



REAL WORLD PROJECT MODELING IN AURORA THAT SUPPORTS RELATIONSHIP DIAGRAMMING METHOD (RDM) & RELATIONSHIP DIAGRAMMING CRITICAL PATH METHOD (RDCPM) FUNCTIONALITY

CPM Construction Conference 2026

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Lessons Learned from Clients

The Boeing Company



Air Force Satellite Scheduling



Mitsubishi Heavy Industries



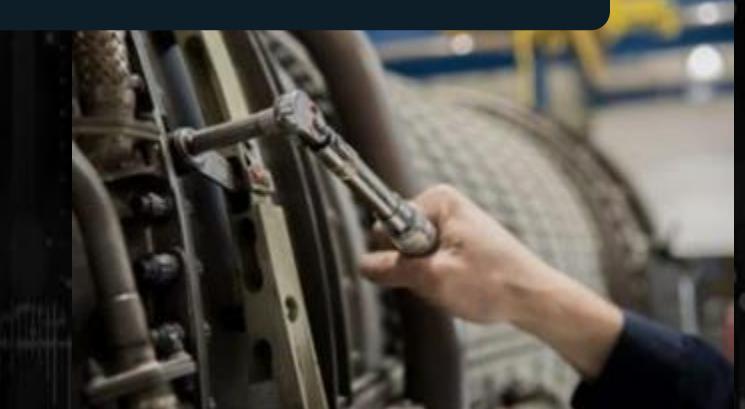
General Dynamics Electric Boat



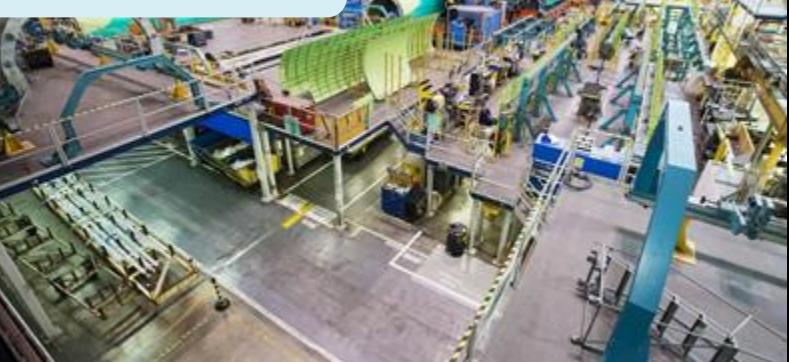
Siemens Integrated Program Planning & Execution



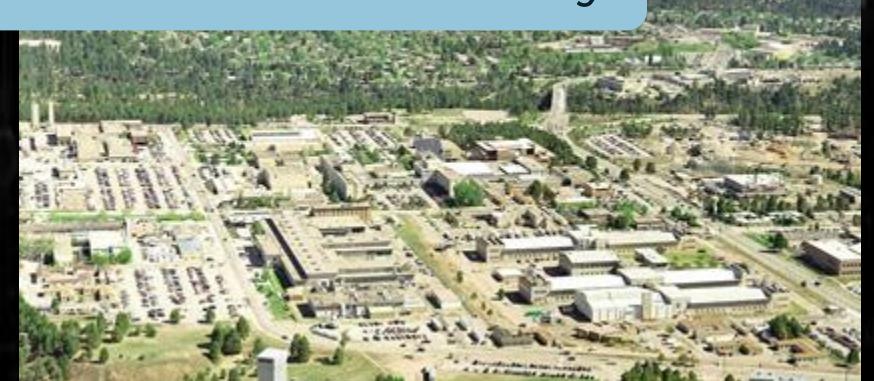
Camcar Textron



Spirit AeroSystems



Los Alamos National Library



LESSONS & RESULTS

- Project models require more real-world constraints
 - Significant productivity lost due to inferior model details
- Learn from the human schedulers
- Model to level of detail required
 - RDM & RD CPM
- Reveal & explain the schedule
- Easy & fast to perform scenarios / what-ifs
- Results: Reduced project duration & greater transparency



PROJECT MODEL NEEDS TO BE REALISTIC

- Inability to model many real-world situations causes model to update inaccurately during execution

EXECUTION EXCELLENCE

1. Model to the level of detail needed
2. Generated Global Priorities based on model & current situation
3. Humans make final decisions on what to work based on global priorities & other real-world factors, then update model with status

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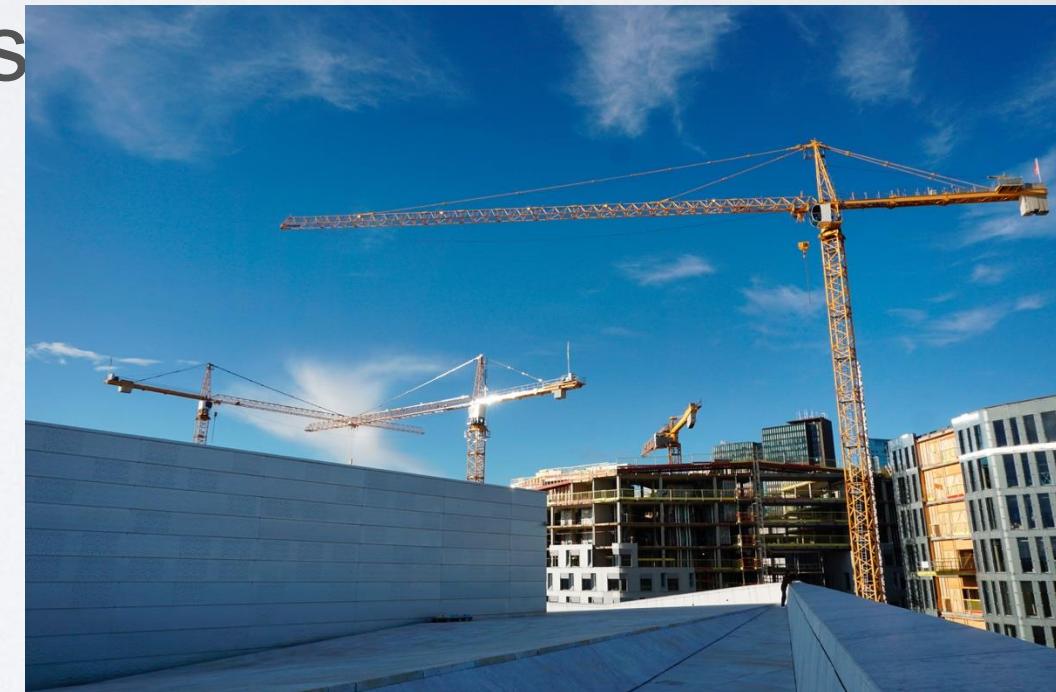
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- RDM & RDCPM

- Reveal & explain the schedule

- Easy & fast to perform scenarios / what-ifs

- Results: Reduced project duration & greater

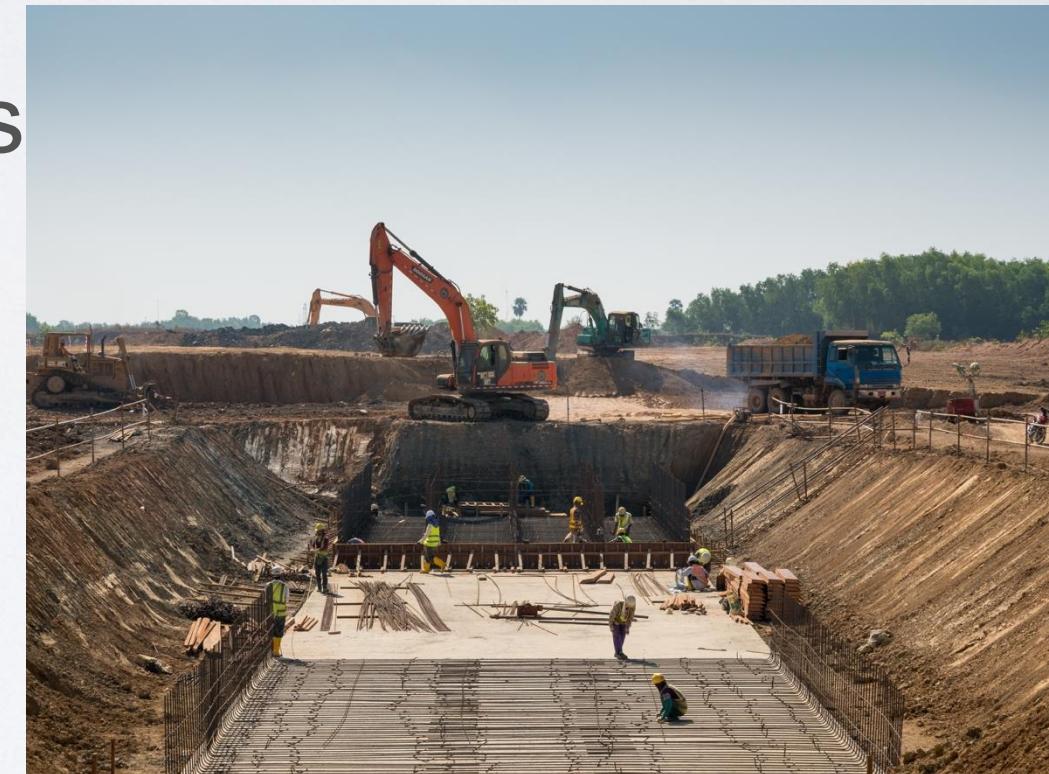


LEARN FROM HUMAN SCHEDULERS

- Different scheduling applications generally require some different modeling capabilities, but many overlap
 - Human experts help drive the best decision per what non-standard modeling capabilities are most apropos
- When decisions / tradeoffs need to be made, use the expertise of expert schedulers
 - So that the scheduling system reacts as a human expert wants it to
 - E.g., when to work overtime, when to outsource

