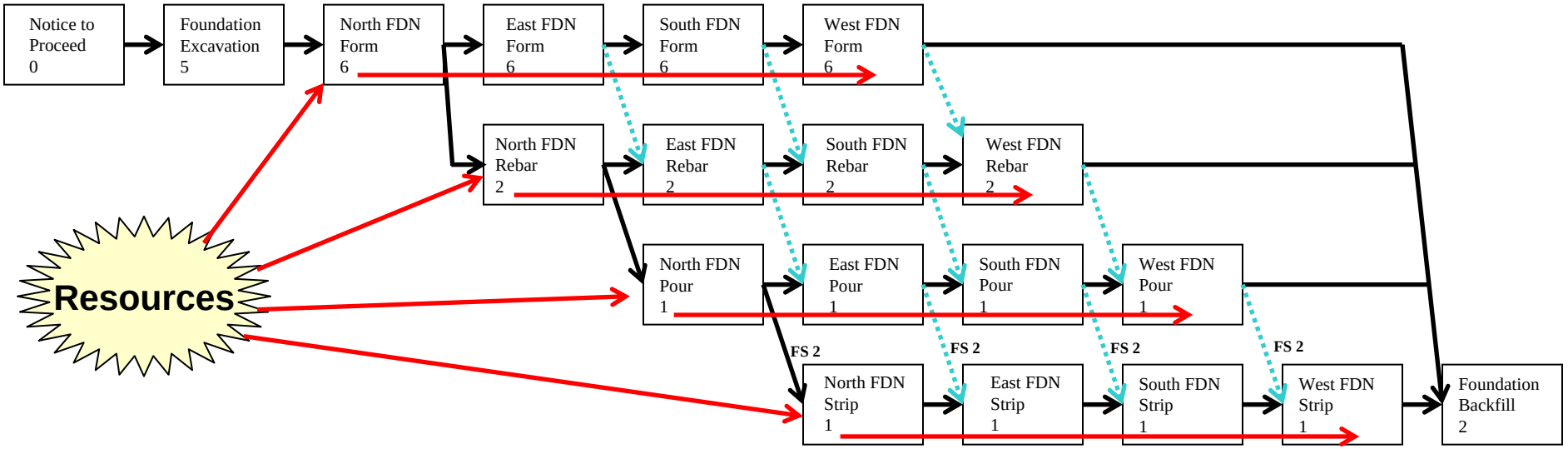
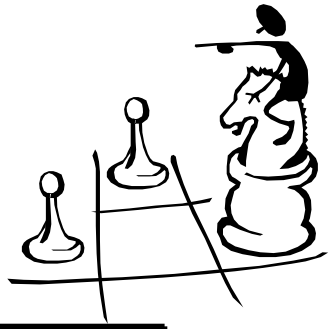
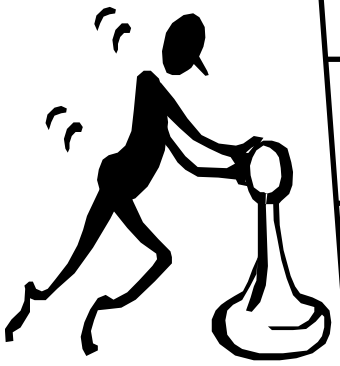
Scheduling Resources is Not CPM





Plan – then Schedule





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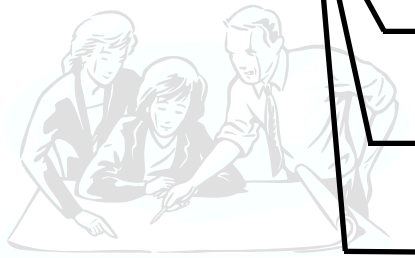
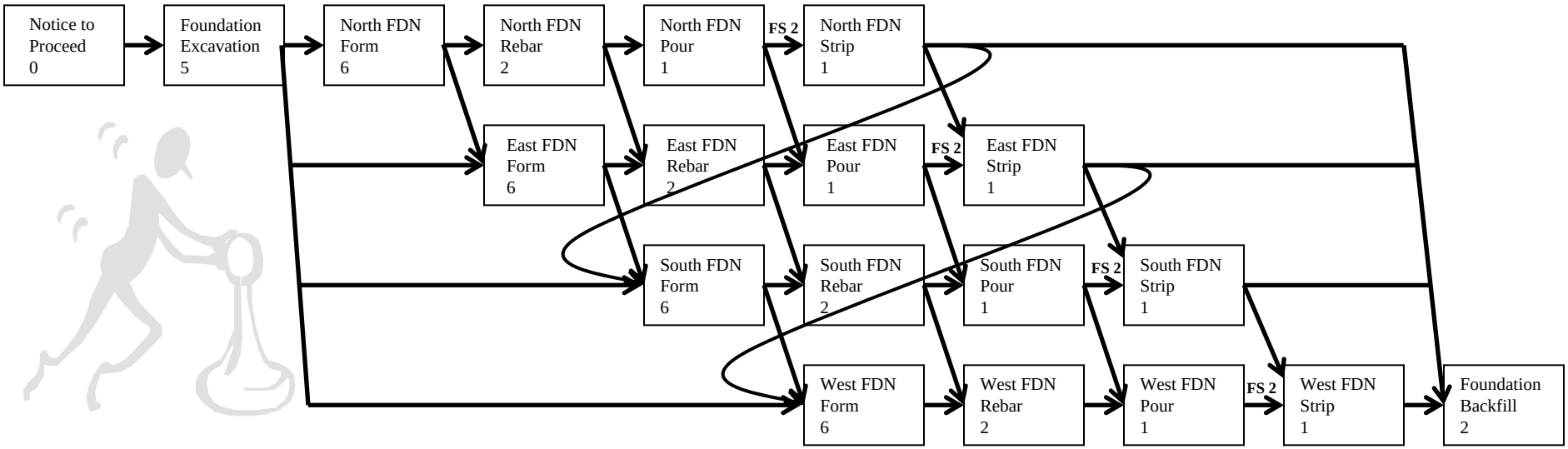
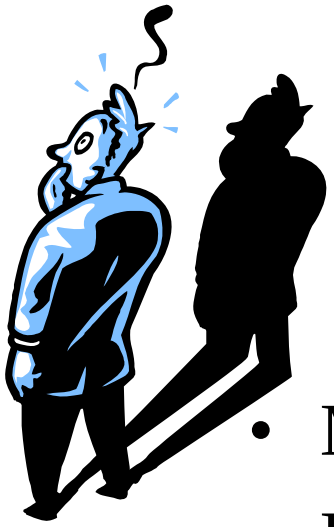






What can we do?

- Maths of 50s watered down to 50s computers
- PCs provide tools (but not skills) to the masses
- More powerful PCs benefit glitz – not maths
- GUI and WYSIWYG i/o favors bar charting
- Wizards further reduce need for skills
- Where is the logic?

COVER STORY PROJECT MANAGEMENT

Critics Can't Find the Logic in Many of Today's CPM Schedules

Users want software with flexibility, but is it true CPM?

Proposed Solution

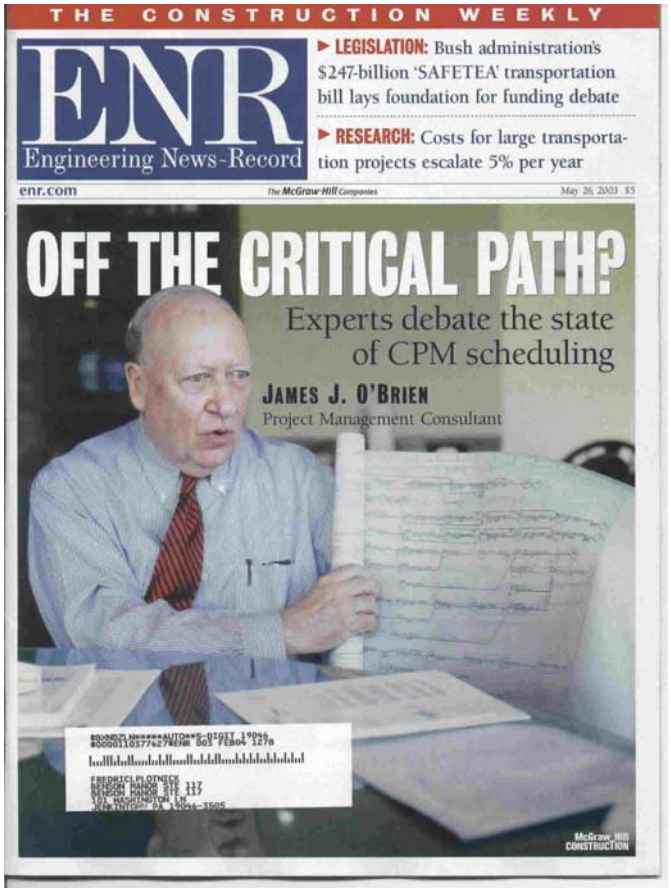
RDM

Relationship Diagramming Method

Introduction by James J. O'Brien

Improving CPM

Restoring the Original Promise



- Kelley expected more from CPM
  but was limited by early computers
- free and independent float
- RDM created ~ 2003 to 2005
- "amazing grasp of the obvious"
- "what Kelley was looking for"

Relationship Diagramming Method

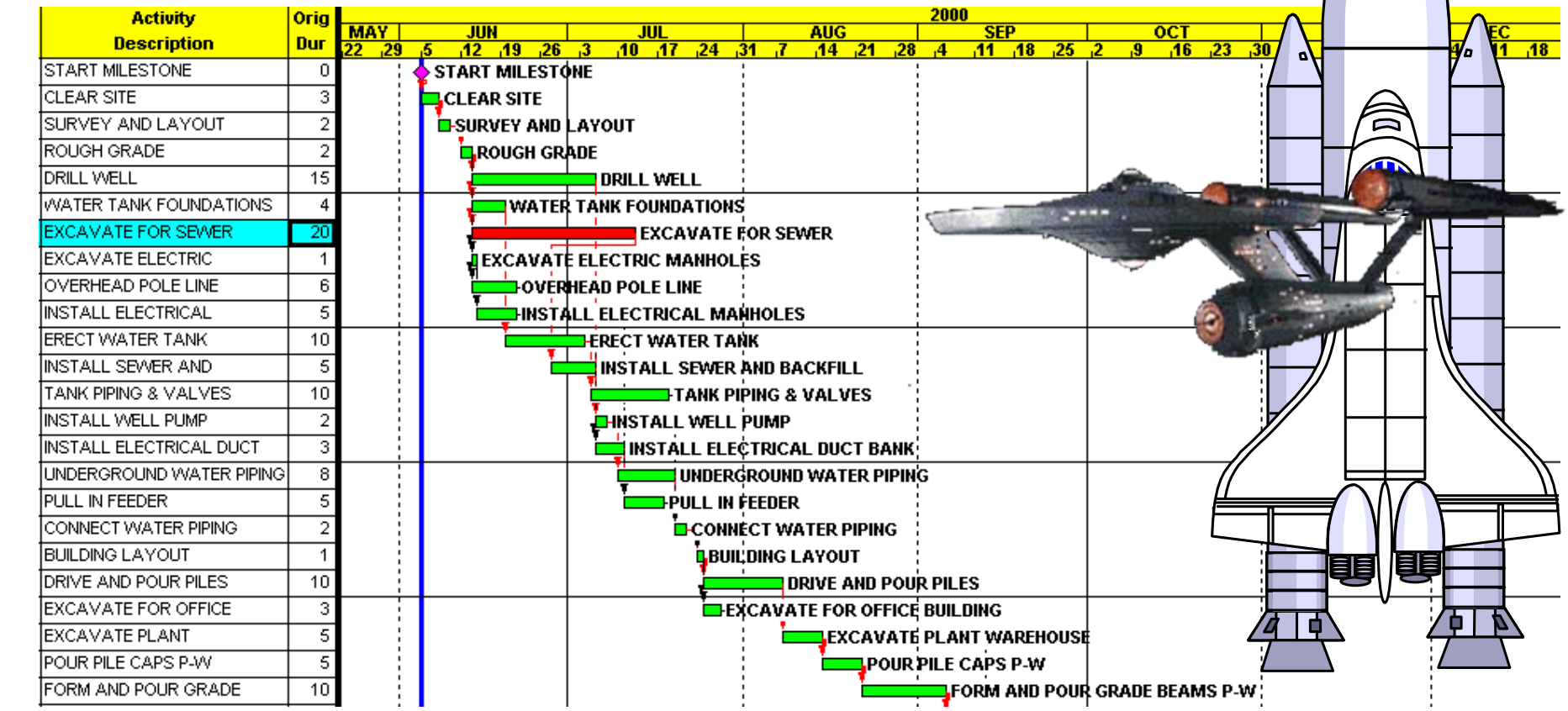
more about

RDM requires you to **record the relationships between activities** ...

... and allows the computer to recalculate the impact of changes made ...

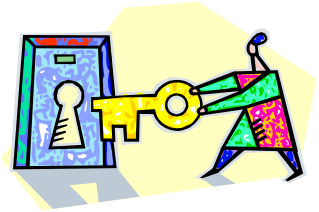
... reducing the 40%+ rework effort to that of a keystroke

Activity Description	Orig Dur
START MILESTONE	0
CLEAR SITE	3
SURVEY AND LAYOUT	2
ROUGH GRADE	2
DRILL WELL	15
WATER TANK FOUNDATIONS	4
EXCAVATE FOR SEWER	20
EXCAVATE ELECTRIC	1
OVERHEAD POLE LINE	6
INSTALL ELECTRICAL	5
ERECT WATER TANK	10
INSTALL SEWER AND	5
TANK PIPING & VALVES	10
INSTALL WELL PUMP	2
INSTALL ELECTRICAL DUCT	3
UNDERGROUND WATER PIPING	8
PULL IN FEEDER	5
CONNECT WATER PIPING	2
BUILDING LAYOUT	1
DRIVE AND POUR PILES	10
EXCAVATE FOR OFFICE	3
EXCAVATE PLANT	5
POUR PILE CAPS P-W	5
FORM AND POUR GRADE	10



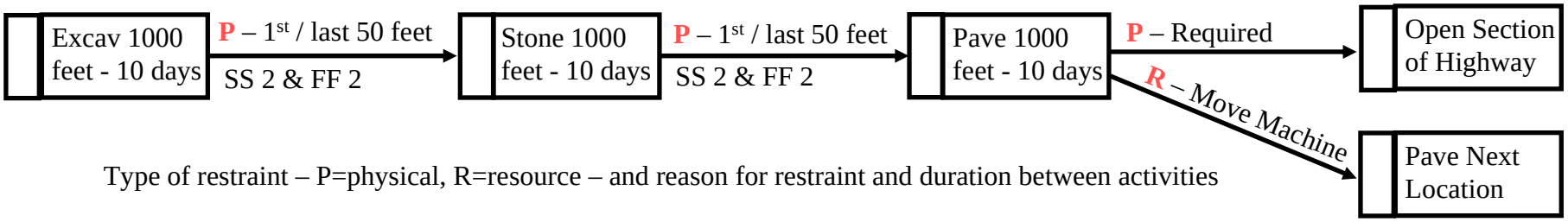
Relationship Diagramming Method

- **Five** classes of new coding:
- The **Event** Code
- The **Duration** Code
- The **Reason Why** Code
- The Expanded **Lead Lag** Code
- The **Relationship** Code



Reason/Why Codes

- Record the **reason why** the restraint exists
  - physical – how important – description
  - resource – crew/craft/equipment/forms/materials/etc.



Type of restraint – P=physical, R=resource – and reason for restraint and duration between activities

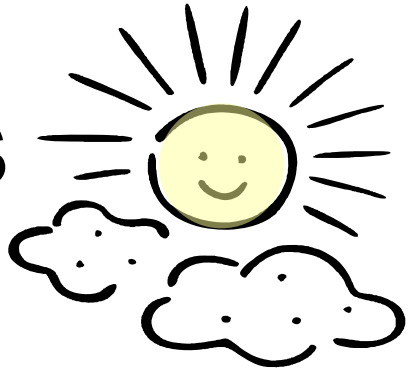
Check for:

- physical open ends
- duplicative resource logic

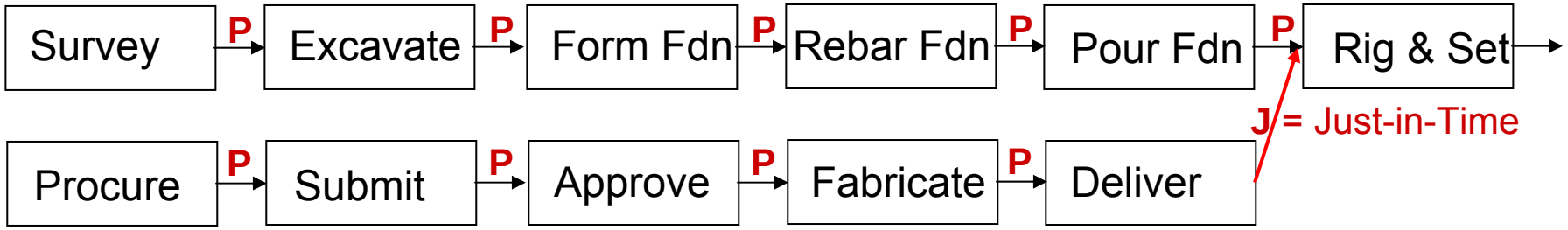
What if:

- add crews/equip/forms…?
- add falsework/relax code?

Reason/Why Codes



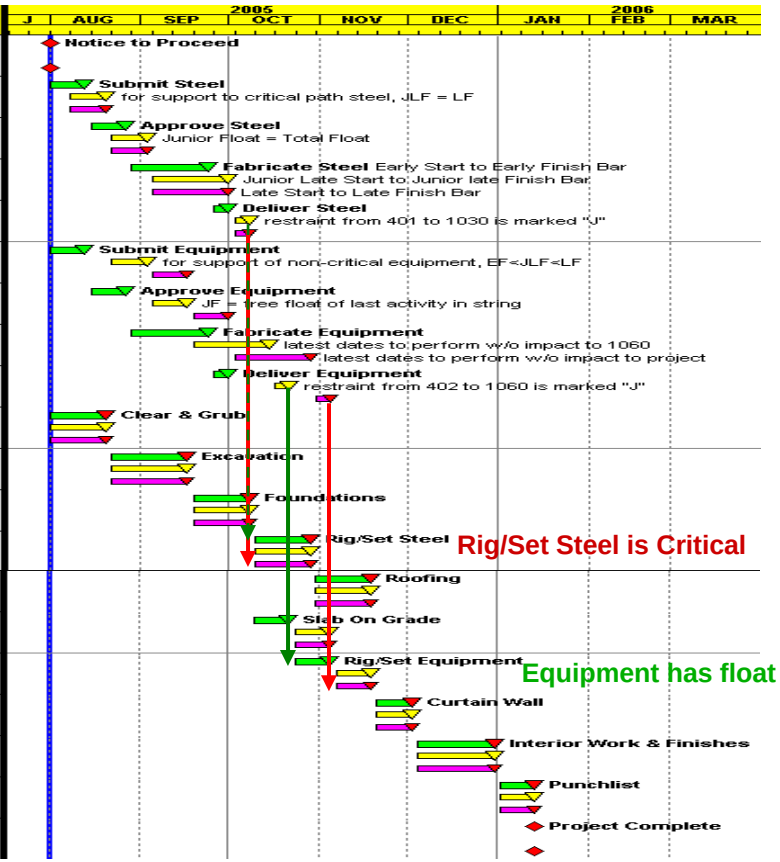
- Special **reason why** codes
- physical – just-in-time or subordinate support
  - calculate latest dates to not delay early start of successor to restraint



Additional code data on restraints

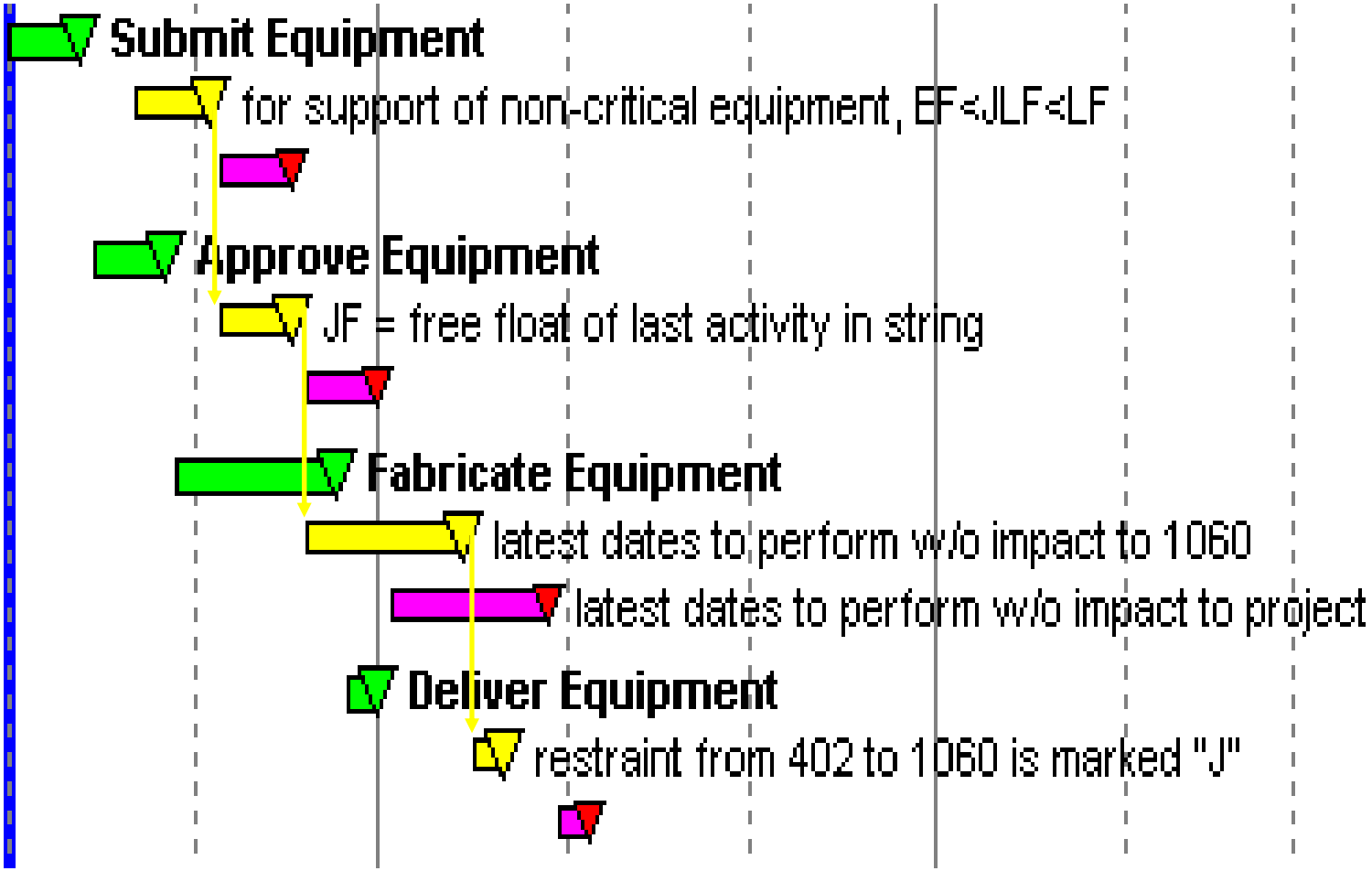
- Just-in-Time Physical Restraint
- distinguish “prevent delaying project” / “prevent delaying work crew”
- calculate new attributes JLS, JLF, JTF

Activity ID	Activity Description	Orig Dur	Total Float	Free Float	Junior Float	Early Start	Early Finish	Late Finish	Junior Finish
10	Notice to Proceed	0	0	0	0	01AUG05			
101	Submit Steel	10	5	0	5	01AUG05	12AUG05	19AUG05	19AUG05
201	Approve Steel	10	5	0	5	15AUG05	26AUG05	02SEP05	02SEP05
301	Fabricate Steel	20	5	0	5	29AUG05	23SEP05	30SEP05	30SEP05
401	Deliver Steel	5	5	5	5	26SEP05	30SEP05	07OCT05	07OCT05
102	Submit Equipment	10	25	0	15	01AUG05	12AUG05	16SEP05	02SEP05
202	Approve Equipment	10	25	0	15	15AUG05	26AUG05	30SEP05	16SEP05
302	Fabricate Equipment	20	25	0	15	29AUG05	23SEP05	28OCT05	14OCT05
402	Deliver Equipment	5	25	15	15	26SEP05	30SEP05	04NOV05	21OCT05
1000	Clear & Grub	15	0	0	0	01AUG05	19AUG05	19AUG05	19AUG05
1010	Excavation	20	0	0	0	22AUG05	16SEP05	16SEP05	16SEP05
1020	Foundations	15	0	0	0	19SEP05	07OCT05	07OCT05	07OCT05
1030	Rig/Set Steel	15	0	0	0	10OCT05	28OCT05	28OCT05	28OCT05
1040	Roofing	15	0	0	0	31OCT05	18NOV05	18NOV05	18NOV05
1050	Slab On Grade	10	10	0	10	10OCT05	21OCT05	04NOV05	04NOV05
1060	Rig/Set Equipment	10	10	10	10	24OCT05	04NOV05	18NOV05	18NOV05
1070	Curtain Wall	10	0	0	0	21NOV05	02DEC05	02DEC05	02DEC05
1080	Interior Work & Finishes	20	0	0	0	05DEC05	30DEC05	30DEC05	30DEC05
1090	Punchlist	10	0	0	0	02JAN06	13JAN06	13JAN06	13JAN06
1099	Project Complete	0	0	0	0		13JAN06	13JAN06	13JAN06



Legend – Top Line (Green) is Early Dates, Middle Line (Yellow) is Junior Dates, Bottom Line (Purple) is Late Dates

Just-in-Time Date & Float Attribute



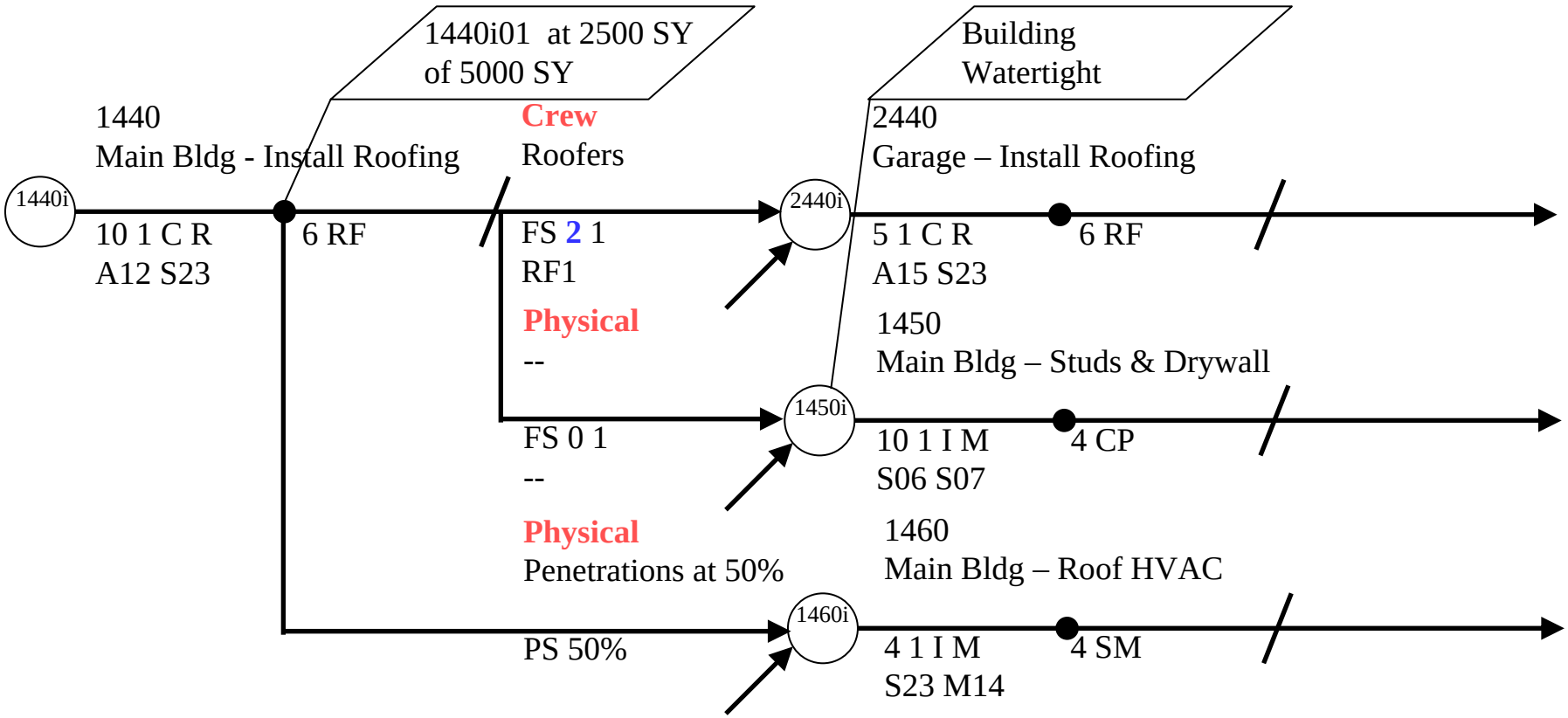
Legend – Top Line (Green) is Early Dates, Middle Line (Yellow) is Junior Dates, Bottom Line (Purple) is Late Dates

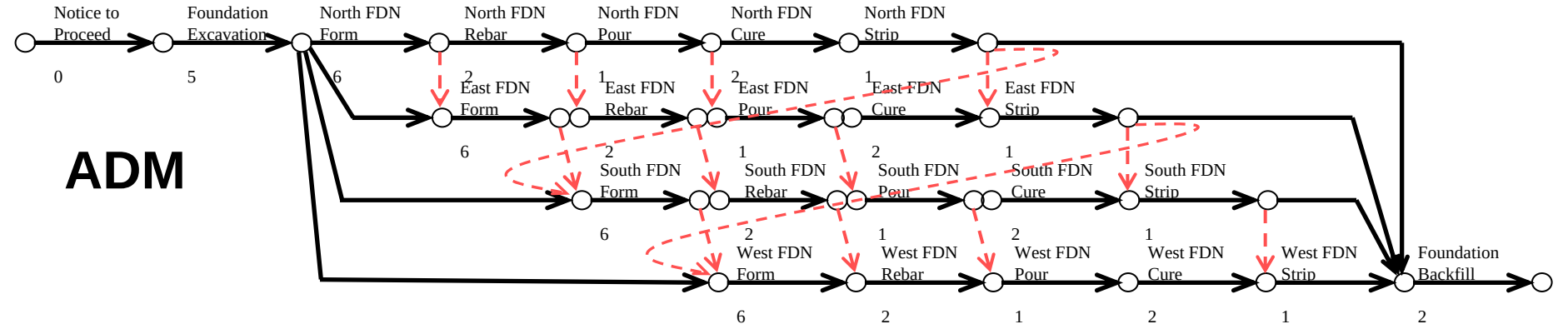
Relationship Codes

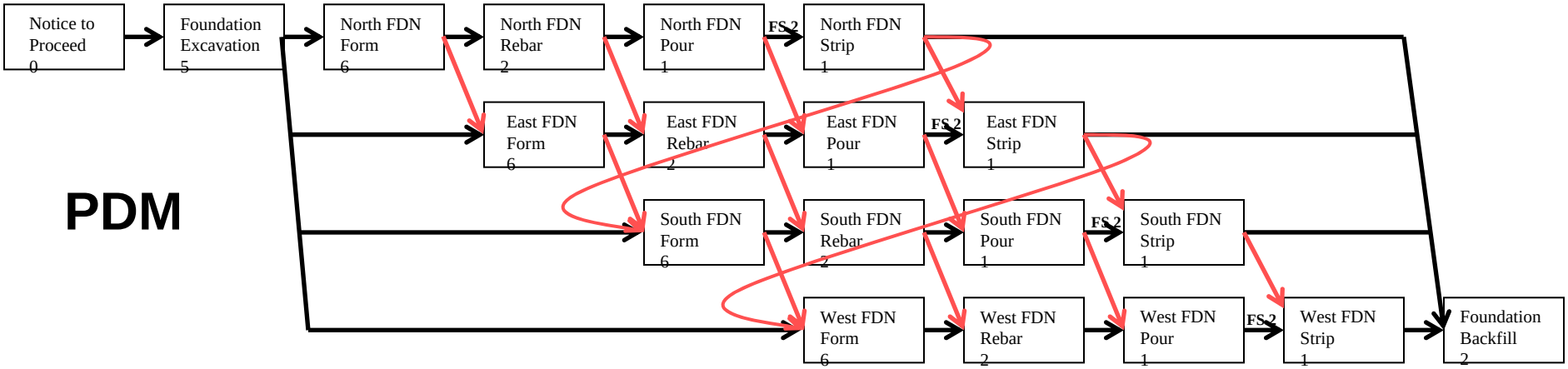
- Restraint v Relationship Codes
- resource codes – user defined activity codes
- Calculation “on the fly?”
- conduit – cable – connections – energize
- rig pump – pipe to pump – run wire to pump
- Highlight the Handoff
- mechanical to electrical subcontractor
- crew movement between job area locations
- is there a handoff or demob/remob duration?