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MODEL TO LEVEL OF DETAIL REQUIRED

- Technical constraints (E.g., F-S, F-F, S-F, lags)
- Resources
 - Labor: Occupation, skills, certifications
 - Equipment, Tools (e.g., cranes)
- Usage constraints – e.g., tool can only be used for so many hours continuously &/or during a day.
- Spatial / physical space – e.g.,
 - job requires a certain location or type of space
 - two elements should (or should not) be next to each other
- Equipment substitutions – equipment down, know & use substitutes



HIERARCHY OF RESOURCES

Resources

→ **LABOR**

→ **Occupation: e.g., Welding**

→ **Skills/Certifications**

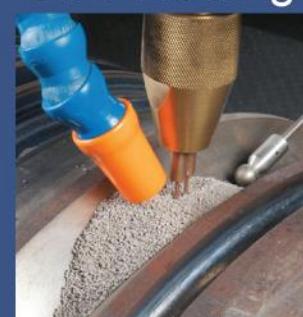


Submerged
Arc Welding



(Canadian Fabricating & Welding, 2019)

Flux Cored
Arc Welding



(Venus Wires, 2018)

Gas Tungsten Arc
Welding



Gas Tungsten Arc
Welding 6" Pipe

Gas Metal Arc
Welding

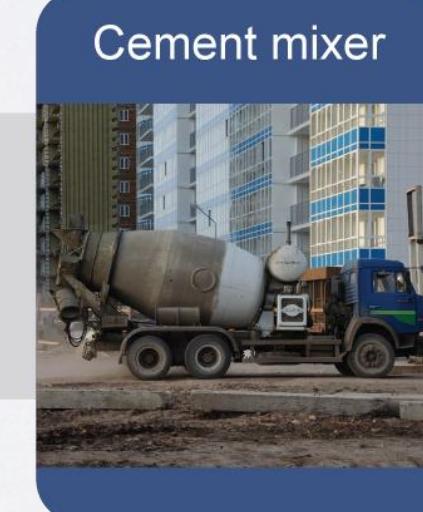
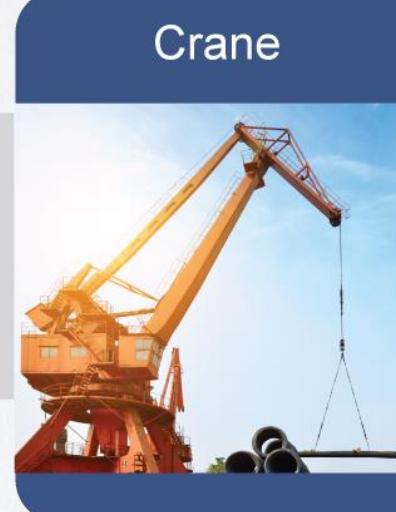


(TEK, 2020)

EQUIPMENT RESOURCES

Resources

- **LABOR**
- **EQUIPMENT/TOOLS**



EQUIPMENT SUBSTITUTIONS

- Equipment down, know & use substitutes



PREFERRED RESOURCES

Specify a preference order when defining a set of resources that are mostly interchangeable.

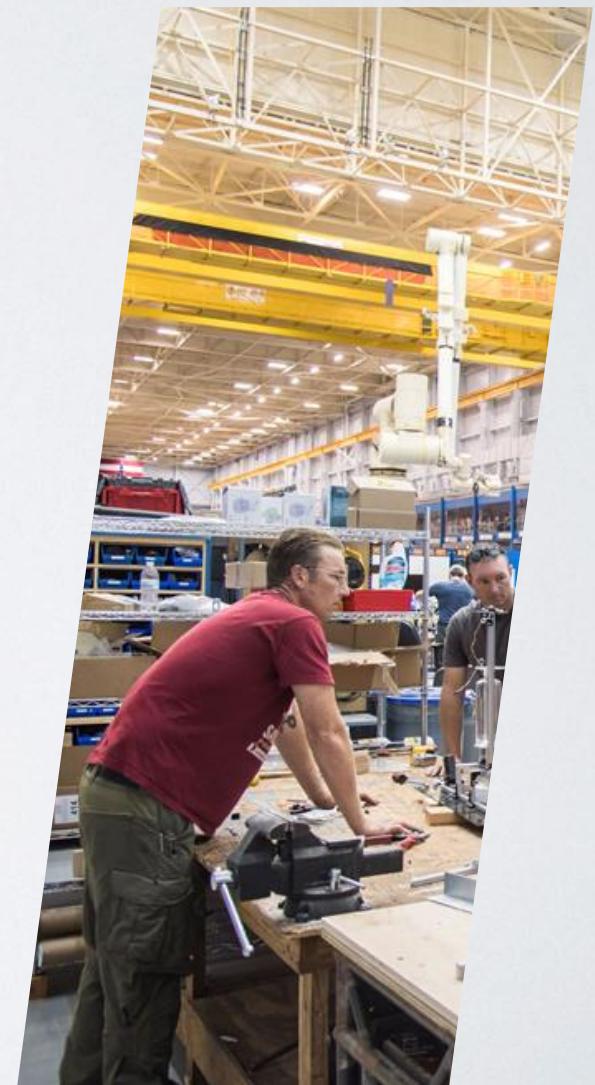
Prefer work in default shop

Prefer work by tech, but supervisor can substitute

Prefer certain equipment

Prefer certain lab space

Use consistent auditors for a client

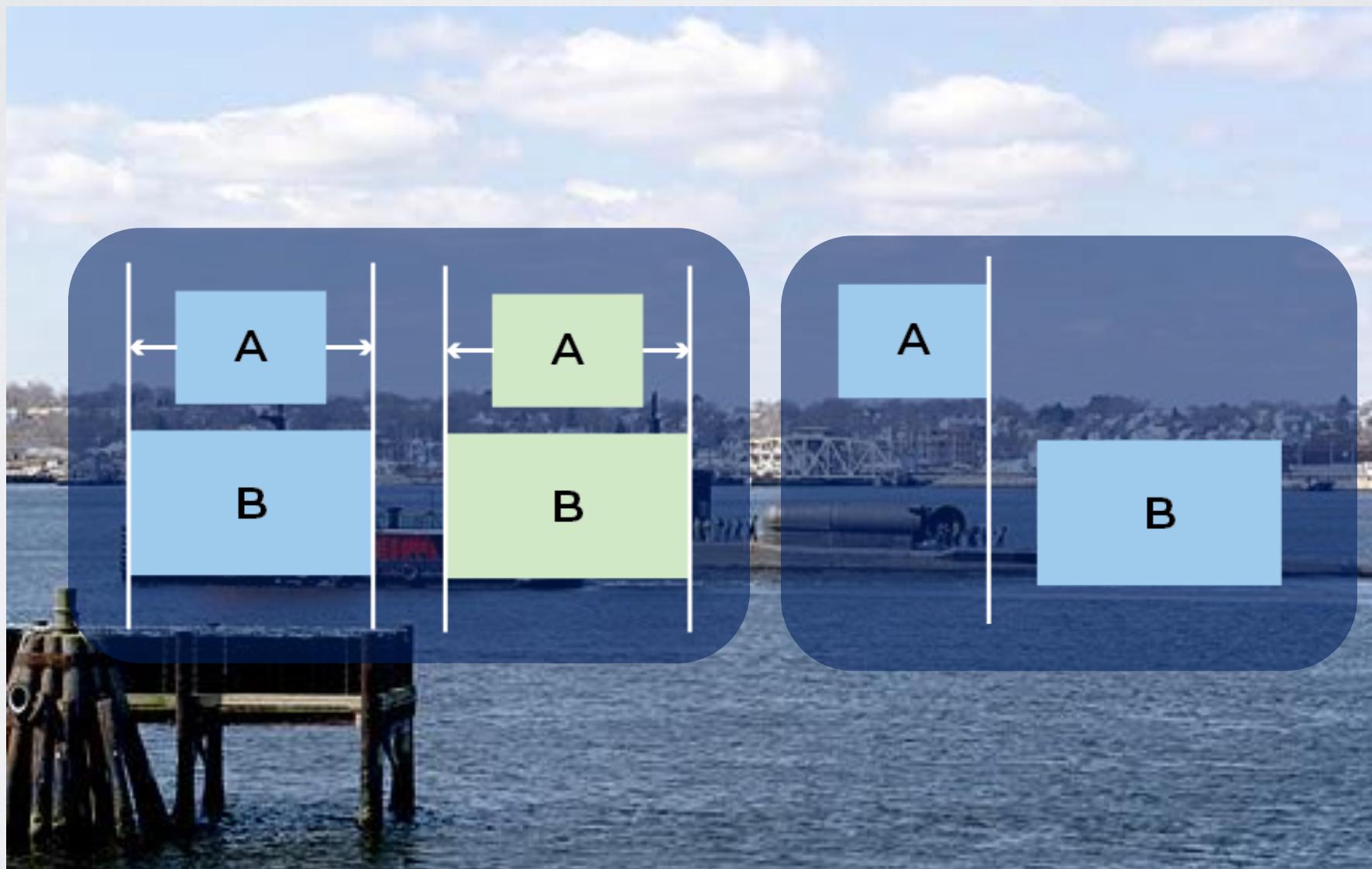


EQUIPMENT: USAGE CONSTRAINTS

- E.g., tool can only be used for so many hours continuously &/or during a day.

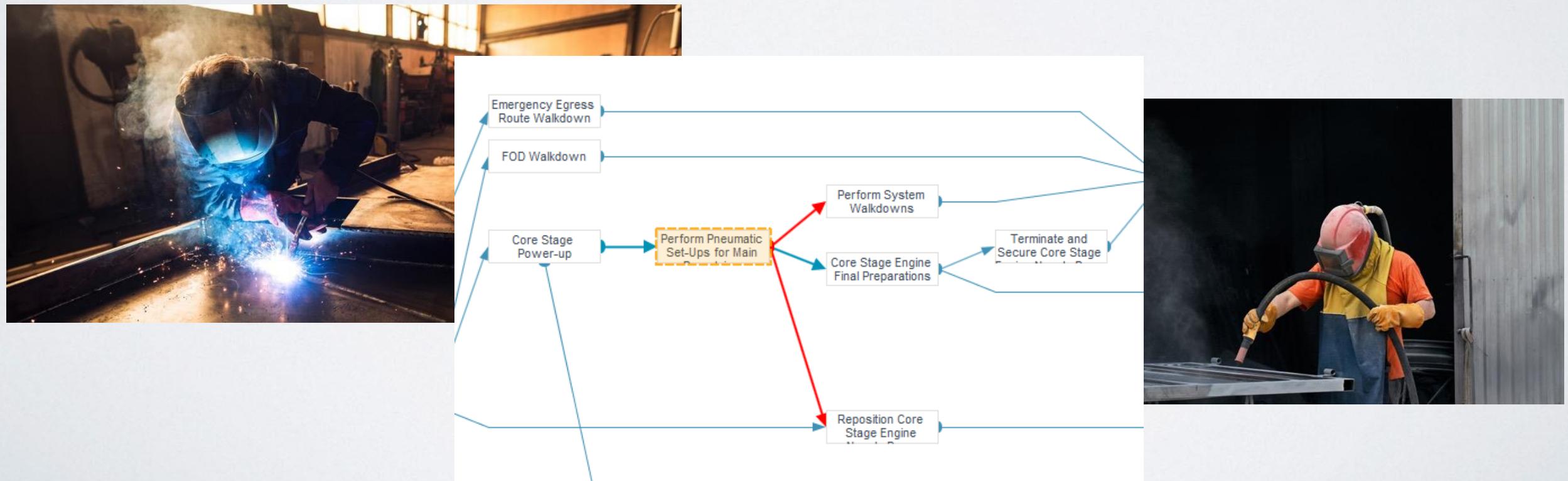


CONCURRENT & NON-CONCURRENT



SPATIAL / PHYSICAL SPACE CONSTRAINTS

- For example:
 - Job requires a certain location or type of space
 - Two elements should (or should not) be next to each other
 - Concurrent or non-concurrent constraint



ERGONOMIC CONSTRAINTS – INDIVIDUAL LIMITATIONS ON WORK CONDITIONS

- E.g., only work so long:
continuously requiring kneeling, and/or
so much kneeling during a shift



SHIFT-BASED CONSTRAINTS

- This is a set of properties that allows the user to control how jobs interact with shift breaks
- Only start a job if it can finish during the same shift
- Job can only be performed during the day shift
- Job can take multiple shifts, but requires same resource constraints

ALTERNATIVE RESOURCE COMBINATIONS

- A task may require a Plumber and a Mechanic; however, there may also be Cross-trained person that can perform Plumber and Mechanic operations. So, the resource requirements for a task could be (Plumb & Mech) OR (Cross-trained).
- For cases where the same number of people are always needed, the resource requirement could be ((Plumb & Mech) OR (Cross-trained & Mech) OR (Plumb & Cross-trained) OR (2 Cross-trained)).
- Aurora's intelligent scheduling assigns the Cross-trained individuals to maximize throughput

SUCCESSOR START WITHIN LIMITED TIME FRAME

Normal

Finish \leq Start

Offset: 0

Max Offset:

offset calendar Select

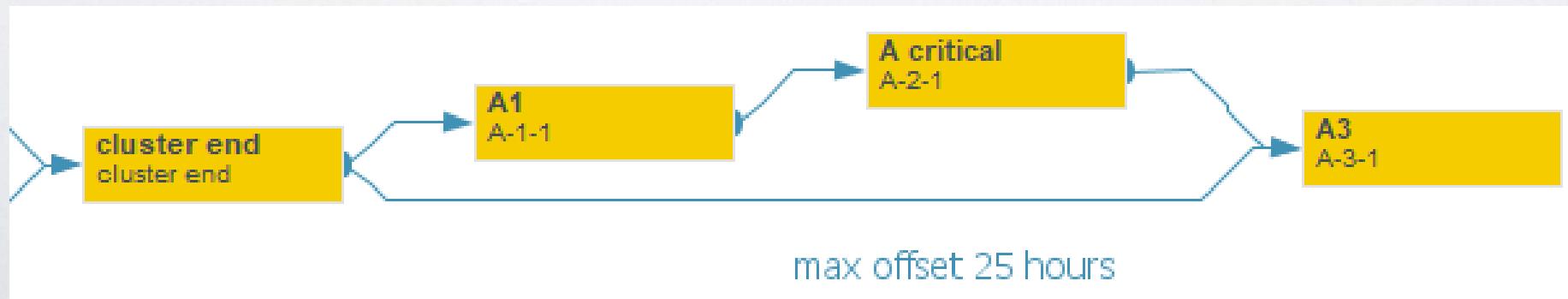
Core Properties

Note:

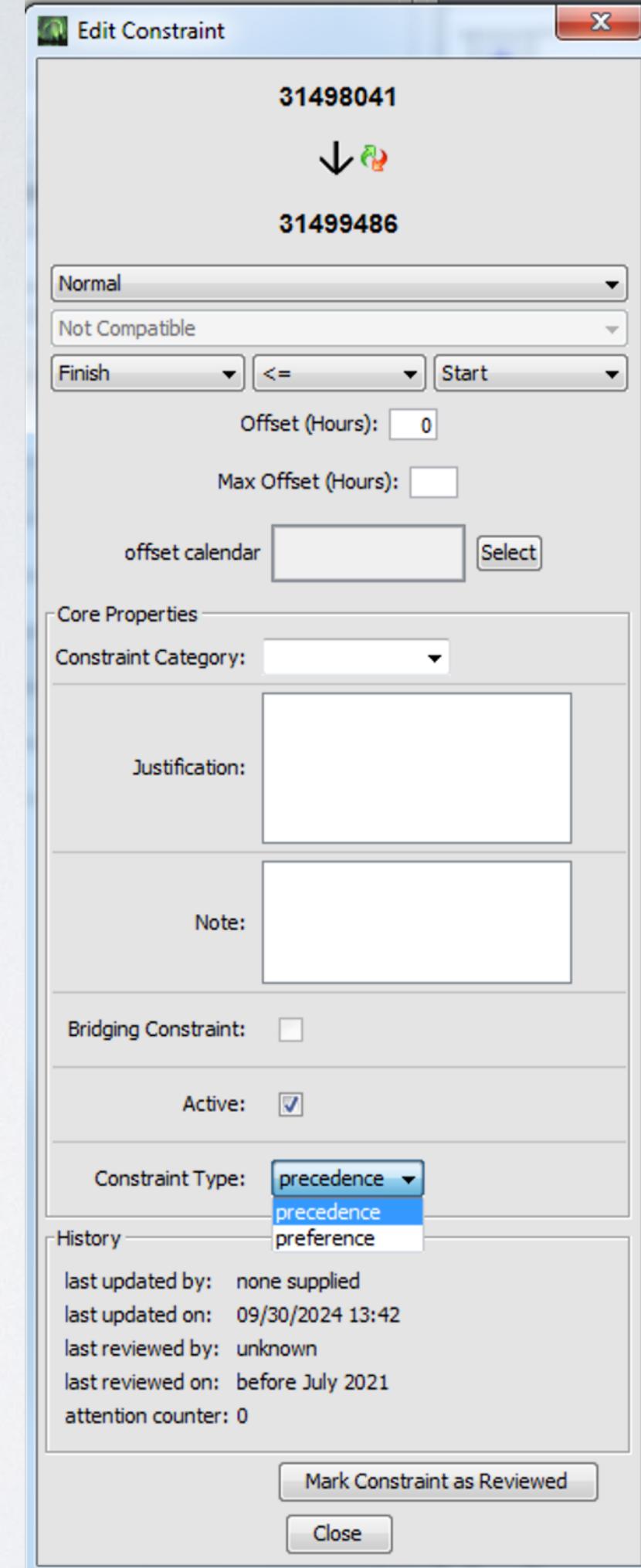
Bridging Constraint:

Active:

Close



ENHANCED CONSTRAINT DIALOG

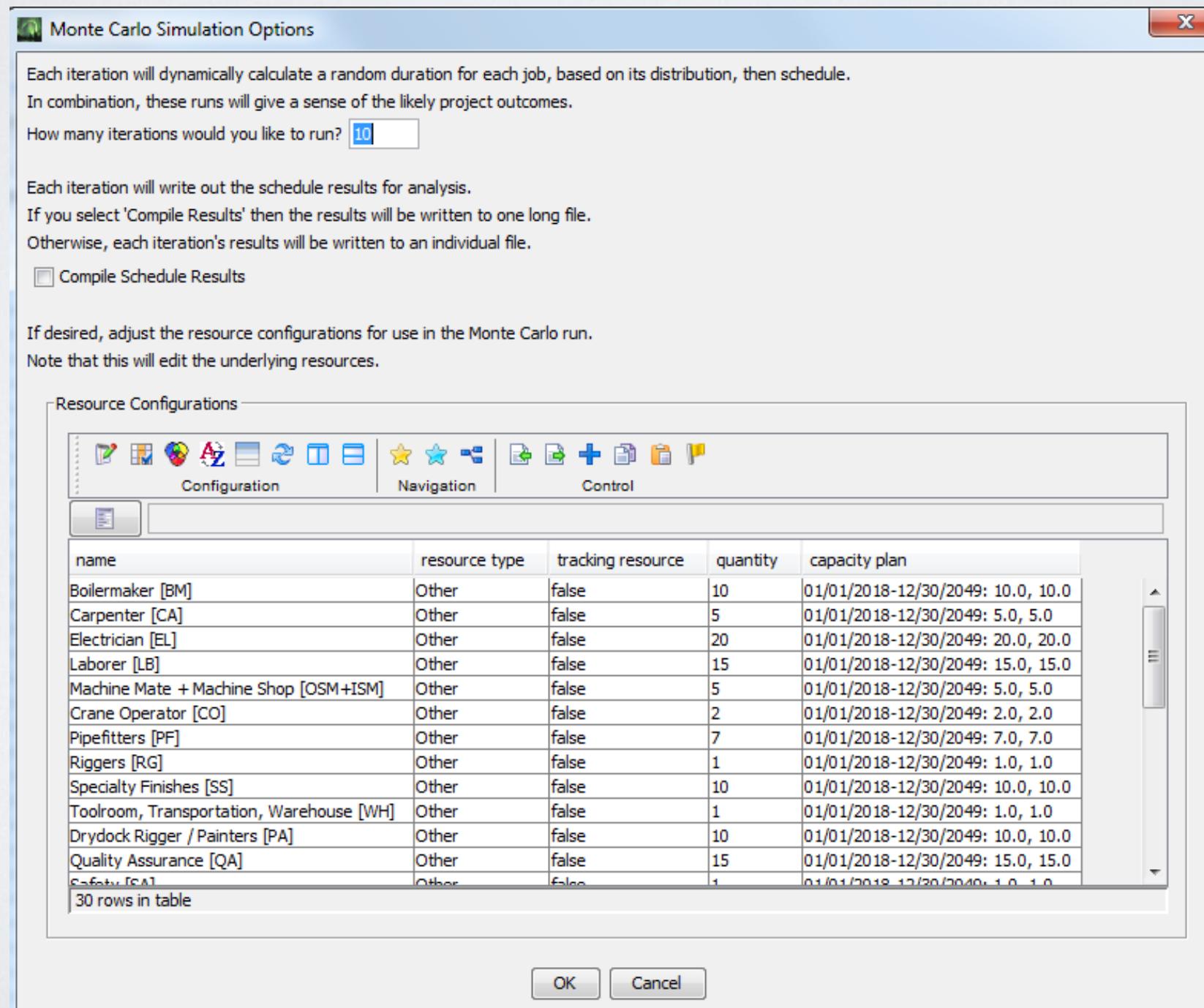


INTEGRATION WITH DIGITAL TWIN

- Aurora is incorporated in the Siemens Integrated Project Planning & Execution (IPP&E) Xcelerator product.
- Links schedule tasks with digital



MONTE CARLO RISK SIMULATION



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OVERLAP WITH RDM & RDCPM

- CT – Contiguous
- CC – Concurrent
- Continuous / Interruptible
- Risk / Monte Carlo
- Calendars of Durations of Activities and Restraints
- Event Codes
- Passage versus progress
- Reason/Why Codes: Reason/Why Restraint Code, Other Restraint Codes and Restraint Description Fields

CT – CONTIGUOUS
CC – CONCURRENT

- Aurora has the same functionality in the ABSOLUTE Finish-to-Start constraints, F=S.
- Aurora supports concurrent constraints.
In addition, Aurora supports non-concurrent constraints

CONTINUOUS / INTERRUPTIBLE

RISK / MONTE CARLO

- Aurora supports both continuous and interruptible activities.
- Aurora supports Monte Carlo analysis
 - Including fully resource loaded models with all the sophisticated modeling capabilities described herein and other capabilities unique to Aurora.

CALENDARS OF DURATIONS OF ACTIVITIES AND RESTRAINTS

EVENT CODES

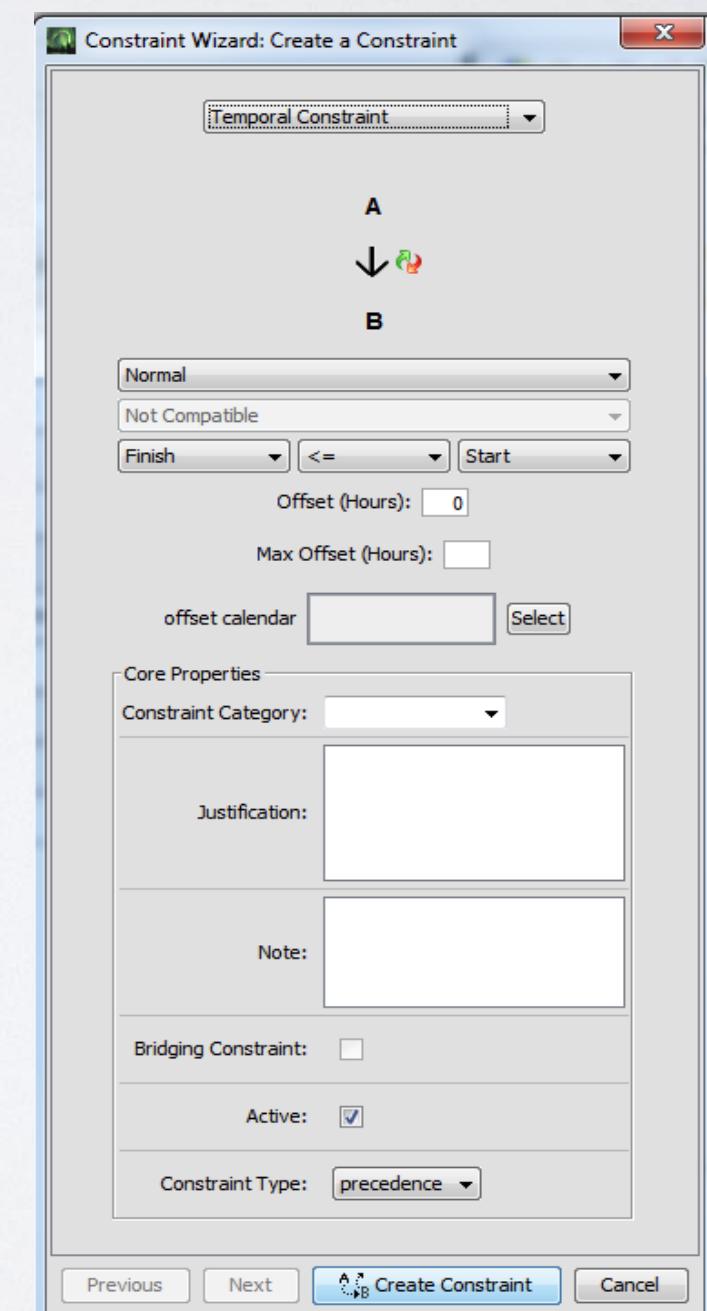
- Aurora supports complex calendars.
- Aurora supports shift-based constraints
- In Aurora Event Codes can be supported via Aurora's ability to support a large amount of user defined fields. So, a user defined field could be created called
 - Event Code Start
 - Event Code End
- If an Event Code is needed within an activity, then the activity can be split into multiple sub-activities connected with ABSOLUTE Finish-to-Start constraints, F=S.