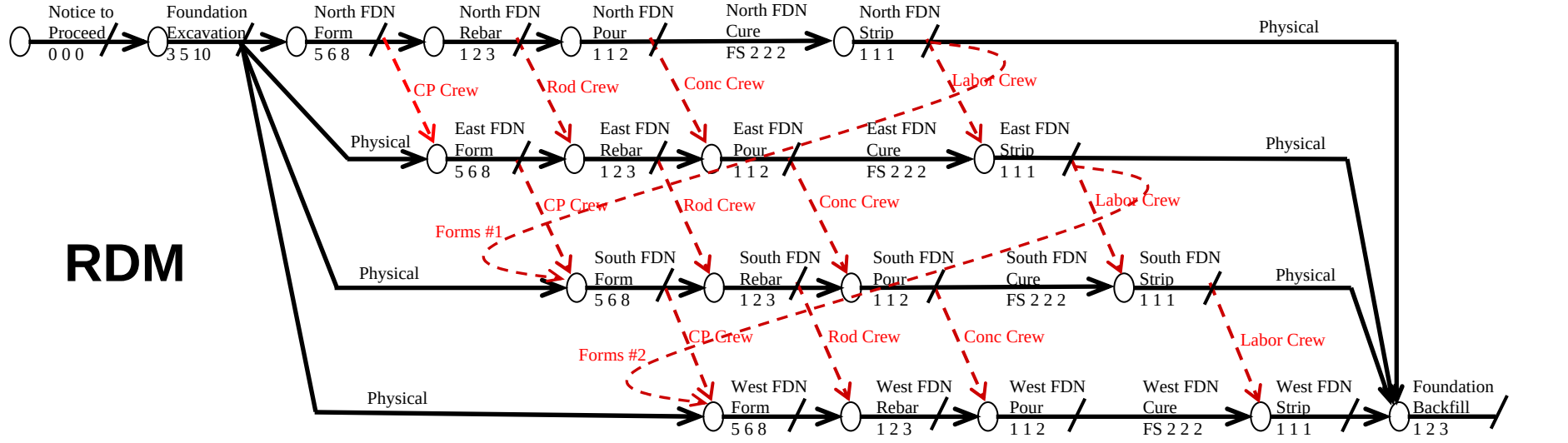
Put it all together …

event codes & text
duration codes
reason/why codes & text
expanded lead/lag codes
relationship codes



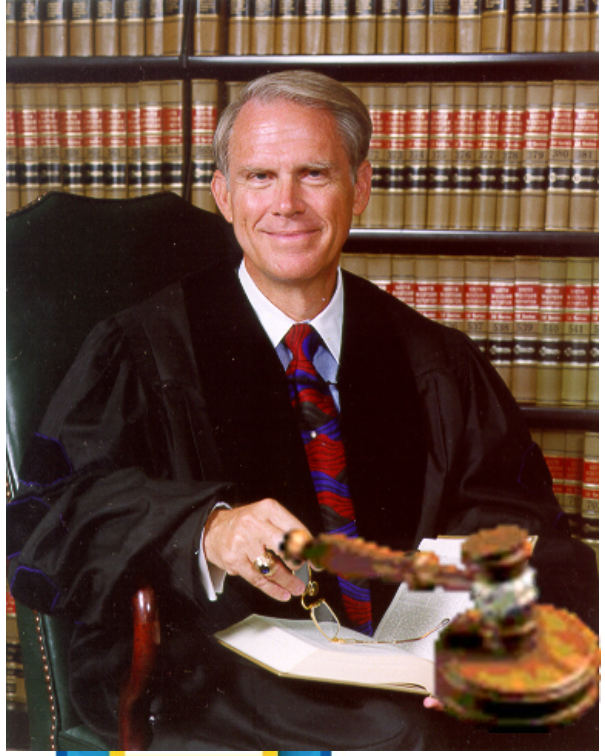

ADM
Notice to Proceed
0
Foundation Excavation
5
North FDN Form
6
North FDN Rebar
2
North FDN Pour
1
North FDN Cure
2
North FDN Strip
1
East FDN Form
6
East FDN Rebar
2
East FDN Pour
1
East FDN Cure
2
East FDN Strip
1
South FDN Form
6
South FDN Rebar
2
South FDN Pour
1
South FDN Cure
2
South FDN Strip
1
West FDN Form
6
West FDN Rebar
2
West FDN Pour
1
West FDN Cure
2
West FDN Strip
1
Foundation Backfill
2


PDM
Notice to Proceed
0
Foundation Excavation
5
North FDN Form
6
North FDN Rebar
2
North FDN Pour
1
FS 2
North FDN Strip
1
East FDN Form
6
East FDN Rebar
2
East FDN Pour
1
FS 2
East FDN Strip
1
South FDN Form
6
South FDN Rebar
2
South FDN Pour
1
FS 2
South FDN Strip
1
West FDN Form
6
West FDN Rebar
2
West FDN Pour
1
FS 2
West FDN Strip
1
Foundation Backfill
2


RDM
Notice to Proceed
0 0 0
Foundation Excavation
3 5 10
North FDN Form
5 6 8
North FDN Rebar
1 2 3
North FDN Pour
1 1 2
North FDN Cure
FS 2 2 2
North FDN Strip
1 1 1
CP Crew
Rod Crew
Conc Crew
Labor Crew
Physical
East FDN Form
5 6 8
East FDN Rebar
1 2 3
East FDN Pour
1 1 2
East FDN Cure
FS 2 2 2
East FDN Strip
1 1 1
Forms #1
South FDN Form
5 6 8
South FDN Rebar
1 2 3
South FDN Pour
1 1 2
South FDN Cure
FS 2 2 2
South FDN Strip
1 1 1
Forms #2
West FDN Form
5 6 8
West FDN Rebar
1 2 3
West FDN Pour
1 1 2
West FDN Cure
FS 2 2 2
West FDN Strip
1 1 1
Foundation Backfill
1 2 3

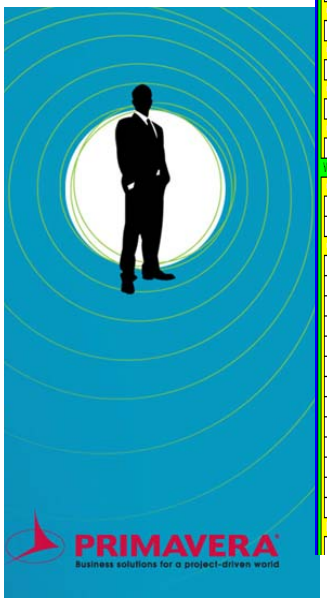
Industry Adoption

RDM is now in Primavera's Pertmaster v8.2



Hailey Burton Cartwright Construction Company v. Macaw Casino Company

Activity ID	Activity Description	Orig Dur	BOD	MOD	RESP	LOC1	LOC2	Early Start	Early Finish
Macau Casinos Inc									
Site									
Site									
10	SiteG0 Notice to Proceed	0	0	0	O	S	G0	30MAY05	
Cartwright Construction Inc									
Site									
Site									
1000	SiteG0 Mobilize	10	10	10	C	S	G0	30MAY05	10JUN05
9990	SiteG0 Residential Building Punchlist	10	10	10	C	S	G0	19JUN06	30JUN06
Garage Street									
1100	SiteGS Clear & Rough Grade at Elev 0+00	10	10	13	C	S	GS	13JUN05	24JUN05
1105	SiteGS Survey & Layout at Elev 0+00	10	10	13	C	S	GS	27JUN05	08JUL05
1220	SiteGS Form/Pour Slab Street Level	6	6	8	C	S	GS	21OCT05	28OCT05
1225	SiteGS Form/Pour Stair Towers GS-CL	10	10	13	C	S	GS	31OCT05	11NOV05
Garage Level 2									
1215	SiteG2 Form/Pour Slab	6	6	8	C	S	G2	13OCT05	20OCT05
Garage Level 3									
1210	SiteG3 Form/Pour Slab	6	6	8	C	S	G3	05OCT05	12OCT05
Garage Level 4									
1205	SiteG4 Form/Pour Slab	6	6	8	C	S	G4	27SEP05	04OCT05
Garage Level 5									
1200	SiteG5 Form/Pour Slab	6	6	8	C	S	G5	19SEP05	26SEP05
West Tower									
Garage Street									
1110	WestGS Form/Pour Footers	10	10	13	C	W	GS	11JUL05	22JUL05
1115	WestGS Erect, Bolt, Plumb Steel to Elev 77	20	20	26	C	W	GS	25JUL05	19AUG05
Casino & Lobby Level									
1120	WestCL Form/Pour Slab @ Casino Level	10	10	13	C	W	CL	22AUG05	02SEP05
1125	WestCL Erect, Bolt, Plumb Steel to Elev 227	20	20	26	C	W	CL	05SEP05	30SEP05
10100	WestCL Layout Floor	1	1	2	C	W	CL	20APR06	20APR06
10105	WestCL Studs & Drywall/1	2	2	3	C	W	CL	22MAY06	23MAY06
10110	WestCL R/I Plumbing	2	2	3	C	W	CL	22MAY06	23MAY06
10115	WestCL HVAC Ductwork	2	2	3	C	W	CL	22MAY06	23MAY06
10120	WestCL R/I Electric	2	2	3	C	W	CL	24MAY06	25MAY06
10125	WestCL Plumbing Test	1	1	2	C	W	CL	24MAY06	24MAY06
10130	WestCL Drywall/2 & Finishes	2	2	3	C	W	CL	26MAY06	29MAY06
10135	WestCL Electric Fixtures	2	2	3	C	W	CL	30MAY06	31MAY06
10140	WestCL Plumbing Fixtures	2	2	3	C	W	CL	30MAY06	31MAY06
10145	WestCL HVAC Fixtures	1	1	2	C	W	CL	30MAY06	30MAY06
10150	WestCL Paint & Carpeting	2	2	3	C	W	CL	01JUN06	02JUN06
Residential Level 02									
1335	West02 Form/Pour Slab	4	4	5	C	W	02	24NOV05	29NOV05



Pertmaster Risk Expert - [C:\... \RDM Pertmaster\CMAP.plan - Gantt Chart*]

File Edit View Insert Format Plan Risk Reports Tools Window Help

ID	Description	Rem Duration	Start	Finish	Minimum Duration	Most Likely	Maximum Duration	Task Existence %
10	SiteG0 Notice to Proceed	0	30/May/05					
1000	SiteG0 Mobilize	10	30/May/05	10/Jun/05	8	10	13	
1100	SiteGS Clear & Rough Grade at Elev 0+00	13	13/Jun/05	29/Jun/05	8	10	13	
1105	SiteGS Survey & Layout at Elev 0+00	13	30/Jun/05	18/Jul/05	8	10	13	
1110	WestGS Form/Pour Footers	13	19/Jul/05	04/Aug/05	8	10	13	
1115	WestGS Erect, Bolt, Plumb Steel to Elev 77	26	05/Aug/05	09/Sep/05	17	20	26	
1120	WestCL Form/Pour Slab @ Casino Level	13	12/Sep/05	28/Sep/05	8	10	13	
1125	WestCL Erect, Bolt, Plumb Steel to Elev 227	26	29/Sep/05	03/Nov/05	17	20	26	
1130	West10 Form/Pour Slab @ Elev 227	13	04/Nov/05	22/Nov/05	8	10	13	
1135	West10 Erect, Bolt, Plumb Steel to Elev 417	26	23/Nov/05	28/Dec/05	17	20	26	
1140	WestRF Form/Pour Slab @ Elev 417	13	29/Dec/05	16/Jan/06	8	10	13	
1150	WestRF Roofing	13	17/Jan/06	02/Feb/06	8	10	13	
1200	SiteG5 Form/Pour Slab	8	18/Oct/05	27/Oct/05	5	6	8	
1205	SiteG4 Form/Pour Slab	8	28/Oct/05	08/Nov/05	5	6	8	
1210	SiteG3 Form/Pour Slab	8	09/Nov/05	18/Nov/05	5	6	8	
1215	SiteG2 Form/Pour Slab	8	21/Nov/05	30/Nov/05	5	6	8	
1220	SiteGS Form/Pour Slab Street Level	8	01/Dec/05	12/Dec/05	5	6	8	

30 May 05

what's new on the screen?
restraints have different colors
two late start/finish bars
reference to link category
reference to ignore link

Gantt Chart | Logic Trace | Uncertainty | Risk Outputs | Gantt and Graph | Gantt and Sheet | Import Check

Task Details

<< >> ID: 1140 Description: WestRF Form/Pour Slab @ Elev 417

General | Dates | Constraints | Links | Resources | Costs | Risk and Uncertainty | User Fields | Splits

Original Duration: 13
Rem Duration: 13
% Complete: 0% Define...
Can stretch: Default

Calendar: Cal1
Type: Normal
Priority: 50

WBS:
OBS:
Comment:

Ready

Finish : 01/Nov/06

Gantt Chart | Logic Trace | Uncertainty | Risk Outputs | Gantt and Graph | Gantt and Sheet | Import Check

Task Details

<< >> ID: 1140 Description: WestRF Form/Pour Slab @ Elev 417

General | Dates | Constraints | Links | Resources | Costs | Risk and Uncertainty | User Fields

Predecessors

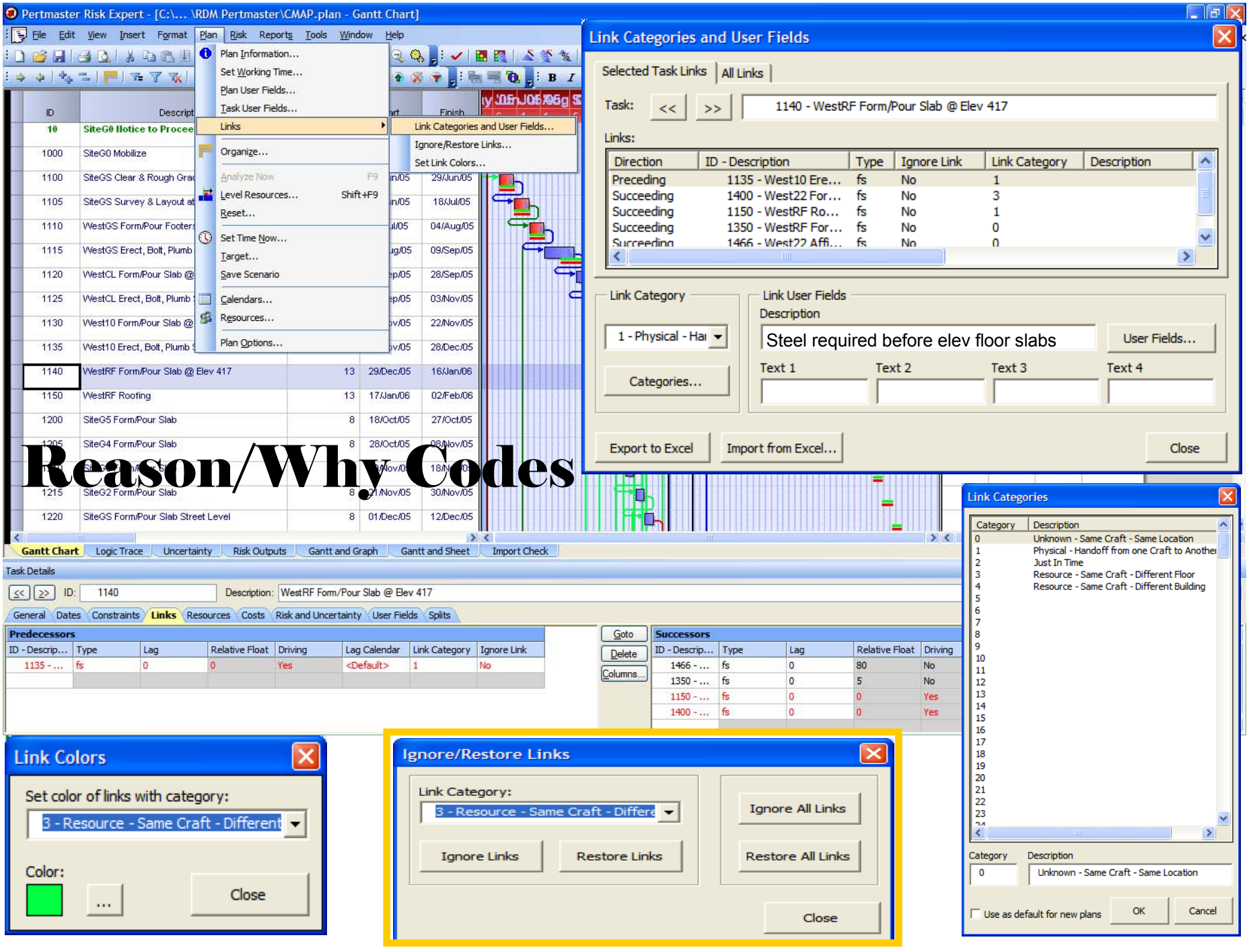
ID - Descrip...	Type	Lag	Relative Float	Driving	Lag Calendar	Link Category	Ignore Link
1135 - ...	fs	0	0	Yes	<Default>	1	No

Goto
Delete
Columns...