PASSAGE VERSUS PROGRESS

- In Aurora the default offset lead/lag capability satisfies the passage version of “overlap of activities”.
 - The usage of sub-activities connected with ABSOLUTE Finish-to-Start constraints, F=S, can be used so that a sub-activity is created to represent the amount of progress required, and then another constraint would be created between the sub-activity and the other activity that was waiting for the progress to complete.

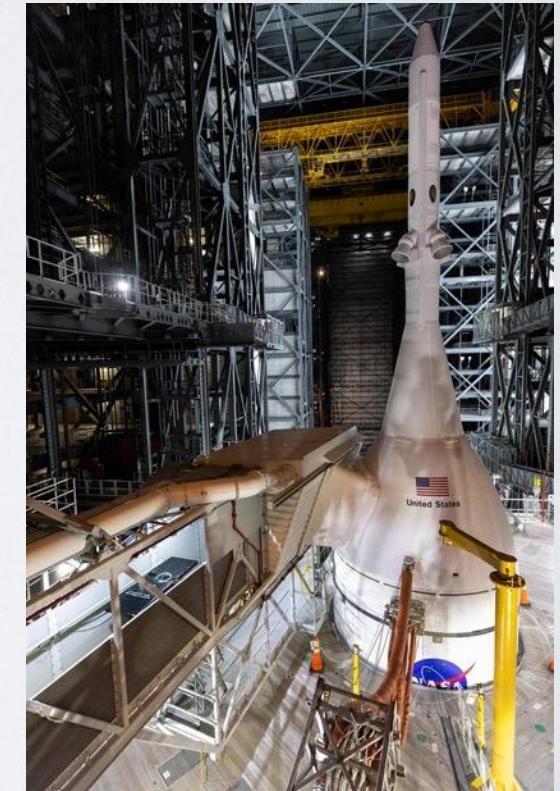
REASON/WHY RESTRAINT CODE & RESTRAINT DESCRIPTION FIELDS

- For physical constraints, the Reason/why can be entered as part of the constraint definition, Justification field.

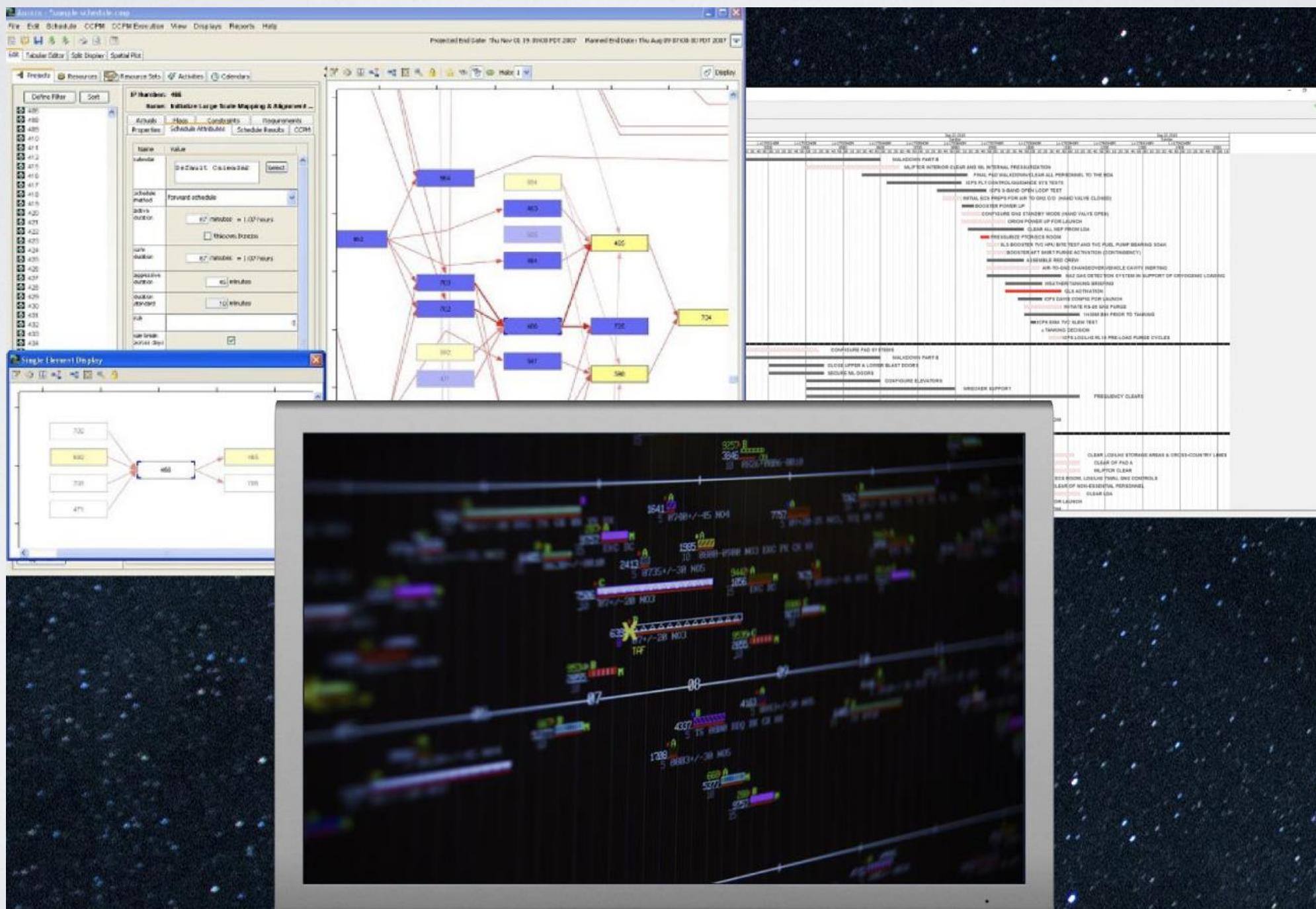


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REVEAL AND EXPLAIN THE SCHEDULE



PROJECT NETWORK

File Edit Schedule Utilities CCPM CCPM Execution View Displays PERT Chart Reports Help

New Open Save Print Preview Schedule

Projected End Date: 04/02/2016 17:00 Planned End Date: 04/15/2011 15:24

Edit Gantt Chart PERT Chart Gantt Chart Histogram Plot Tabular Editor

Projects Resources Resource Sets Activities Calendars

Instances Filter Sort Export

Project: CCPM-EWS-005

Job: CSMP Summary

Task Name: Electrical equipment Reverse Os...

Property Search:

Properties Details

activity code: Equipment Reverse Osmosis Fa

task name: Equipment Reverse Osmosis Fa

job:

CSMP Summary:

project: CCPM-EWS-005

external id: 11

description:

work assignment:

job type: In Sequence

position:

user attributes:

name	value
ProjectUID	180040

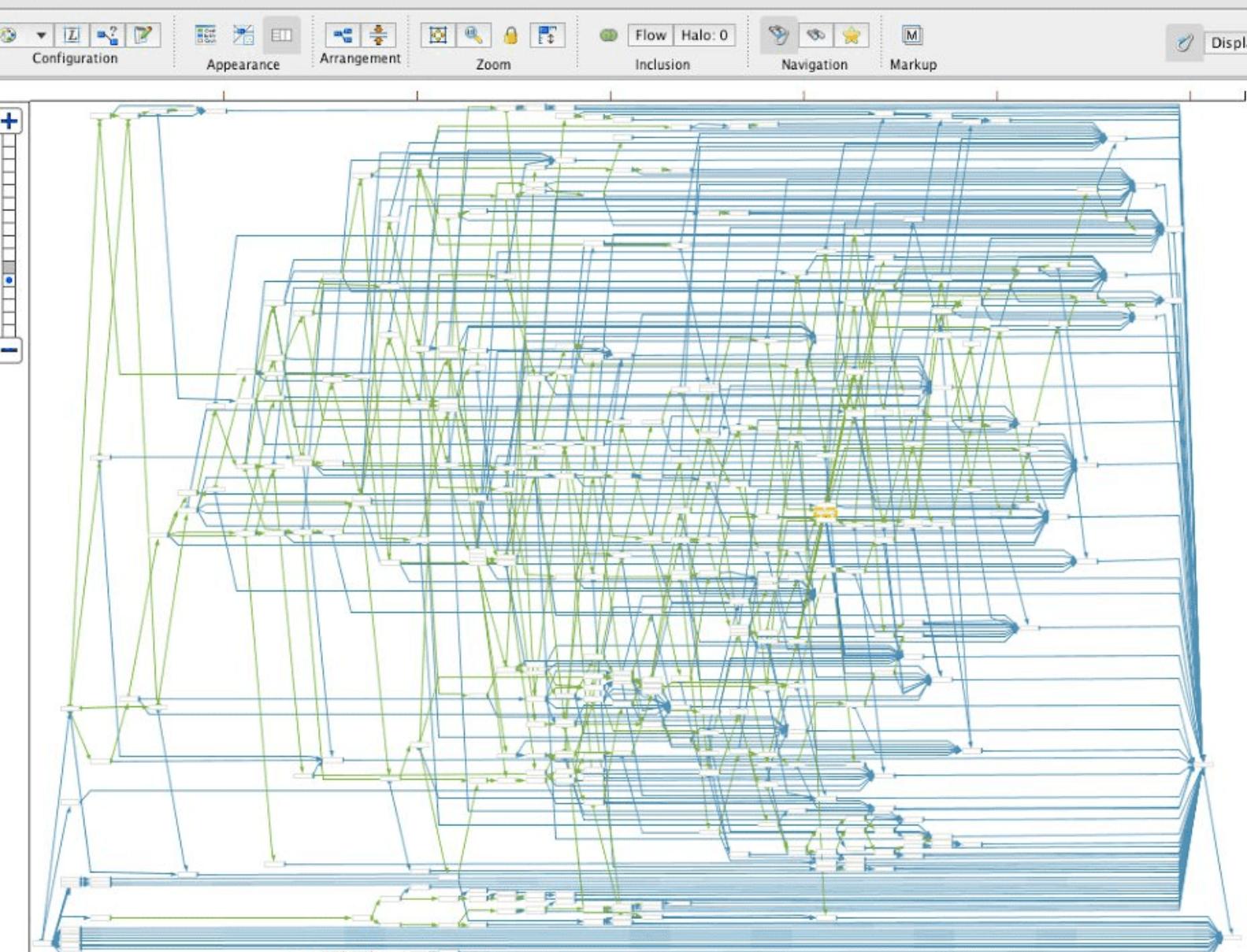
Add Remove

New Project New Instance

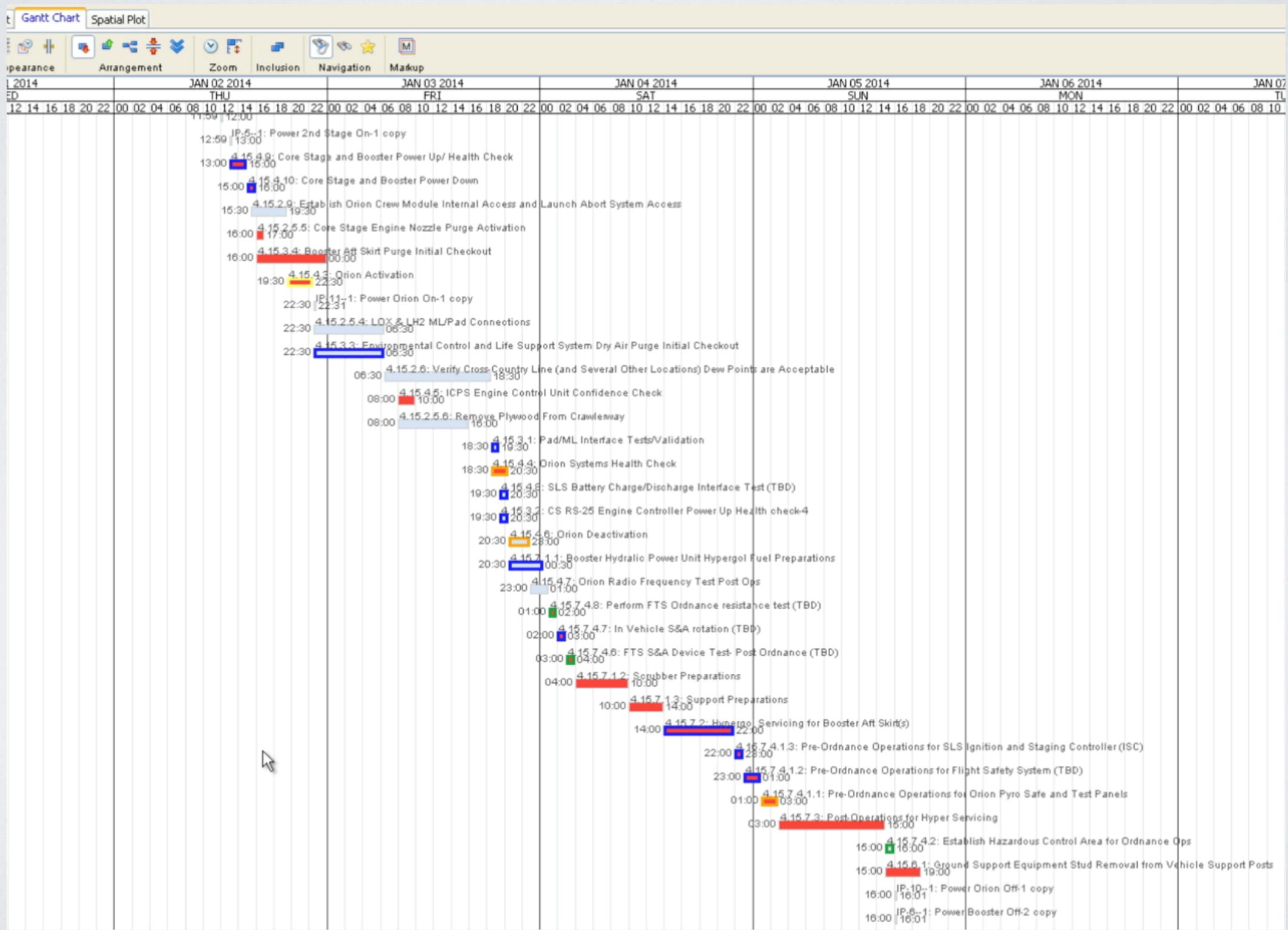
Add Task Delete

Copy

Configuration Appearance Arrangement Zoom Inclusion Navigation Markup Display



GANTT CHART COLOR-CODED PER USER DESIRED CRITERIA



RESOURCE CONTENTION: VISUAL

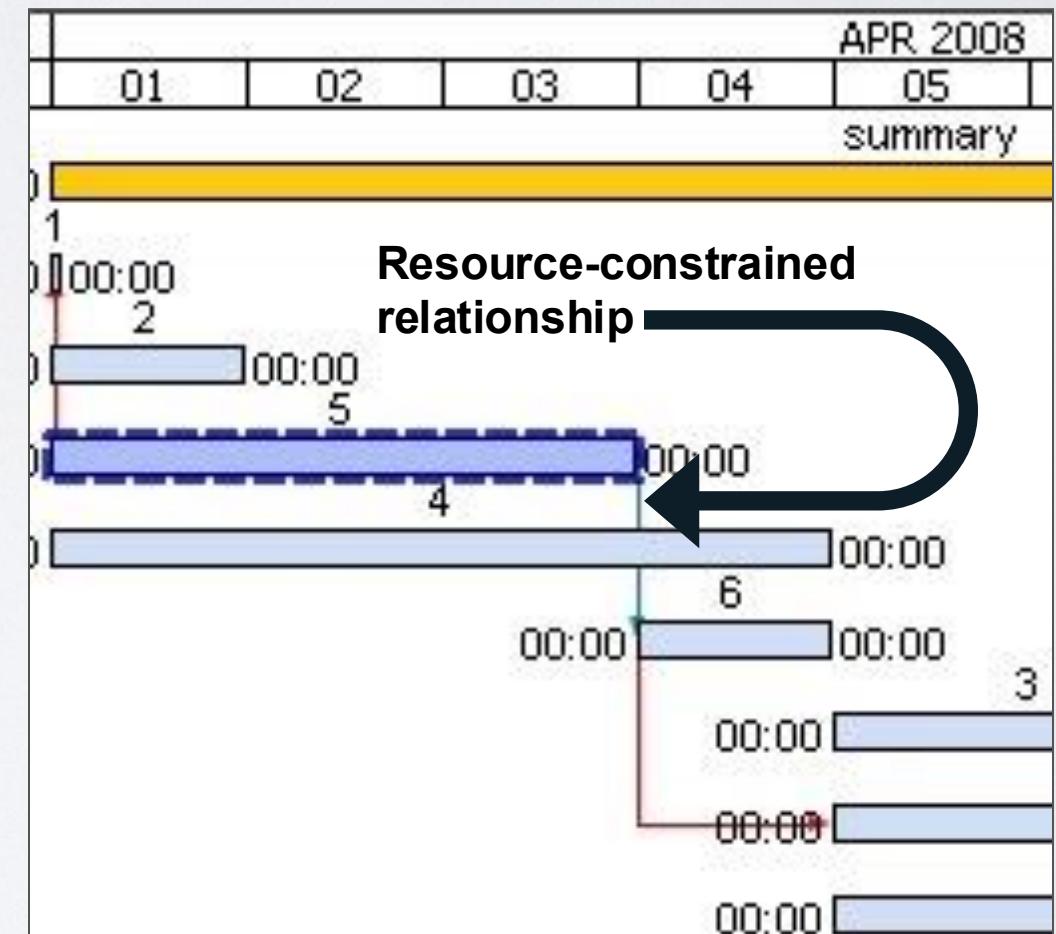
- Viewing resource contentions

In this sample schedule, each task has a resource requirement attached as follows

Task #	Resources Needed
2	1
3	2
4	2
5	2

Note that there is a total amount of only 5 resources. Tasks 2, 4, and 5 are started at the same time (5 resources used). Task 2 completes, but there are not enough resources left to start Task 6, so Task 6 must wait until Task 5 is complete.

Aurora shows you this resource-constrained relationship with a blue-grey line between the two Tasks.



TEAM ASSIGNMENT DISPLAY

Aurora - *06132016_debug.cmp

File Edit Schedule Utilities View Displays Personnel Pilot Reports Help

New Open Save Print Preview Schedule

Edit Auditor Training Tabular Editor Results Display

Configuration Appearance Zoom Inclusion Navigation Markup Uncategorized

Jun 13 2016 Jun 14 2016 Jun 15 2016 Jun 16 2016 Jun 17 2016

Monday Tuesday Wednesday Thursday Friday

DAY 738 DAY 739 DAY 740 DAY 741 DAY 742

09 10 11 12 13 14 08 09 10 11 12 13 14 08 09 10 11 12 13 14 08 09 10 11 12 13 14 08 09

Michael Starkman 06/14/2016 00:00

27	27	19	19	19	19	19	19	19	19	19	19	19	19	19	20	20	20	20	20	20	21	21	21	21	21	24	24
06/22/2016	06/22/2016	06/30/2016	06/30/2016	06/30/2016	06/30/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	
6 00:00	16 00:00	16 00:00	016	016	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00	6 00:00	16 00:00
T898001																											

Jun 13 2016 Jun 14 2016 Jun 15 2016 Jun 16 2016 Jun 17 2016

Monday Tuesday Wednesday Thursday Friday

DAY 738 DAY 739 DAY 740 DAY 741 DAY 742

09 10 11 12 13 14 08 09 10 11 12 13 14 08 09 10 11 12 13 14 08 09 10 11 12 13 14 08 09

Gary (preferred) 06/23/2016 06/24/2016 07/01/2016 07/01/2016

25	24	17	17	18	18	18	18	18	19	19	19	19	19	19	20	20	20	20	21	21	21	21	21	24	24	
06/23/2016	06/24/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	07/01/2016	
016	016	16	16	audit	audit																					
T898001																										

Gary (preferred) 06/25/2016 06/26/2016 06/27/2016 06/28/2016

26	26	26	26	26	27	27	27	27	28	23	22	22	21	22	22	22	22	21	21	21	21	21	21	21	24	24
06/25/2016	06/26/2016	06/27/2016	06/28/2016	06/29/2016	06/22/2016	06/22/2016	06/22/2016	06/22/2016	06/27/2016	06/28/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	
16	16	16	16	audit	audit	audit	audit	audit	audit	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	
R684002																										

Lacey (preferred) 06/27/2016 06/28/2016 06/29/2016 06/30/2016

26	26	26	26	26	27	27	27	27	28	23	22	22	21	22	22	22	22	21	21	21	21	21	21	21	24	24
06/27/2016	06/28/2016	06/29/2016	06/30/2016	06/22/2016	06/22/2016	06/22/2016	06/22/2016	06/22/2016	06/27/2016	06/28/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016	06/29/2016		
16	16	16	16	audit	audit	audit	audit	audit	audit	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16		
R684002																										

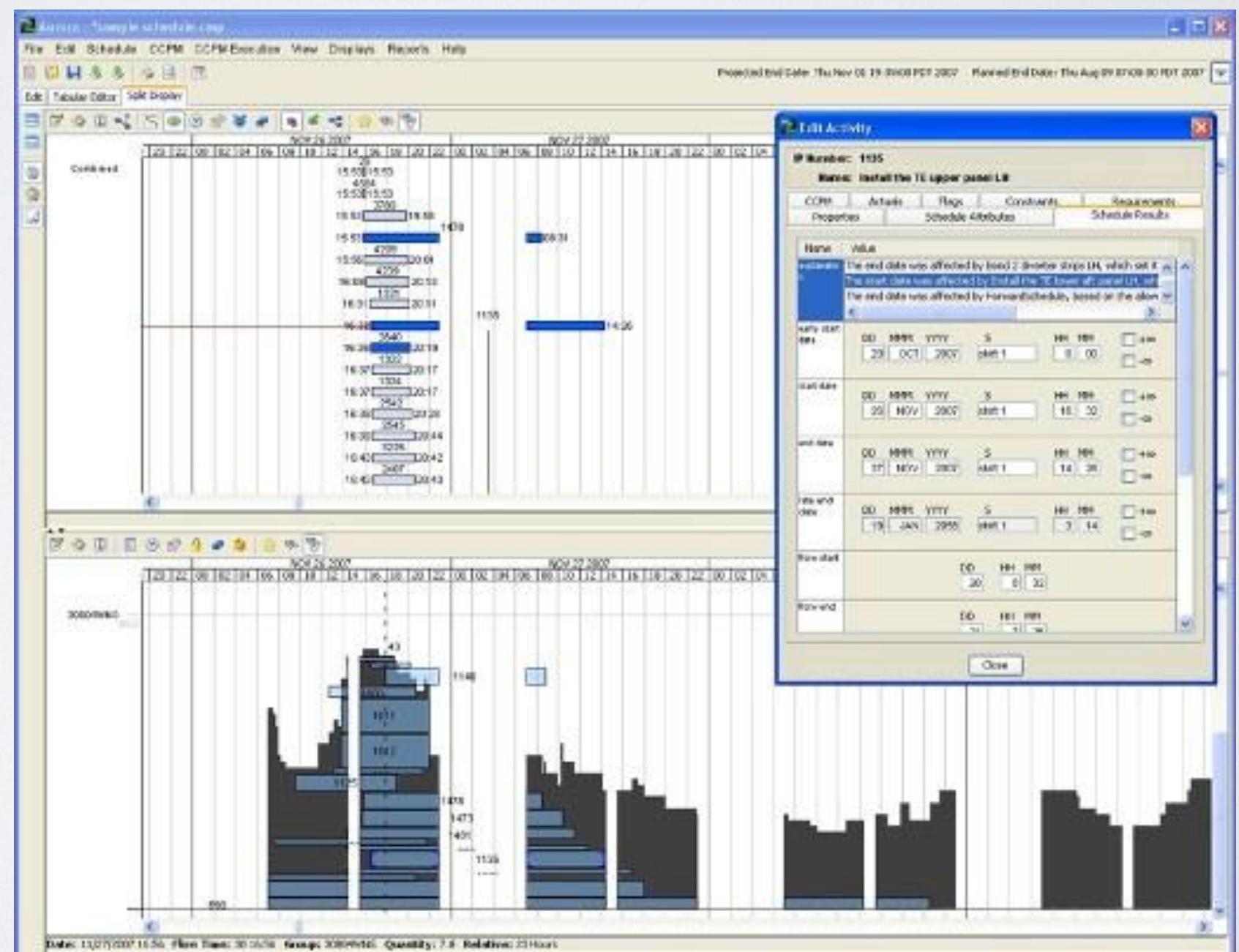
Lisa (backup) 06/27/2016 06/28/2016 06/29/2016 06/30/2016

21	21	21	21	22	22	22	22	23	23	19	19	19	19	20	20	20	20	24	24	24	24	25	25	25	24	24
06/27/2016	06/28/2016	06/29/2016	06/30/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016		
16	16	16	16	audit	audit	audit	audit	audit	audit	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16		
R638002																										