Successors

ID - Descrip...	Type	Lag	Relative Float	Driving	Lag Calendar	Link Category	Ignore Link
1466 - ...	fs	0	80	No	<Default>	0	No
1350 - ...	fs	0	5	No	<Default>	0	No
1150 - ...	fs	0	0	Yes	<Default>	1	No
1400 - ...	fs	0	0	Yes	<Default>	3	No

Ready | Filter: None | Sort: ID | Actual: $0 | Remaining: $0 | Total: $0 | Plan Finish : 01/Nov/06


Pertmaster Risk Expert - [C:\... \RDM Pertmaster\CMAP.plan - Gantt Chart]
File Edit View Insert Format Plan Risk Reports Tools Window Help
Plan Information...
Set Working Time...
Plan User Fields...
Task User Fields...
Links
Organize...
Analyze Now F9
Level Resources... Shift+F9
Reset...
Set Time Now...
Target...
Save Scenario
Calendars...
Resources...
Plan Options...
Link Categories and User Fields...
Ignore/Restore Links...
Set Link Colors...
Link Categories and User Fields
Selected Task Links
All Links
Task: << >> 1140 - WestRF Form/Pour Slab @ Elev 417
Links:
Direction | ID - Description | Type | Ignore Link | Link Category | Description
Preceding | 1135 - West10 Ere... | fs | No | 1
Succeeding | 1400 - West22 For... | fs | No | 3
Succeeding | 1150 - WestRF Ro... | fs | No | 1
Succeeding | 1350 - WestRF For... | fs | No | 0
Link Category
1 - Physical - Ha
Categories...
Link User Fields
Description
Steel required before elev floor slabs
User Fields...
Text 1
Text 2
Text 3
Text 4
Export to Excel
Import from Excel...
Close
Reason/Why Codes
Gantt Chart
Logic Trace
Uncertainty
Risk Outputs
Gantt and Graph
Gantt and Sheet
Import Check
Task Details
ID: 1140
Description: WestRF Form/Pour Slab @ Elev 417
General
Dates
Constraints
Links
Resources
Costs
Risk and Uncertainty
User Fields
Splits
Predecessors
ID - Descrip... | Type | Lag | Relative Float | Driving | Lag Calendar | Link Category | Ignore Link
1135 - ... | fs | 0 | 0 | Yes | <Default> | 1 | No
Goto
Delete
Columns...
Successors
ID - Descrip... | Type | Lag | Relative Float | Driving
1466 - ... | fs | 0 | 80 | No
1350 - ... | fs | 0 | 5 | No
1150 - ... | fs | 0 | 0 | Yes
1400 - ... | fs | 0 | 0 | Yes
Link Colors
Set color of links with category:
3 - Resource - Same Craft - Different
Color:
...
Close
Ignore/Restore Links
Link Category:
3 - Resource - Same Craft - Differe
Ignore Links
Restore Links
Ignore All Links
Restore All Links
Close
Link Categories
Category | Description
0 Unknown - Same Craft - Same Location
1 Physical - Handoff from one Craft to Another
2 Just In Time
3 Resource - Same Craft - Different Floor
4 Resource - Same Craft - Different Building
Category 0
Description Unknown - Same Craft - Same Location
Use as default for new plans
OK
Cancel

Relationship Codes

Pertmaster Risk Expert - [C:\... \RDM Pertmaster\CMAP.plan - Gantt Chart]

File Edit View Insert Format Plan Risk Reports Tools Window Help

ID	Description	Rem Duration	Start	Finish	Just In Time Finish	Late Finish	Minimum Duration	Most Likely	Maximum Duration	Task Existence %
10	SiteG0 Notice to Proceed	0	30/May/05		27/May/05					
1000	SiteG0 Mobilize	10	30/May/05	10/Jun/05	10/Jun/05	10/Jun/05	8	10	13	
1100	SiteGS Clear & Rough Grade at Elev 0+00	13	13/Jun/05	29/Jun/05	29/Jun/05	29/Jun/05	8	10	13	
1105	SiteGS Survey & Layout at Elev 0+00	13	30/Jun/05	18/Jul/05	18/Jul/05	18/Jul/05	8	10	13	
1110	WestGS Form/Pour Footers	13	19/Jul/05	04/Aug/05	04/Aug/05	04/Aug/05	8	10	13	
1115	WestGS Erect, Bolt, Plumb Steel to Elev 77	26	05/Aug/05	09/Sep/05	28/Sep/05	28/Sep/05	17	20	26	
1120	WestCL Form/Pour Slab @ Casino Level	13	12/Sep/05	28/Sep/05	17/Oct/05	17/Oct/05	8	10	13	
1125	WestCL Erect, Bolt, Plumb Steel to Elev 227	26	29/Sep/05	03/Nov/05	22/Nov/05	22/Nov/05	17	20	26	
1130	West10 Form/Pour Slab @ Elev 227	13	04/Nov/05	22/Nov/05	09/Dec/05	09/Dec/05	8	10	13	
1135	West10 Erect, Bolt, Plumb Steel to Elev 417	26	23/Nov/05	28/Dec/05	16/Jan/06	16/Jan/06	17	20	26	
1140	WestRF Form/Pour Slab @ Elev 417	13	29/Dec/05	16/Jan/06	02/Feb/06	02/Feb/06	8	10	13	
1150	WestRF Roofing	13	17/Jan/06	02/Feb/06	28/Jun/06	28/Jun/06	8	10	13	
1200	SiteG5 Form/Pour Slab	8	18/Oct/05	27/Oct/05	16/Aug/06	16/Aug/06	5	6	8	
1205	SiteG4 Form/Pour Slab	8	28/Oct/05	08/Nov/05	28/Aug/06	28/Aug/06	5	6	8	

Gantt Chart | Logic Trace | Uncertainty | Risk Outputs | Gantt and Graph | Gantt and Sheet

Task Details

<< >> ID: 1130 Description: West10 Form/Pour Slab @ Elev 227

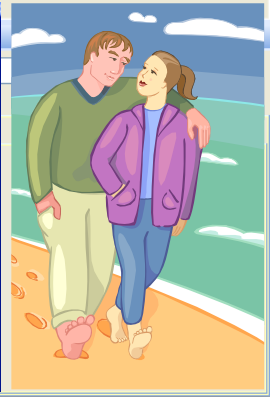
General | Dates | Constraints | Links | Resources | Costs | Risk and Uncertainty | User Fields | Splits

Dates | Durations | Costs | Numbers | Text | Codes | Notes

	Codes
RESP	C - Cartwright Construction Inc
SUBC	
CRSZ	10
CRTY	CP
SHT1	
SHT2	
LOC1	W - West Tower
LOC2	10
CRIT	

Link Categories

Category	Description
0	Unknown - Same Craft - Same Location
1	Physical - Handoff from one Craft to Another
2	Just In Time
3	Resource - Same Craft - Different Floor
4	Resource - Same Craft - Different Building
5	



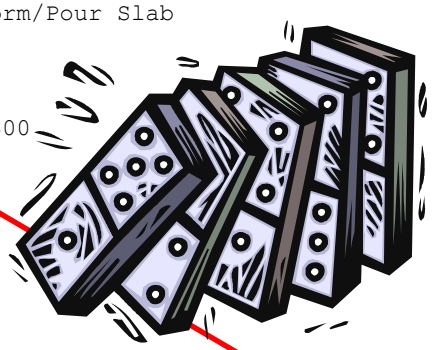
Ready | Filter: None | Sort: ID | Actual: $0 | Remaining: $0 | Total: $0 | Plan Finish : 01/Nov/06

Relationship Codes

```
A           10 - SiteG0 Notice to Proceed
B           1000 - SiteG0 Mobilize
C           fs
D           No
LINKTYPE    0
LINKTITLE   10[fs]       1000
G
H
I
J
K
ACT                10
SUC              1000
ACRTY
SCRTY
ALOC1       S
SLOC1       S
ALOC2       G0
SLOC2       G0

EDIT          ‖<C:>‖TRIAL07P              ‖Rec: 1/1081
```

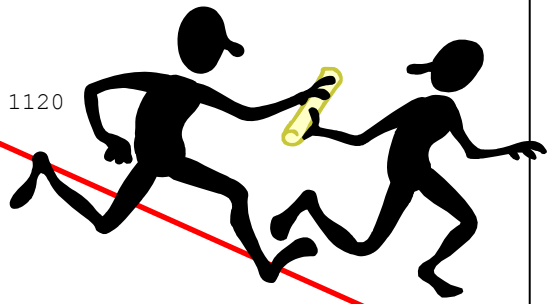
unknown craft – unknown reason/why

```
A           1130 - West10 Form/Pour Slab @ Elev 227
B           1300 - West09 Form/Pour Slab
C           fs
D           No
LINKTYPE    3
LINKTITLE   1130[fs]       1300
G
H
I
J
K
ACT              1130
SUC              1300
ACRTY       CP
SCRTY       CP
ALOC1       W
SLOC1       W
ALOC2       10
SLOC2       09

EDIT          ‖<C:>‖TRIAL07P              ‖Rec: 15/1081
```



same crew – different floor

```
A           1115 - WestGS Erect, Bolt, Plumb Steel to Elev 77
B           1120 - WestCL Form/Pour Slab @ Casino Level
C           fs
D           No
LINKTYPE    1
LINKTITLE   1115[fs]       1120
G
H
I
J
K
ACT              1115
SUC              1120
ACRTY       IW
SCRTY       CP
ALOC1       W
SLOC1       W
ALOC2       GS
SLOC2       CL

EDIT          ‖<C:>‖TRIAL07P              ‖Rec: 7/1081
```



change craft – physical reason/why

```
A           1110 - WestGS Form/Pour Footers
B           2110 - EastGS Form/Pour Footers
C           fs
D           No
LINKTYPE    4
LINKTITLE   1110[fs]       2110
G
H
I
J
K
ACT              1110
SUC              2110
ACRTY       CP
SCRTY       CP
ALOC1       W
SLOC1       E
ALOC2       GS
SLOC2       GS

EDIT          ‖<C:>‖TRIAL07P              ‖Rec: 6/1081
```

same crew – different building

Who asked for RDM?

THE CONSTRUCTION WEEKLY

ENR
Engineering News-Record

► **LEGISLATION:** Bush administration's $247-billion 'SAFETEA' transportation bill lays foundation for funding debate

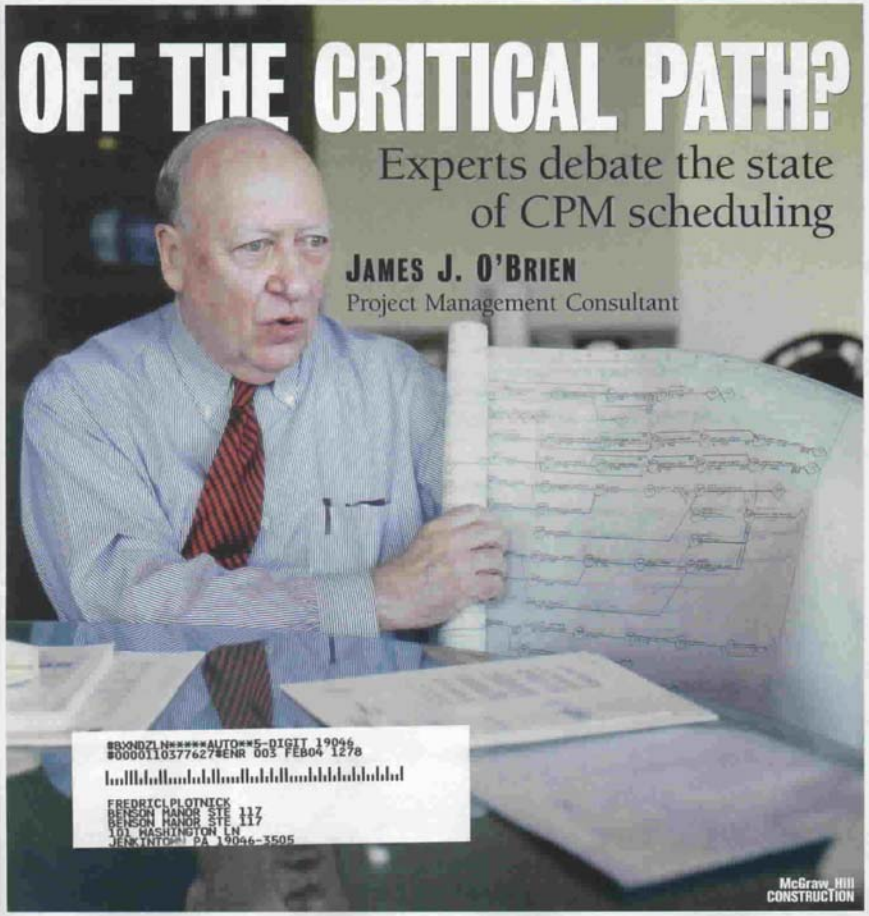
► **RESEARCH:** Costs for large transportation projects escalate 5% per year

enr.com The McGraw-Hill Companies May 26, 2003 $5

OFF THE CRITICAL PATH?

Experts debate the state of CPM scheduling

JAMES J. O'BRIEN
Project Management Consultant



#BXNDZLN*****AUTO**5-DIGIT 19046
#0000110377627#ENR 003 FEB04 1278
FREDRICLPLOTNICK
BENSON MANOR STE 117
BENSON MANOR STE 117
101 WASHINGTON LN
JENKINTOWN PA 19046-3505

Critics Can't Find the Logic in Many of Today's CPM Schedules

Users want software with flexibility, but is it true CPM?

Four scheduling experts, all deeply experienced in the critical path method (CPM) that uses math to draw network diagrams of a project schedule, met recently in a restaurant just outside Philadelphia. The purpose was to discuss a new unit at the Project Management Institute, in Newtown Square, Pa. The College of Scheduling they have launched would promote "the fundamentals of project management" and encourage "a free exchange of ideas."

One of the reasons for starting the college is disconcerting. What is described as a CPM schedule these days sometimes isn't one at all, the four experts claim. If that claim is true, it says a lot about how personal computers have transformed scheduling and what could be in store as technology reshapes other phases of the construction process.

PHOTOS BY MICHAEL OCKMAN FOR ENR; GRAPHIC CENTER BY GUY LAWRENCE AND NANCY ROLLIARD FOR ENR

ALARMED Wickwire (left, above), Ockman and Plotnick see a scheduling crisis.

At the meeting, the four experts lamented the state of scheduling. They say they see widespread abuses of powerful software to produce badly flawed or deliberately deceptive schedules that look good but lack mathematical coherence or common sense about the way the industry works. The result is confusion, delayed projects and lawsuits.

How did this happen? PCs have popularized and democratized CPM schedule writing, which first took hold in construction in the early 1960s, but it has also put scheduling in the hands of many inexperienced and poorly trained practitioners. When they do the work, critics say the basic principals of CPM are sometimes neglected or watered down.

The four men, three of whom are directors of PMI's College of Scheduling, reserved some of their most pointed comments for Primavera Systems Inc., the Bala Cynwyd, Pa.-based company that is the dominant supplier of construction project management and scheduling software. The four men say Primavera puts features in its popular scheduling programs that provide flexibility but are open to abuse.

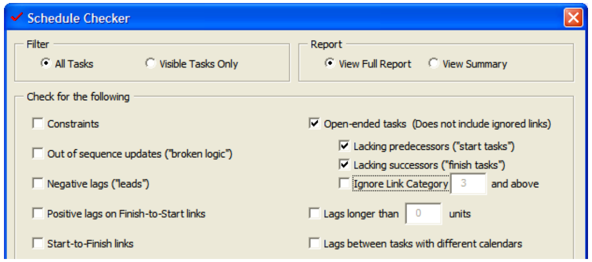
Primavera's headquarters is about 10 miles from where the meeting took place and its president, Richard K. Faris, is active in industry affairs and is a board member of the new College of Scheduling. Significantly, he had not been invited to the

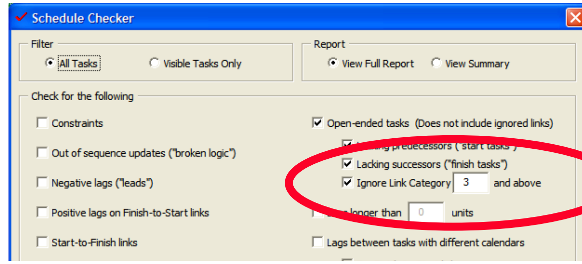
NEW WAY OVERSHADOWS OLD

Arrow Diagramming Method (ADM)

A once-popular but disappearing method of representing project activities with arrows, with a node shown as a circle, representing events at the ends of the arrows. The tail of the arrow is the beginning and the head represents the completion. While it is less flexible than PDM, it has the advantage of defining the logical relationships between activities entirely by the activity numbers.

Who asked for RDM? – You Did!!!





Pertmaster *Project Analytics*

Pertmaster Schedule Check Report

Plan Summary

Title			
File name	C:\cdata\FREE-ENG\PMI\gmicos\0EMAY\RDM Pertmaster\CMAP.plan		
Plan finish date	11/1/2006 5:00:00 PM	Tasks with no progress	575
Plan remaining duration	521	In progress tasks	0
Normal tasks	574	Completed tasks	0
Summary tasks	0	Total tasks	575
Milestone tasks	1	Resource assignments	567
Hammock tasks	0	Budget cost	$0
Monitor tasks	0	Remaining cost	$0
Calendars	4	Actual cost	$0
Links	1099	Total cost	$0
Resources	12		

Report Summary

Task view	All tasks
Constraints	Not checked
Open-ended tasks (Does not include ignored links)	2
Out of sequence updates ("broken logic")	Not checked
Lags longer than 0 units	Not checked
Negative lags ("leads")	Not checked
Positive lags on Finish-to-Start links	Not checked
Start-to-Finish links	Not checked
Lags between tasks with different calendars	Not checked
Links to / from summary tasks	Not checked
Duration uncertainty distribution shape 2	Not checked
Total number of items found	2

2

Open-ended tasks (Does not include ignored links)

Options selected: Predecessors, Successors

For a schedule risk analysis to be meaningful, it is important that tasks' dates are set by logic (e.g. Finish-to-Start links) rather than constraints. This is so that the risk analysis will recognize the knock-on effect of delays. An open-ended task is one that does not have at least one predecessor and one successor – it indicates a possible lack of logic. Consider closing open-ended tasks:
• If a task has no predecessor, try to find some other tasks which could potentially delay it. Leave it as open-ended if it is the project start milestone.
• If a task has no successors, try to find some other tasks which it could potentially delay. Leave it as open-ended if it is a project finish or reporting milestone.

ID	Description	Type	Remaining Duration	Detail
10	SiteG0 Notice to Proceed	Start milestone	0	No predecessors
9990	SiteG0 Residential Building Punchlist	Normal	10	No successors

Pertmaster *Project Analytics*

Pertmaster Schedule Check Report

Plan Summary

Title			
File name	C:\cdata\FREE-ENG\PMI\gmicos\0EMAY\RDM Pertmaster\CMAP.plan		
Plan finish date	11/1/2006 5:00:00 PM	Tasks with no progress	575
Plan remaining duration	521	In progress tasks	0
Normal tasks	574	Completed tasks	0
Summary tasks	0	Total tasks	575
Milestone tasks	1	Resource assignments	567
Hammock tasks	0	Budget cost	$0
Monitor tasks	0	Remaining cost	$0
Calendars	4	Actual cost	$0
Links	1099	Total cost	$0
Resources	12		

Report Summary

Task view	All tasks
Constraints	Not checked
Open-ended tasks (Does not include ignored links)	59
Out of sequence updates ("broken logic")	Not checked
Lags longer than 0 units	Not checked
Negative lags ("leads")	Not checked
Positive lags on Finish-to-Start links	Not checked
Start-to-Finish links	Not checked
Lags between tasks with different calendars	Not checked
Links to / from summary tasks	Not checked
Duration uncertainty distribution shape 2	Not checked
Total number of items found	59

59

Open-ended tasks (Does not include ignored links)

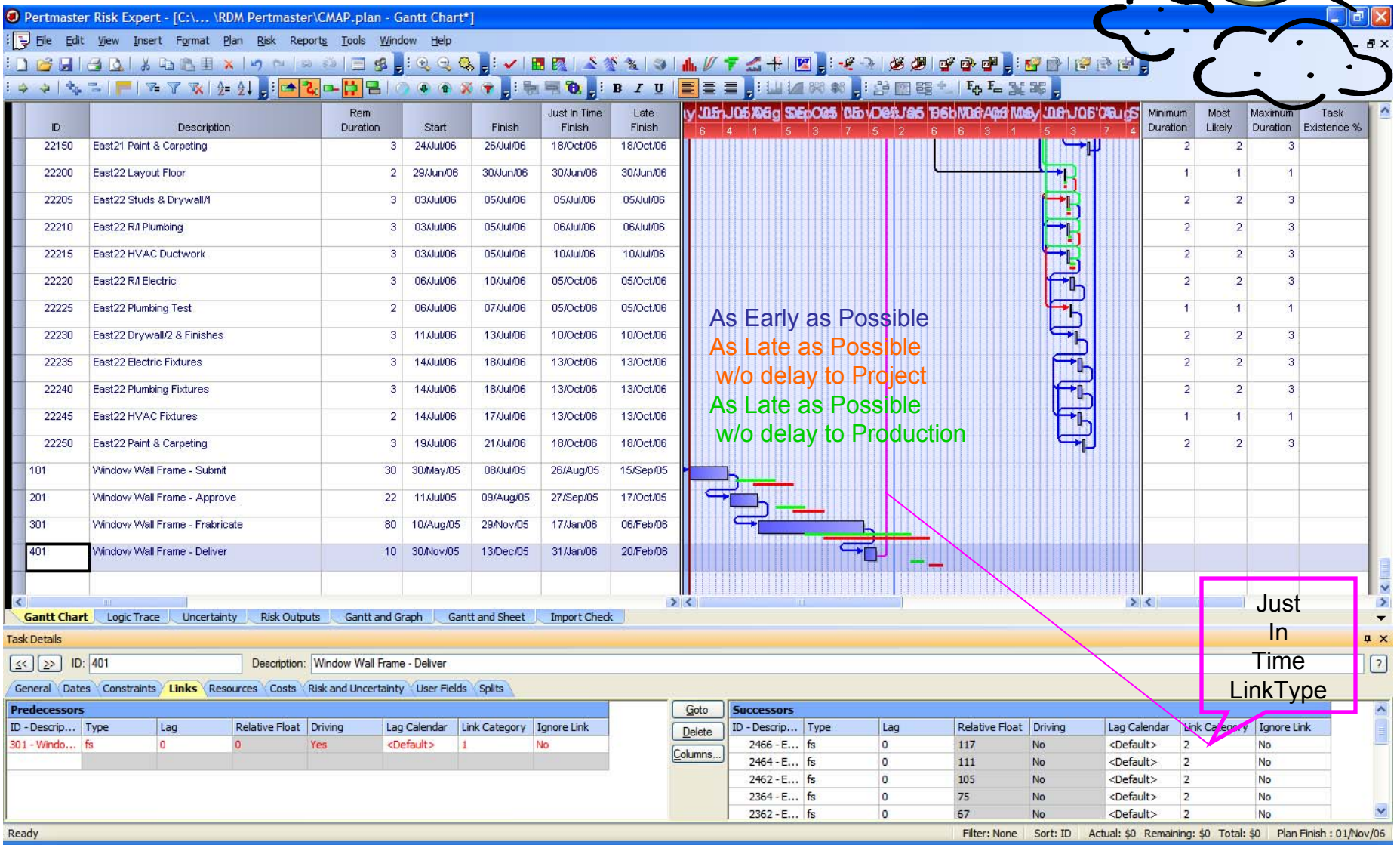
Options selected: Predecessors, Successors

For a schedule risk analysis to be meaningful, it is important that tasks' dates are set by logic (e.g. Finish-to-Start links) rather than constraints. This is so that the risk analysis will recognize the knock-on effect of delays. An open-ended task is one that does not have at least one predecessor and one successor – it indicates a possible lack of logic. Consider closing open-ended tasks:
• If a task has no predecessor, try to find some other tasks which could potentially delay it. Leave it as open-ended if it is the project start milestone.
• If a task has no successors, try to find some other tasks which it could potentially delay. Leave it as open-ended if it is a project finish or reporting milestone.

ID	Description	Type	Remaining Duration	Detail
10	SiteG0 Notice to Proceed	Start milestone	0	No predecessors
1000	SiteG0 Mobilize	Normal	10	Finish has no successors
1100	SiteG5 Clear & Rough Grade at Elev 0-400	Normal	13	Start has no predecessors
1105	SiteG5 Survey & Layout at Elev 0-400	Normal	13	Finish has no successors
1110	WestG5 Form/Pour Footers	Normal	13	Start has no predecessors
1200	SiteG5 Form/Pour Slab	Normal	8	Finish has no successors
1200	SiteG5 Form/Pour Slab	Normal	8	Start has no predecessors

1205	SiteG4 Form/Pour Slab	Normal	8	Finish has no successors
1205	SiteG4 Form/Pour Slab	Normal	8	Start has no predecessors
1210	SiteG3 Form/Pour Slab	Normal	8	Finish has no successors
1210	SiteG3 Form/Pour Slab	Normal	8	Start has no predecessors
1215	SiteG2 Form/Pour Slab	Normal	8	Finish has no successors
1215	SiteG2 Form/Pour Slab	Normal	8	Start has no predecessors
1220	SiteG5 Form/Pour Slab Street Level	Normal	8	Start has no predecessors
1300	West09 Form/Pour Slab	Normal	5	Start has no predecessors
1305	West08 Form/Pour Slab	Normal	5	Start has no predecessors
1310	West07 Form/Pour Slab	Normal	5	Start has no predecessors
1315	West06 Form/Pour Slab	Normal	5	Start has no predecessors
1320	West05 Form/Pour Slab	Normal	5	Start has no predecessors
1325	West04 Form/Pour Slab	Normal	5	Start has no predecessors
1330	West03 Form/Pour Slab	Normal	5	Start has no predecessors
1335	West02 Form/Pour Slab	Normal	5	Start has no predecessors
2402	East21 Form/Pour Slab	Normal	5	Start has no predecessors
1400	West22 Form/Pour Slab	Normal	5	Start has no predecessors
1405	West19 Form/Pour Slab	Normal	5	Start has no predecessors
1410	West18 Form/Pour Slab	Normal	5	Start has no predecessors
1415	West17 Form/Pour Slab	Normal	5	Start has no predecessors
1420	West16 Form/Pour Slab	Normal	5	Start has no predecessors
1425	West15 Form/Pour Slab	Normal	5	Start has no predecessors
1402	West21 Form/Pour Slab	Normal	5	Start has no predecessors
1430	West14 Form/Pour Slab	Normal	5	Start has no predecessors
1435	West13 Form/Pour Slab	Normal	5	Start has no predecessors
1440	West12 Form/Pour Slab	Normal	5	Start has no predecessors
1445	West11 Form/Pour Slab	Normal	5	Start has no predecessors
9990	SiteG0 Residential Building Punchlist	Normal	10	No successors
1350	WestRF Form/Pour Stair Tower Floors 11-RF	Normal	13	Finish has no successors
2110	EastG5 Form/Pour Footers	Normal	13	Start has no predecessors
1340	West10 Form/Pour Stair Tower Floors 1-10	Normal	13	Finish has no successors
2300	East09 Form/Pour Slab	Normal	5	Start has no predecessors
2305	East08 Form/Pour Slab	Normal	5	Start has no predecessors
2310	East07 Form/Pour Slab	Normal	5	Start has no predecessors
2315	East06 Form/Pour Slab	Normal	5	Start has no predecessors
2320	East05 Form/Pour Slab	Normal	5	Start has no predecessors
2325	East04 Form/Pour Slab	Normal	5	Start has no predecessors
2330	East03 Form/Pour Slab	Normal	5	Start has no predecessors
2335	East02 Form/Pour Slab	Normal	5	Start has no predecessors
1404	West20 Form/Pour Slab	Normal	5	Start has no predecessors
2340	East10 Form/Pour Stair Tower Floors 1-10	Normal	13	Finish has no successors
2400	East22 Form/Pour Slab	Normal	5	Start has no predecessors
2405	East19 Form/Pour Slab	Normal	5	Start has no predecessors
2410	East18 Form/Pour Slab	Normal	5	Start has no predecessors
2415	East17 Form/Pour Slab	Normal	5	Start has no predecessors
2420	East16 Form/Pour Slab	Normal	5	Start has no predecessors
2425	East15 Form/Pour Slab	Normal	5	Start has no predecessors
2430	East14 Form/Pour Slab	Normal	5	Start has no predecessors
2435	East13 Form/Pour Slab	Normal	5	Start has no predecessors
2440	East12 Form/Pour Slab	Normal	5	Start has no predecessors
2445	East11 Form/Pour Slab	Normal	5	Start has no predecessors
2404	East20 Form/Pour Slab	Normal	5	Start has no predecessors

Just-in-Time Date & Float Attribute

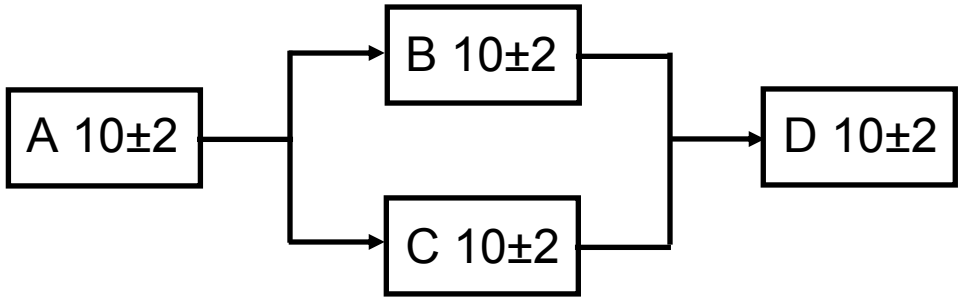


How accurate is the CPM calculation? Risk and Monte Carlo Simulation

A 10±2
B 10±2
C 10±2
D 10±2

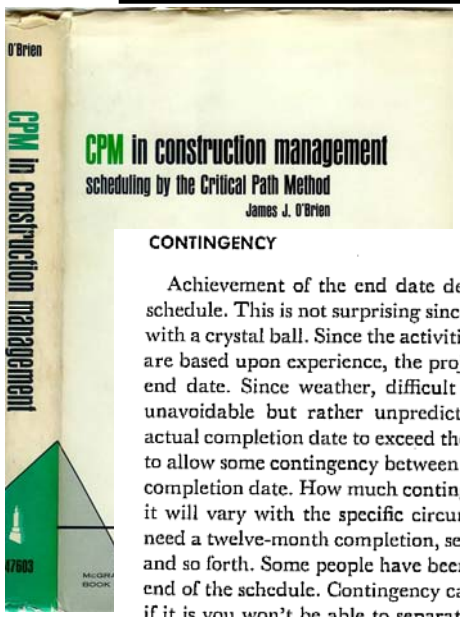
≈ 40

Estimating



Scheduling

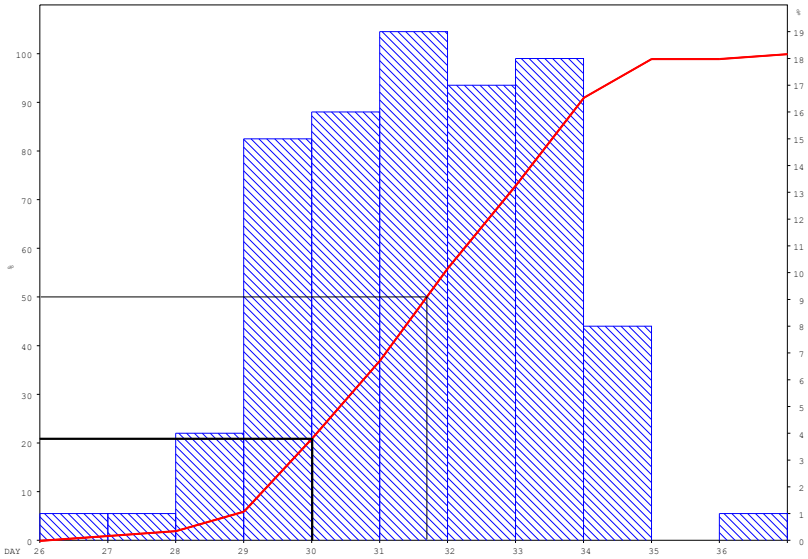
Project Duration ≈ 31⅔



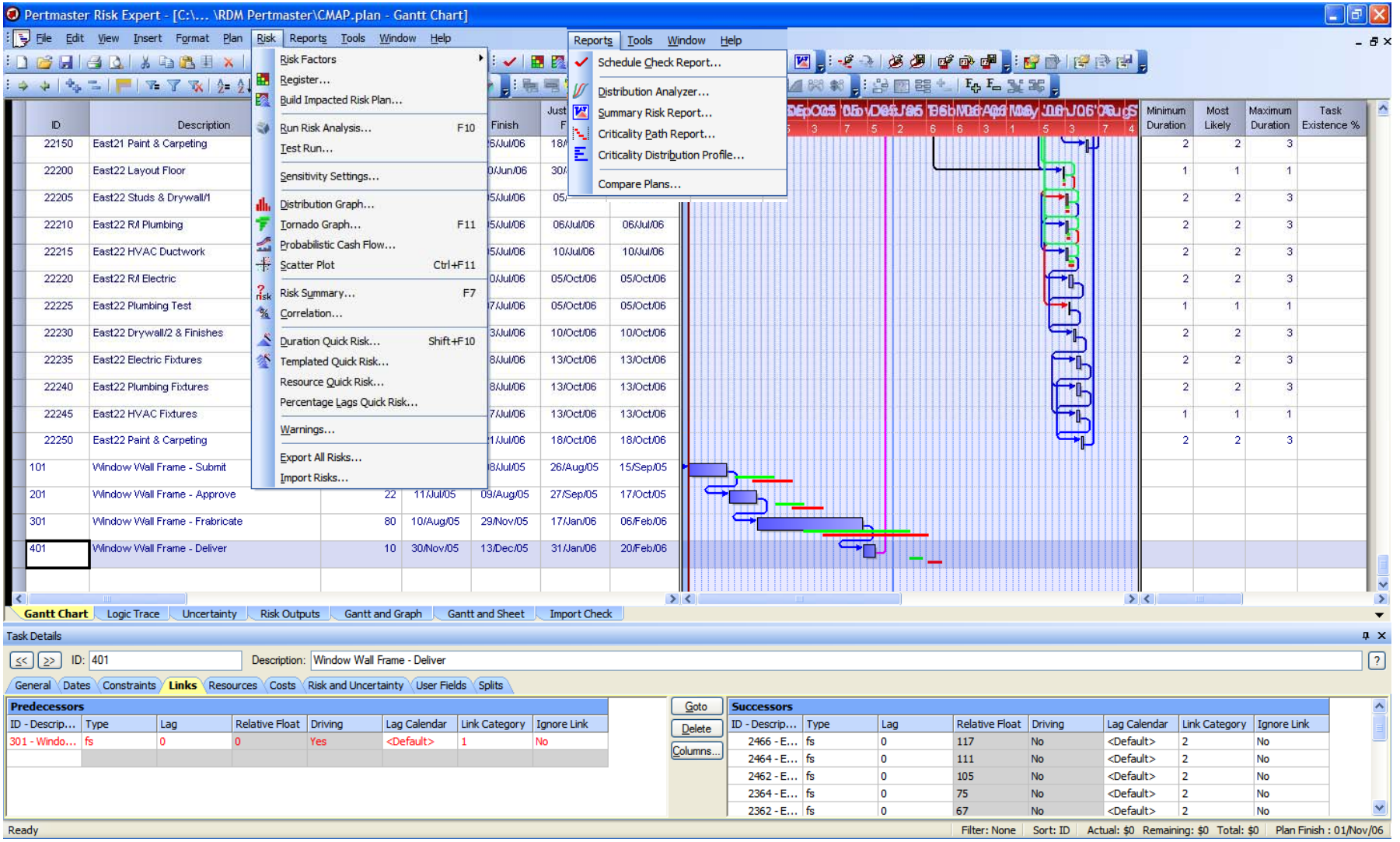
CONTINGENCY

Achievement of the end date desired is unfortunately not an acceptable schedule. This is not surprising since we know that CPM has not furnished us with a crystal ball. Since the activities and times estimates used in the network are based upon experience, the project rarely finishes ahead of the computed end date. Since weather, difficult site conditions, labor disputes, etc., are unavoidable but rather unpredictable, there a definite tendency for the actual completion date to exceed the first CPM end date. It is then reasonable to allow some contingency between the CPM end date and the actual desired completion date. How much contingency? There is no definite answer to this; it will vary with the specific circumstances of the project. However, if you need a twelve-month completion, set your CPM goal at about eleven months, and so forth. Some people have been reluctant to set a flat contingency at the end of the schedule. Contingency can be buried in the activity estimates, but if it is you won't be able to separate true estimates from contingency.

Excerpt from page 142 of CPM in Construction Management



Risk Analysis Features of Pertmaster v8.5



Risk Analysis – 1000 Iterations

Pertmaster Criticality Distribution Report

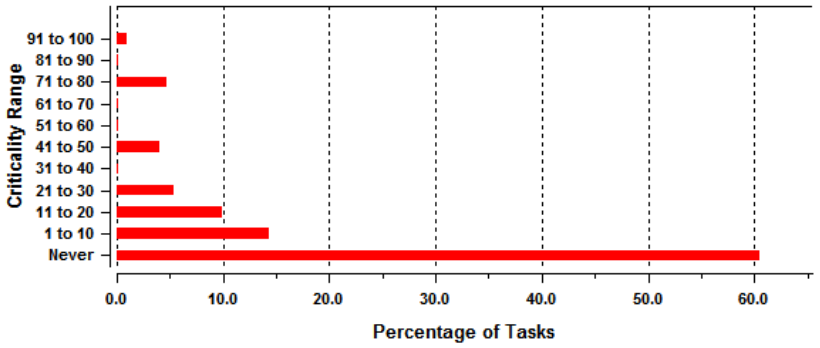
Pertmaster Report - Criticality Distribution Profile

Title:

Path: C:\edata\FREE-ENG\PM\pmicos\08MAY\RDM Pertmaster\CMAP.plan

Number of incomplete normal tasks	574
Number of Critical Tasks	227
Percentage of Tasks Critical	39.55%

Criticality Range	Number of Tasks	Relative Percentage
Never	347	60%
1 to 10	82	14%
11 to 20	57	10%
21 to 30	31	5%
31 to 40	0	0%
41 to 50	23	4%
51 to 60	1	0%
61 to 70	1	0%
71 to 80	27	5%
81 to 90	0	0%
91 to 100	5	1%
TOTAL	574	100%



Close

Risk Analysis Options

General

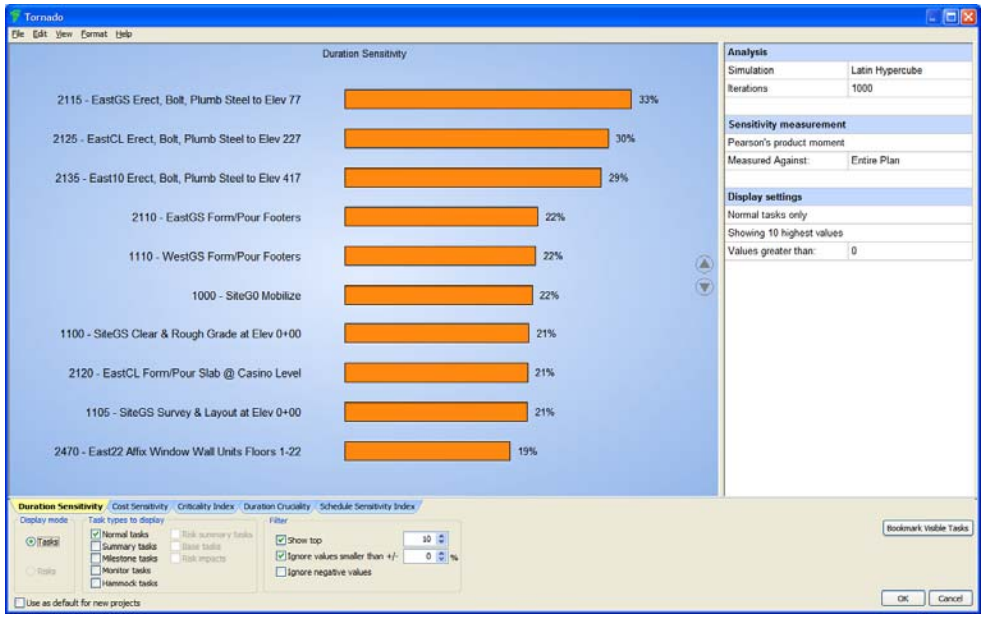
Analyze for 1000 iterations.

Show step through analysis options

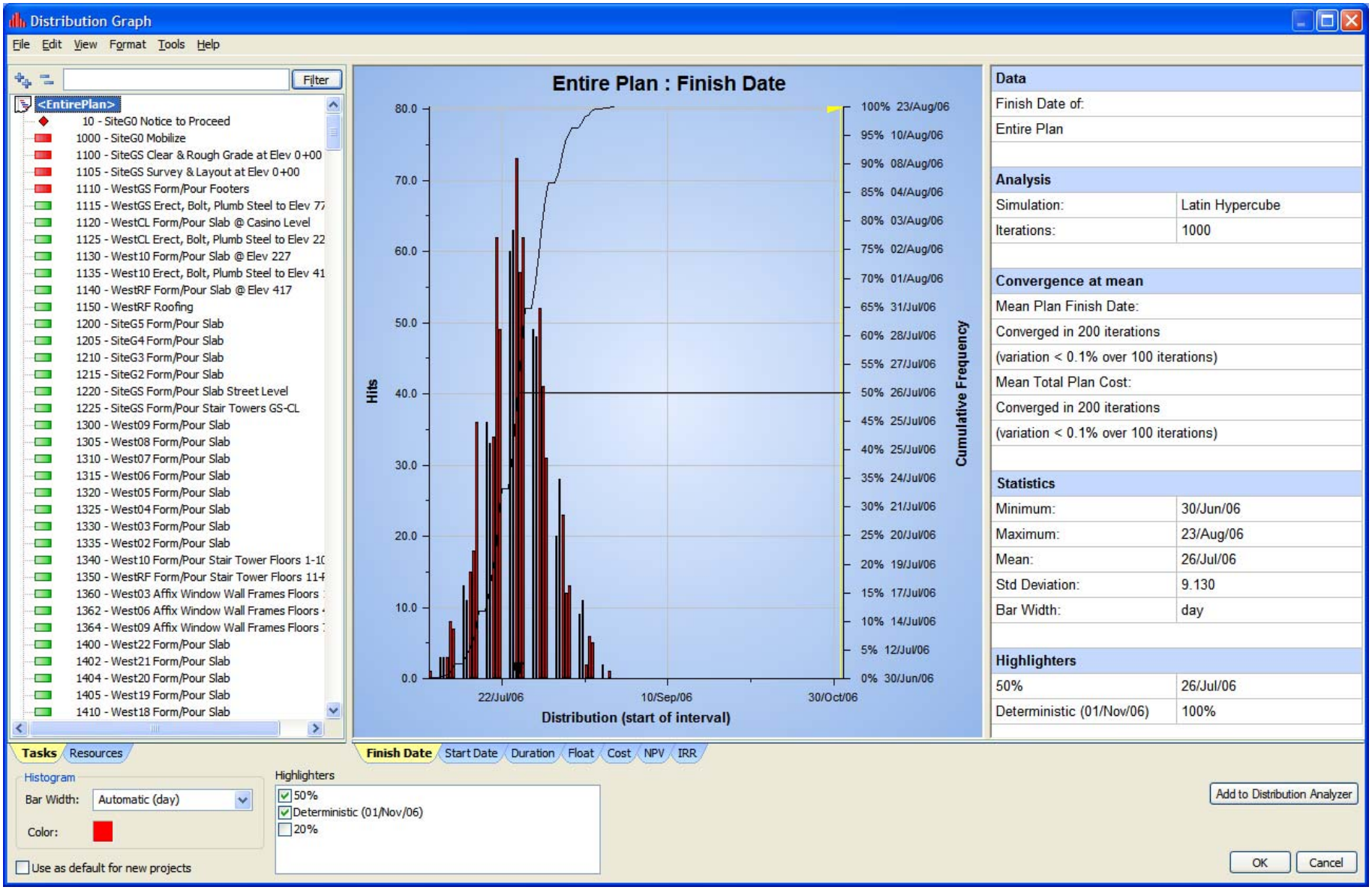
Show Distribution Graph afterwards

Last Analysis Time: 00:00:07

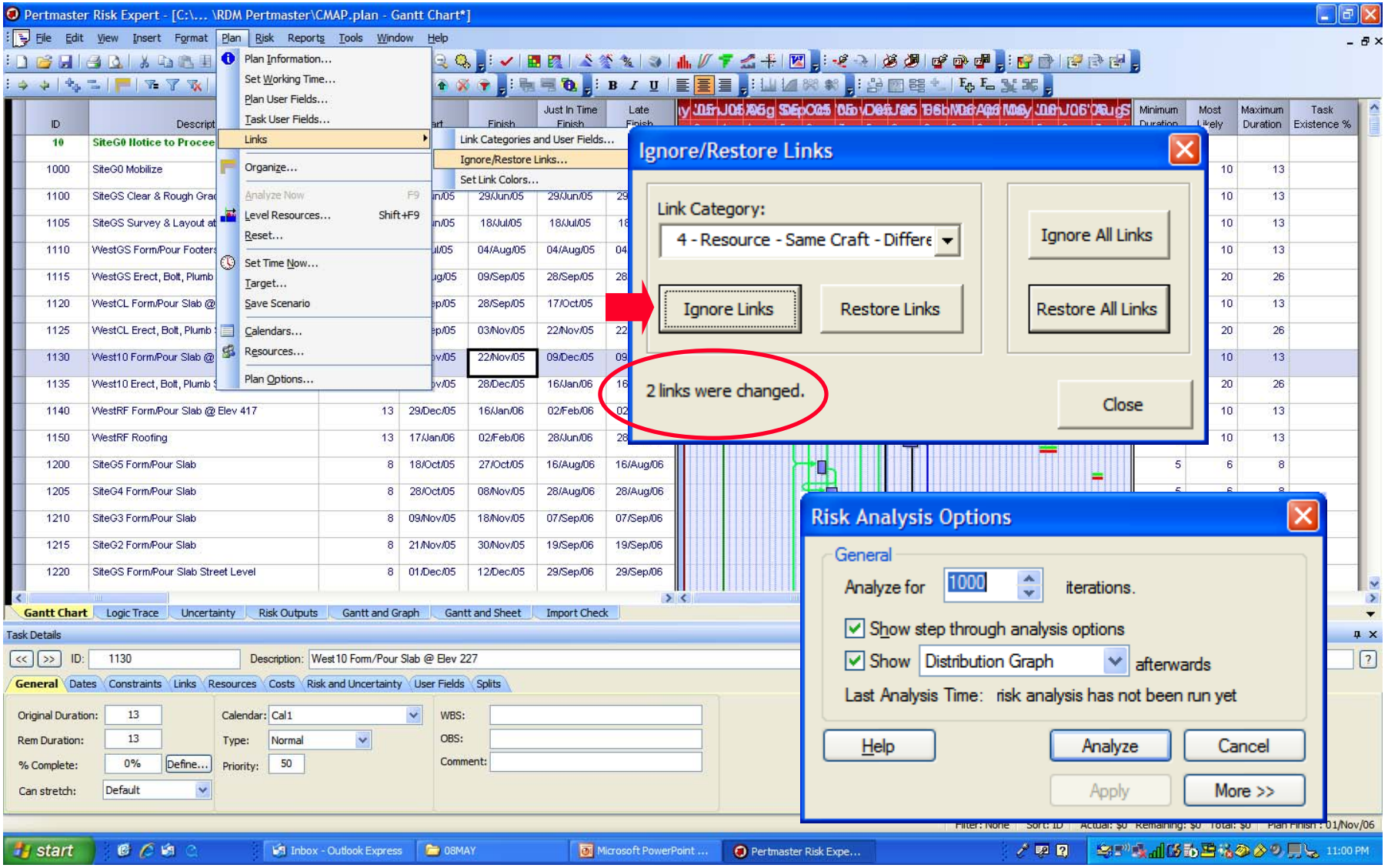
Help | Analyze | Cancel | Apply | More >>



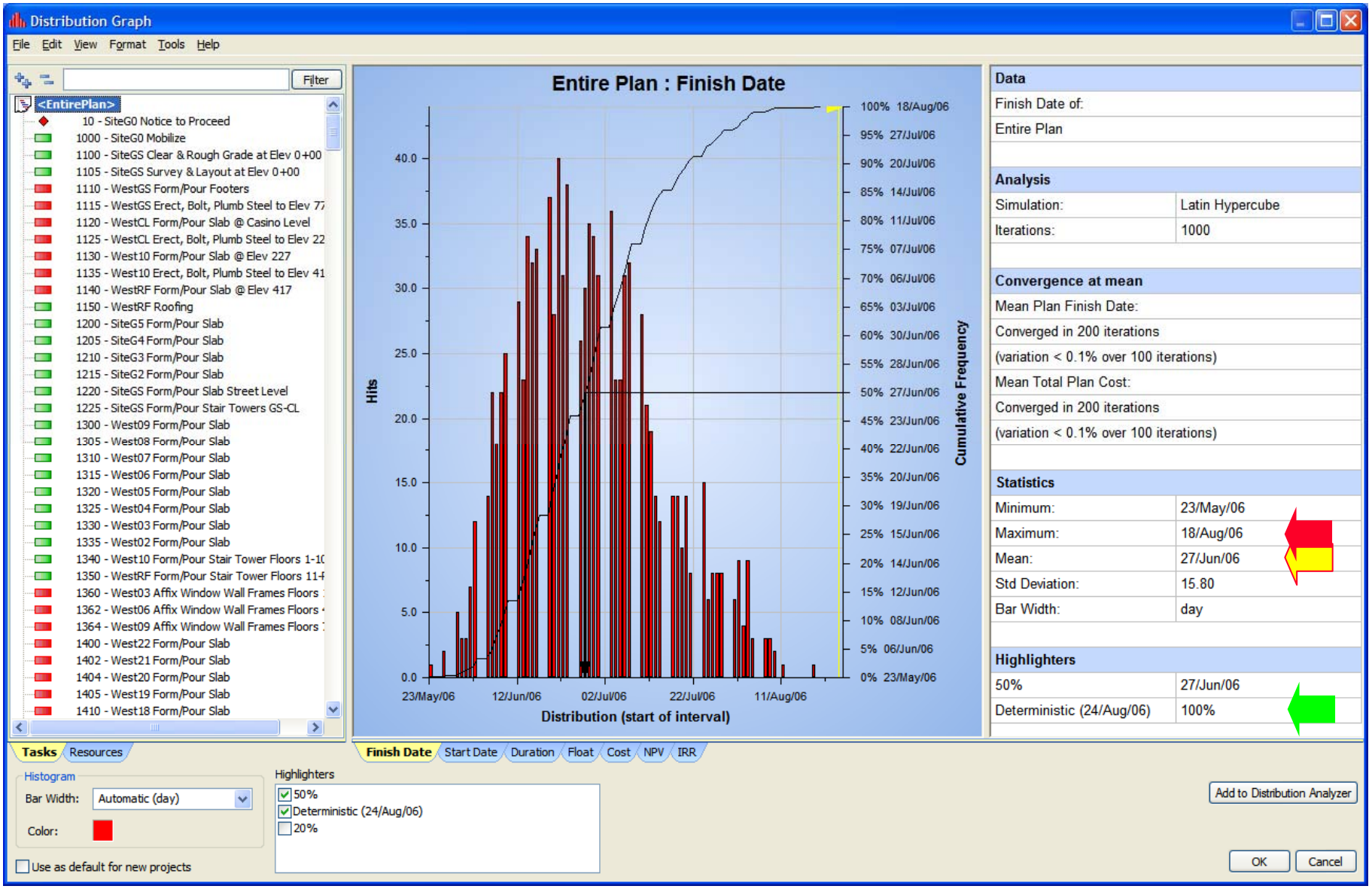
Risk Analysis – 1000 Iterations



Risk Analysis with RDM – 1000 Iterations



Risk Analysis with RDM – 1000 Iterations



Better Specifications

- CPM is a Shop Drawing
- Purpose = Further Assurances
- Owner does not want CPM to **show** timely completion
- Owner wants CPM to **assure** timely completion

Contractor shall provide a CPM:

- that indicates an 80% likelihood of completion on or before June 30, 2009
- prepared in the RDM format to separately show physical planning restraints from resource scheduling restraints
- coded to indicate sub, craft, location …

Updates to the CPM shall include additional reports that incorporate:

- trend analysis starting at 30% for any classification of work or subcontractor
- dynamic re-leveling with up to 25% additional resources if the likelihood of timely project completion falls below 80%
- a cost analysis if resources are to be increased involuntarily beyond 25%

The Road Ahead

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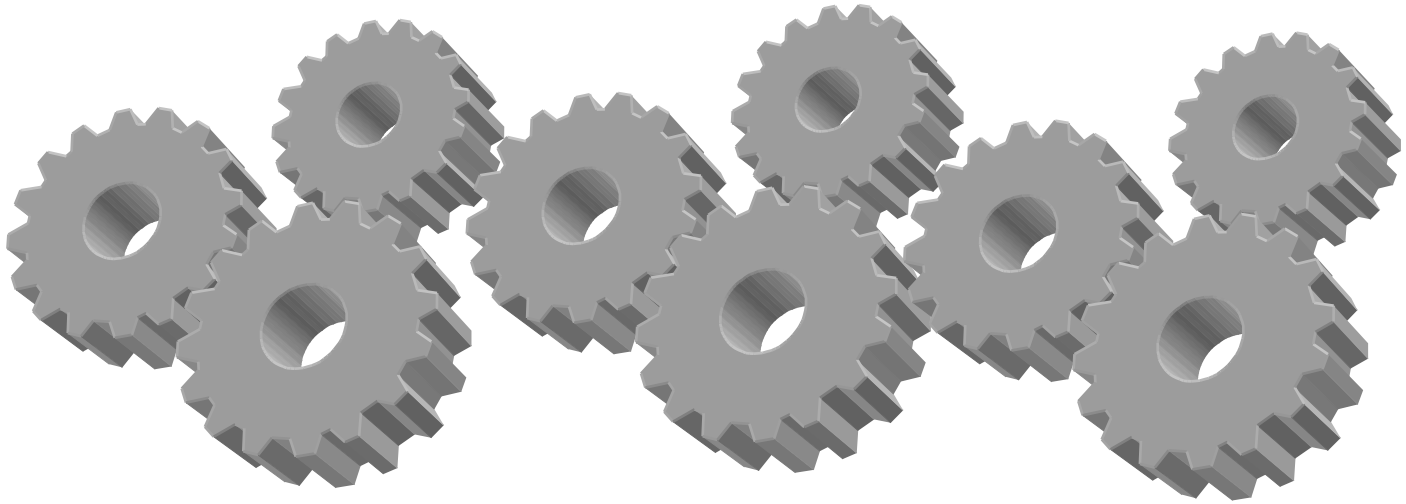
Reason/Why Codes

- Special **reason why** codes
- resource – leveling
  - must suppress (ignore) “R” reason coded restraints for same resource
  - “R” code temporarily replaced with “S” code for reporting and analysis
  - L code restraints track actual resource deployment by leveling routine
  - L coded restraints are deleted each time the leveling routine is re-run



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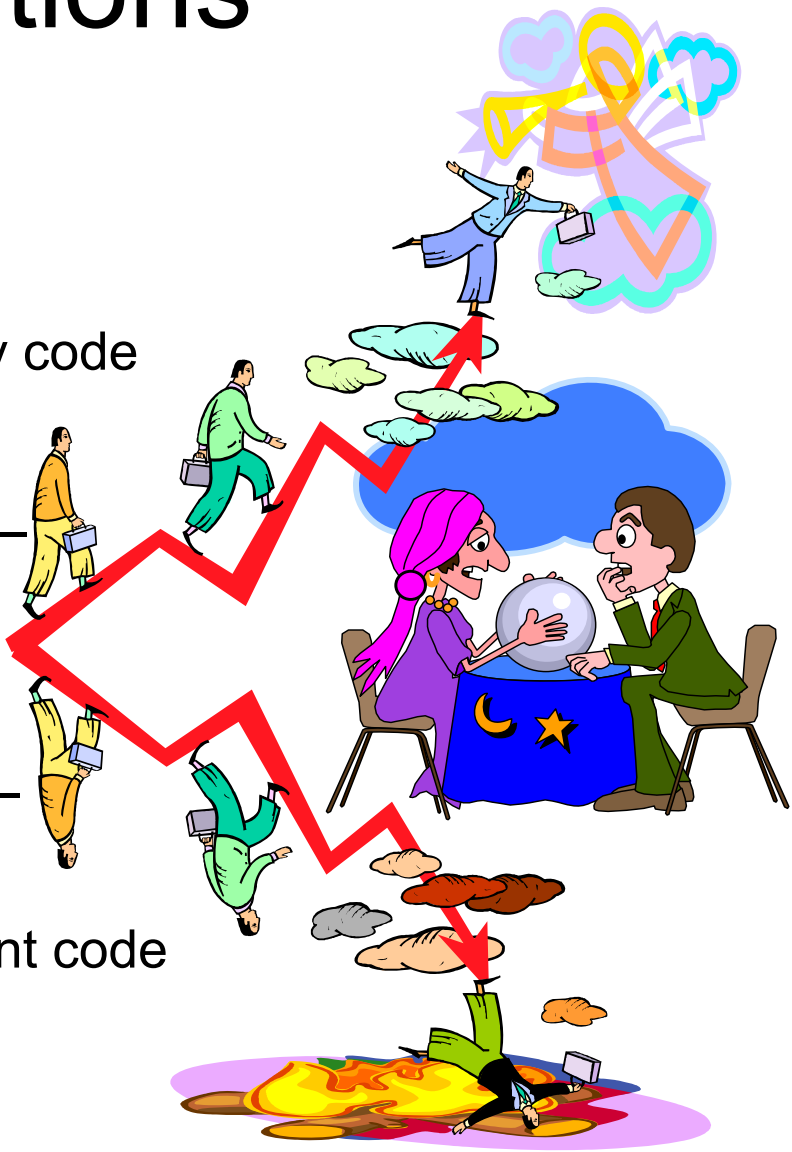
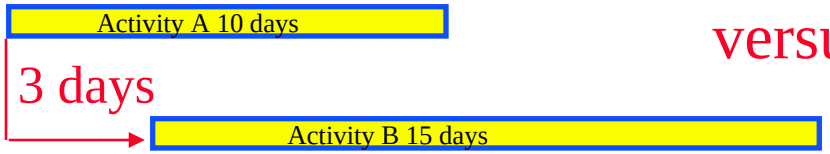
Trend Durations

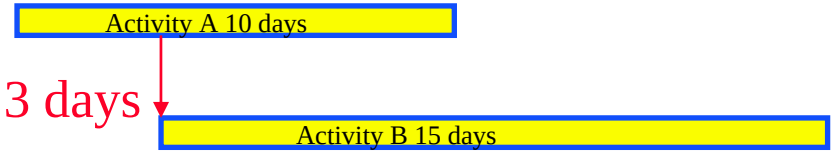
- for ACTIVITIES –
  - based upon any common resource
  - based upon any user defined activity code
- for progress style RESTRAINTS –
  - based upon reference activity
- for passage style RESTRAINTS –
  - based upon any common resource
  - based upon any user defined restraint code

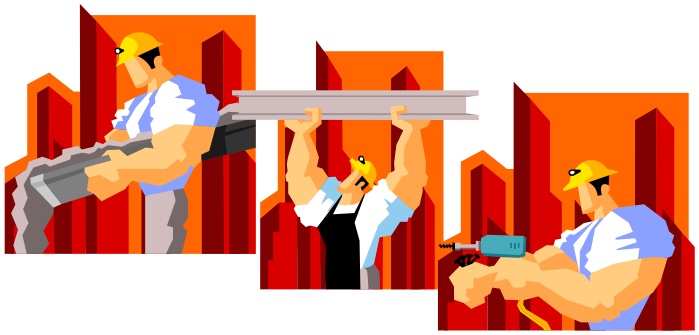


Split Activities
Distinguish Passage v Progress

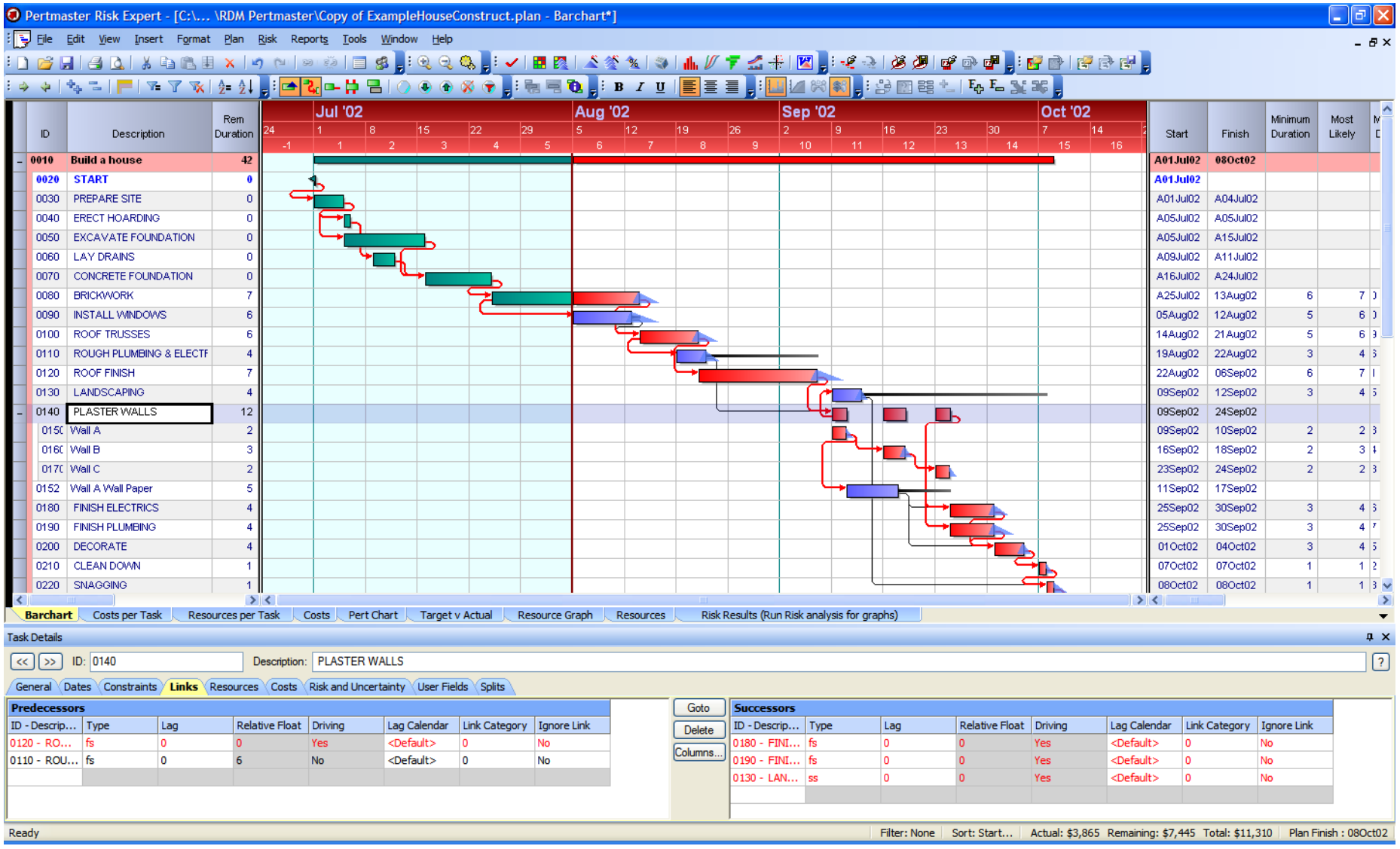


versus

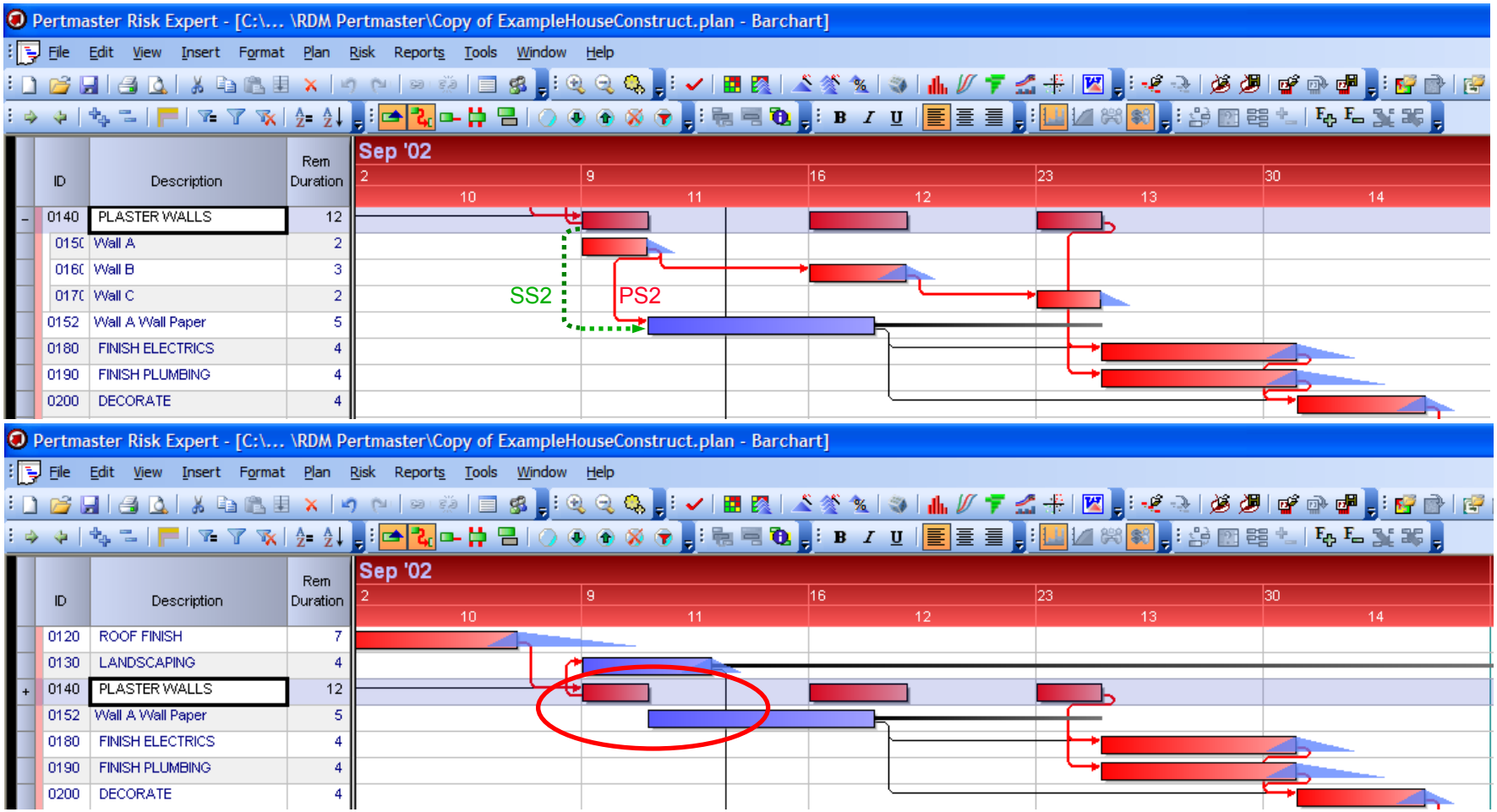




Split Activity Mimics SS v PS



Split Activity Mimics SS v PS



- event between split activities distinguishes
  - start Wall A Wallpaper 2 days after starting Plaster Walls, and
  - start Wall A Wallpaper when 2 days of Plaster Walls completed (Wall A)

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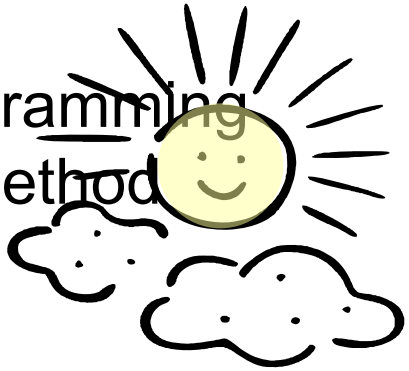
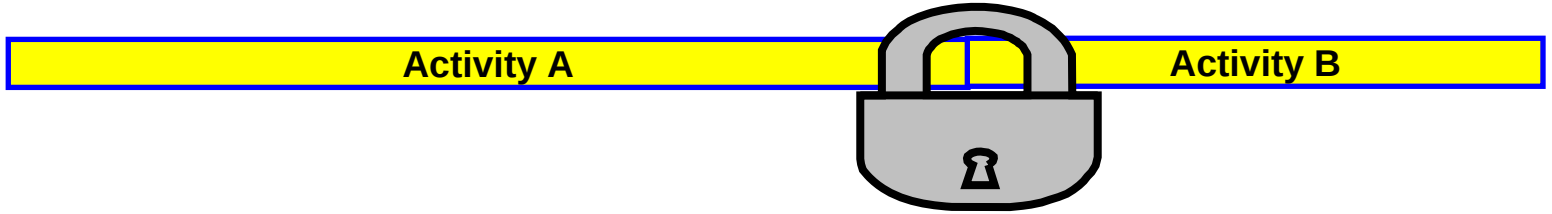
Relationship Diagramming Critical Path Method



- CT – Contiguous
  - representing a Finish-to-Start restraint
  - where the preceding activity may not start until
  - a contiguous and continuous flow of work may occur
  - from the start of the predecessor to the finish of the successor

- The lag portion of this Lead/Lag code
  - represents the longest “weekend” permitted between activities

- The use of this restraint code will be similar to
  - assigning a Zero Free Float constraint to the predecessor
  - affecting the successor activity of THIS restraint only



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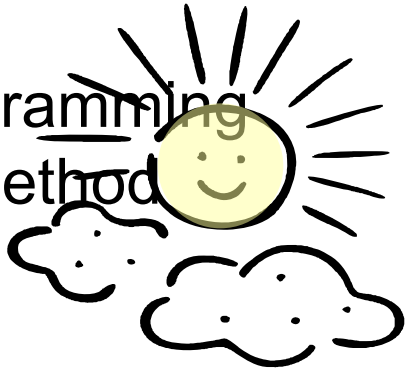
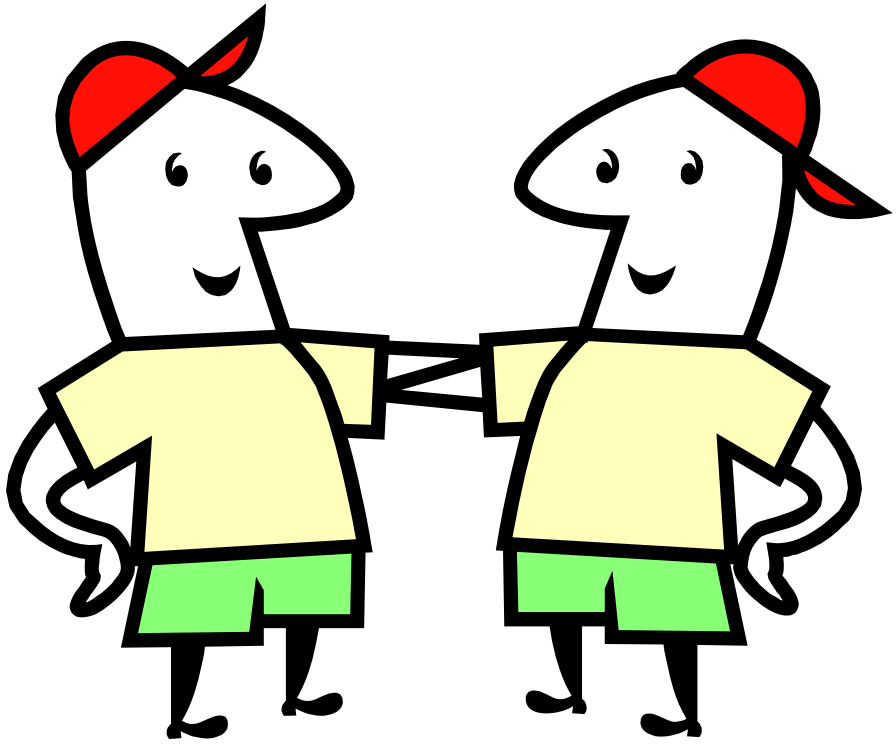
Relationship Diagramming Critical Path Method



- CC – Concurrent
  - representing the two activities must be performed in lock-step
  - this is more than saying two activities joined with SS+FF or PS+FR



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Relationship Diagramming Critical Path Method

- CC – Concurrent
  - representing the two activities must be performed in lock-step
  - this is more than saying two activities joined with SS+FF or PS+FR

- Examples include:
  - erecting a MSE wall and backfilling during placement
  - pouring a concrete slab with embedded electrical conduit
  - coordination of surgeon and anesthesiologist during an operation
  - in each instance possibly being performed by separate subcontractors but under the daily control of only one individual
  - the proper logical means to depict the combination is by only one activity, however the needs for separate rollups by subcontractors and the general desire for such a splitting of this ONE activity indicate a need for this type of restraint code

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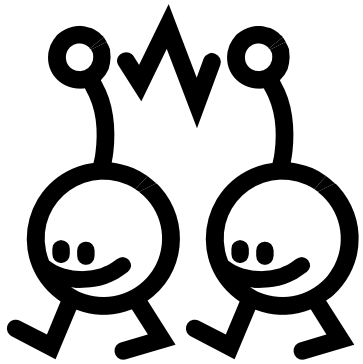
Relationship Diagramming Critical Path Method

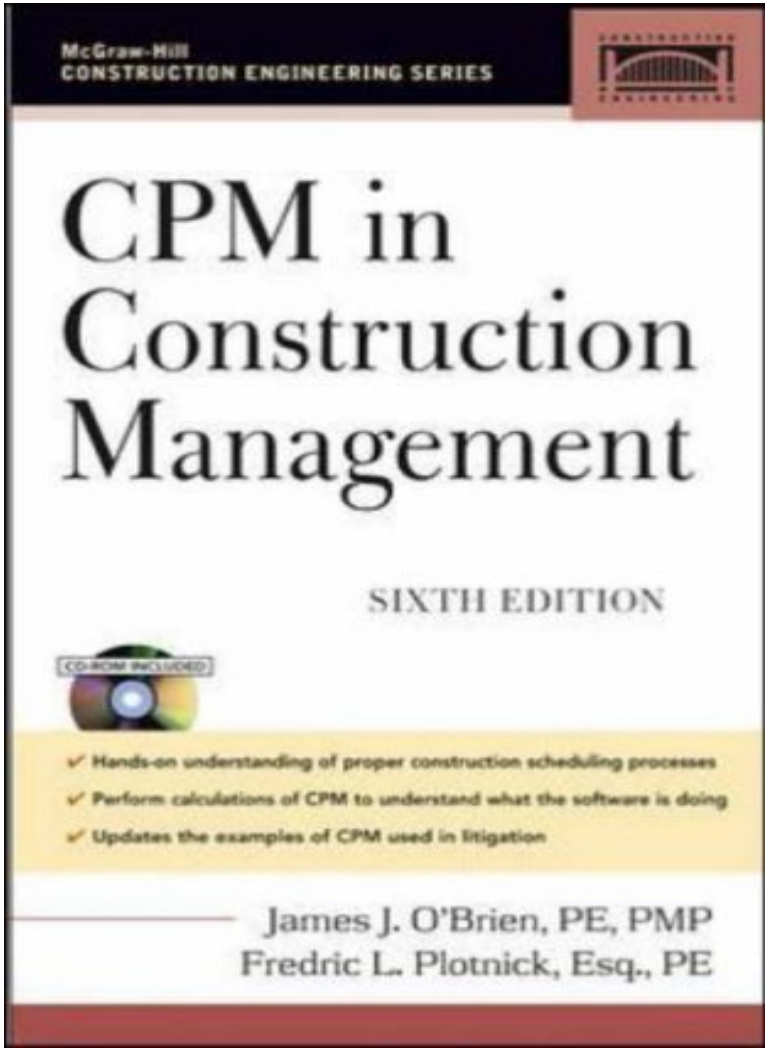
- DS – Duplicate SS+FF restraints sharing the same lag duration
  - the MSCS program of the 1960s and 1970s included a popular “Z” code = combination of SS+FF
  - indicates that the early (but not necessarily the late) start of the two activities would start together or that the two activities (if having the same duration) would be staggered
  - note predecessor and successor activities should have the same duration and calendar
    An error code should be generated for violations.

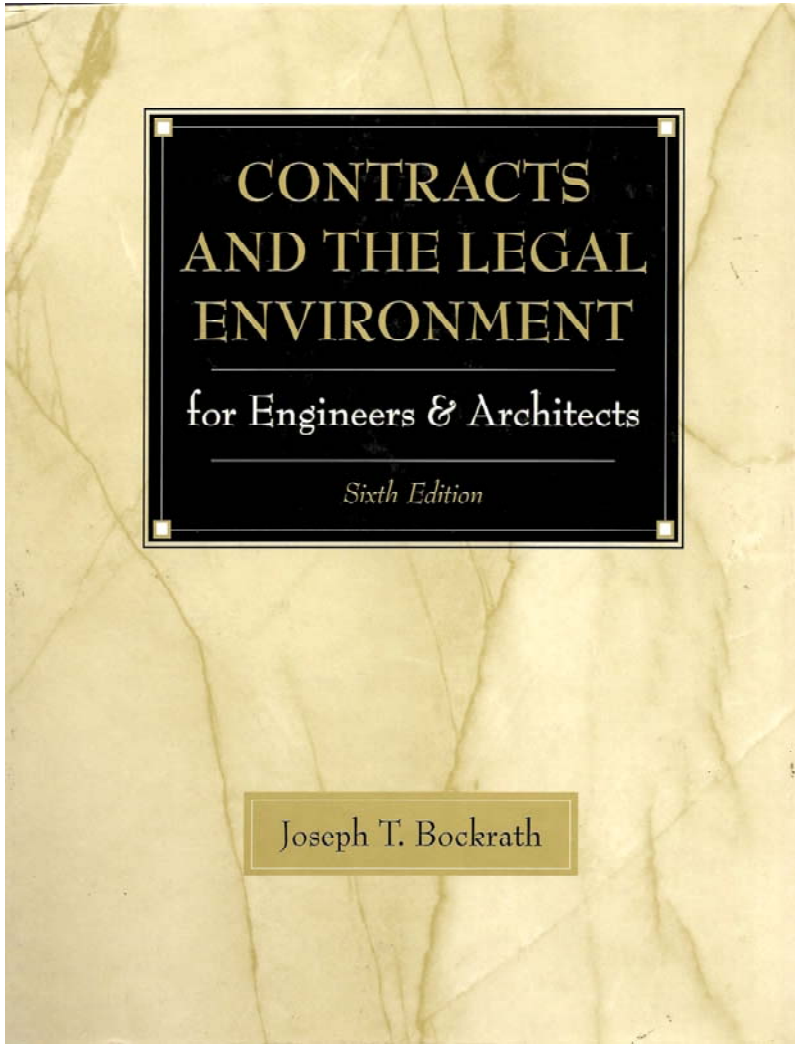
- DP – Duplicate PS+FR restraints sharing the same lag duration
  - Similar to the DS restraint, except the successor activity will be calculated to start after the remaining duration of the predecessor has been reduced by Lag units of time.

- DR – Duplicate RS+FP restraints sharing the same lag duration
  - Similar to the DS restraint, except the successor activity will be calculated to finish after the remaining duration of the predecessor has been reduced to Lag units of time.



Other Contributions





performance of projects is measured by activities
performance of projects is driven by relationships™

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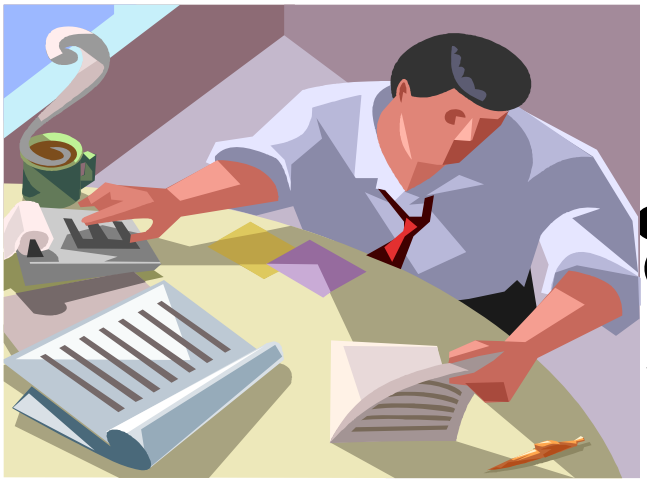

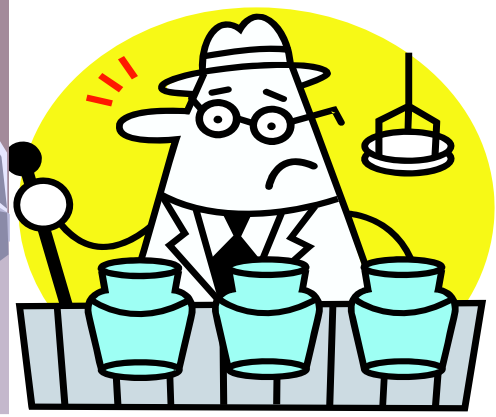

Q&A

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