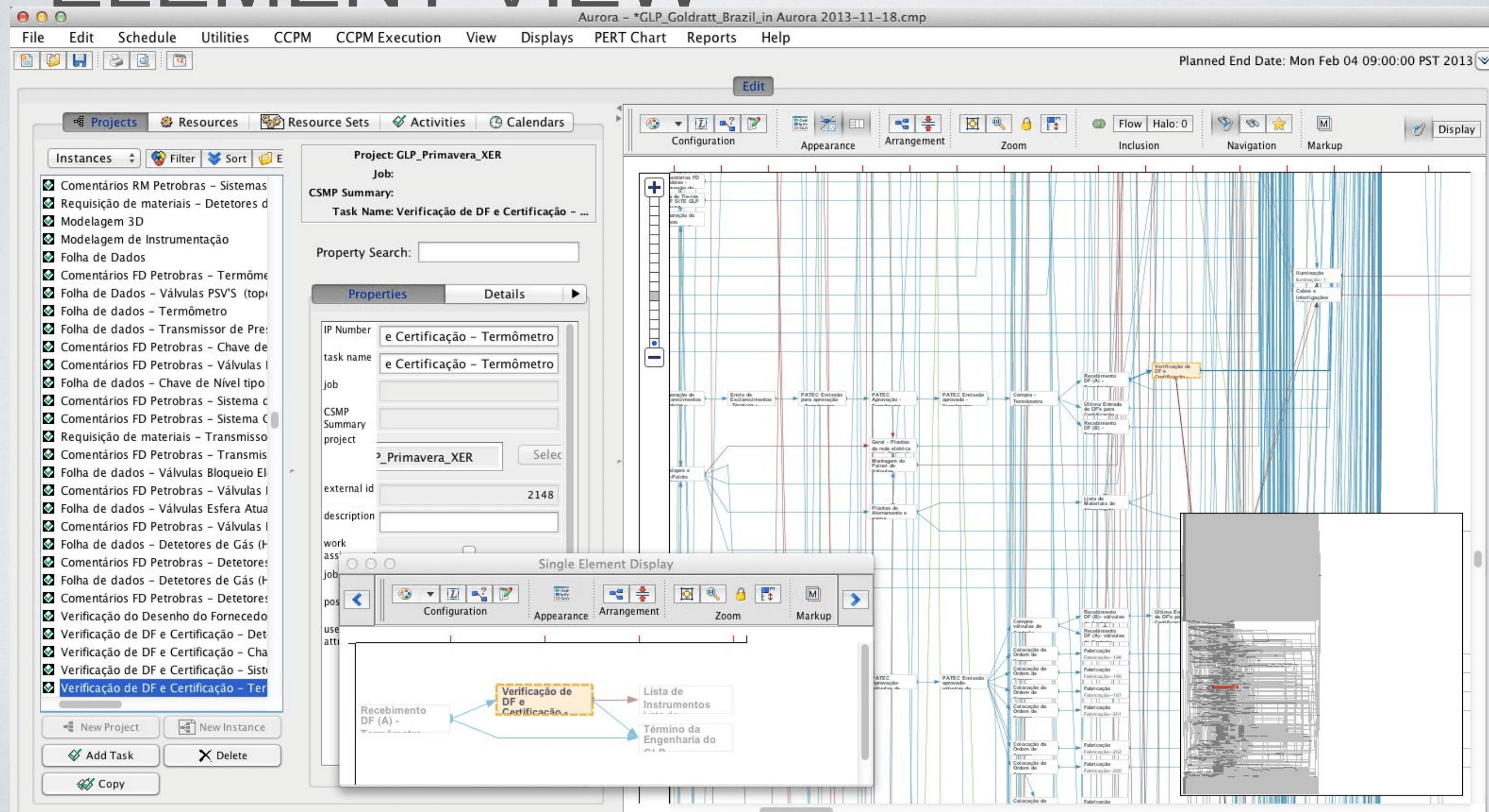
Matt (preferred) 06/27/2016 06/28/2016 06/29/2016 06/30/2016

21	21	21	21	22	22	22	22	23	23	23	23	23	23	24	24	24	24	24	24	24	25	25	25	25	27	27
06/27/2016	06/28/2016	06/29/2016	06/30/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016	06/27/2016		
16	16	16	16	audit	audit	audit	audit	audit	audit	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16		
R638002																										

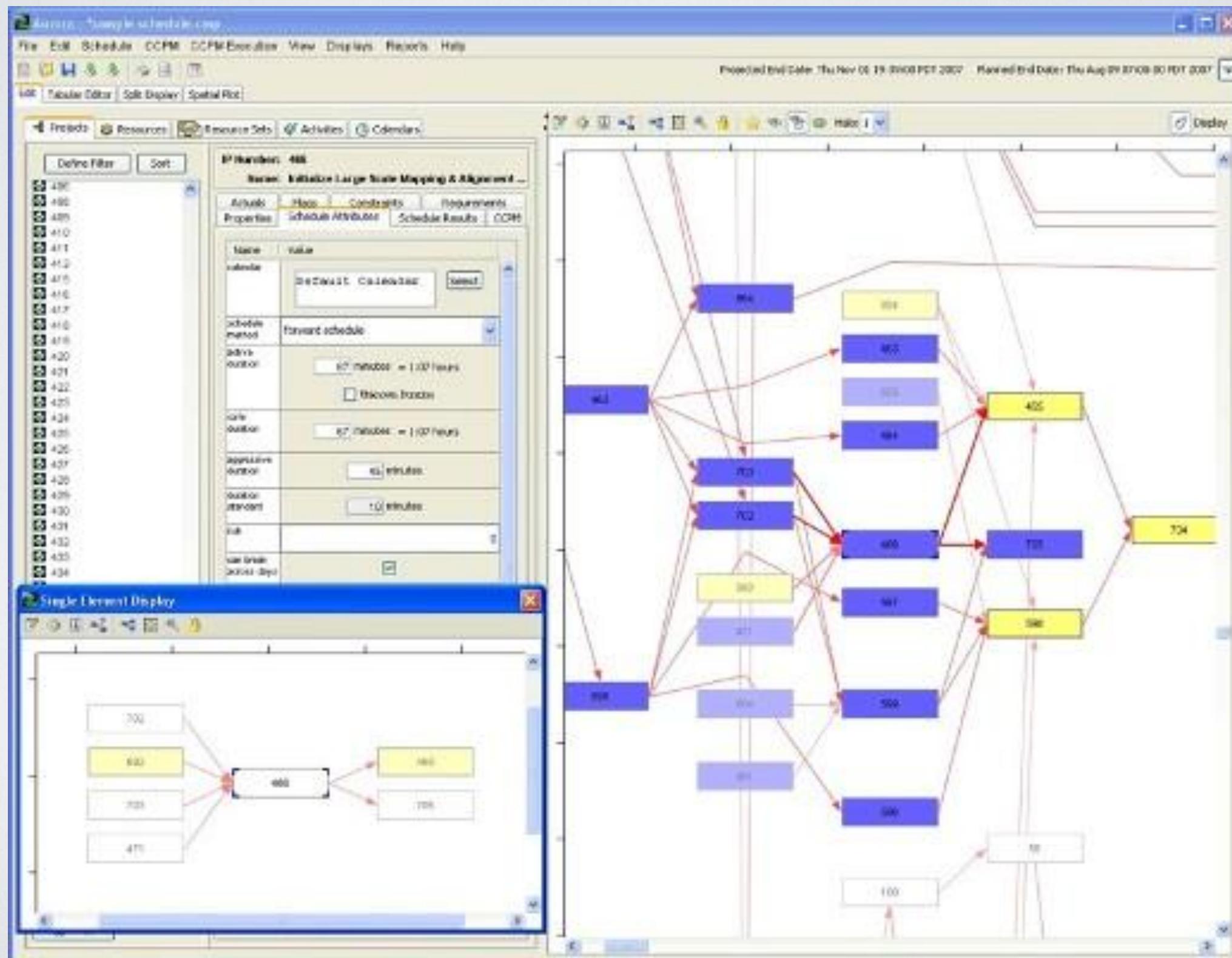
SPLIT VIEW SHOWING GANTT CHART SAME TIME SLICE AS HISTOGRAM, SHOWING ACTIVITIES CONSTITUTING RESOURCE NEED FOR ONE TIME INSTANCE



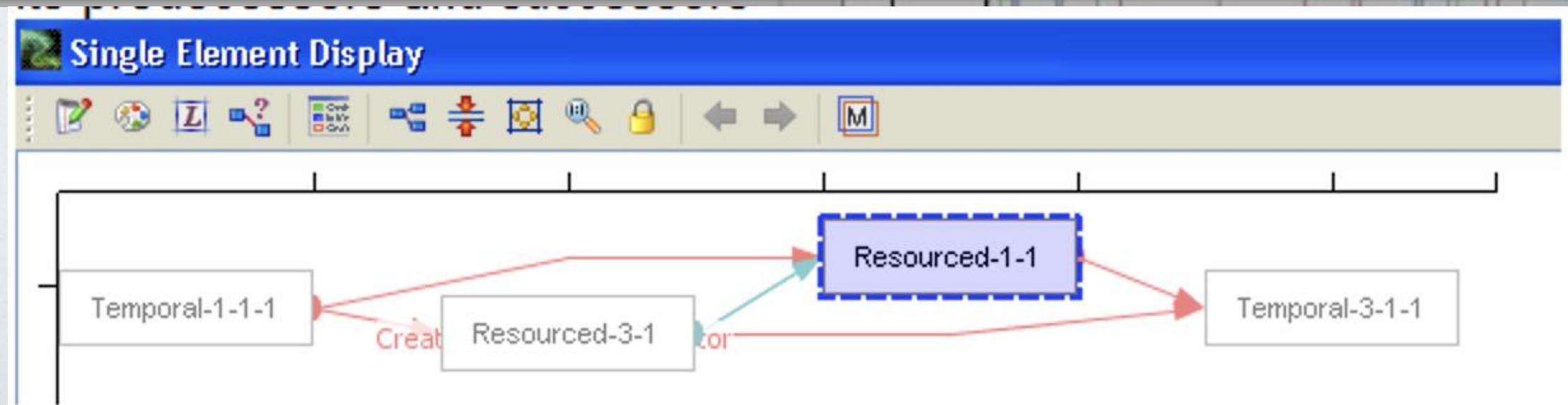
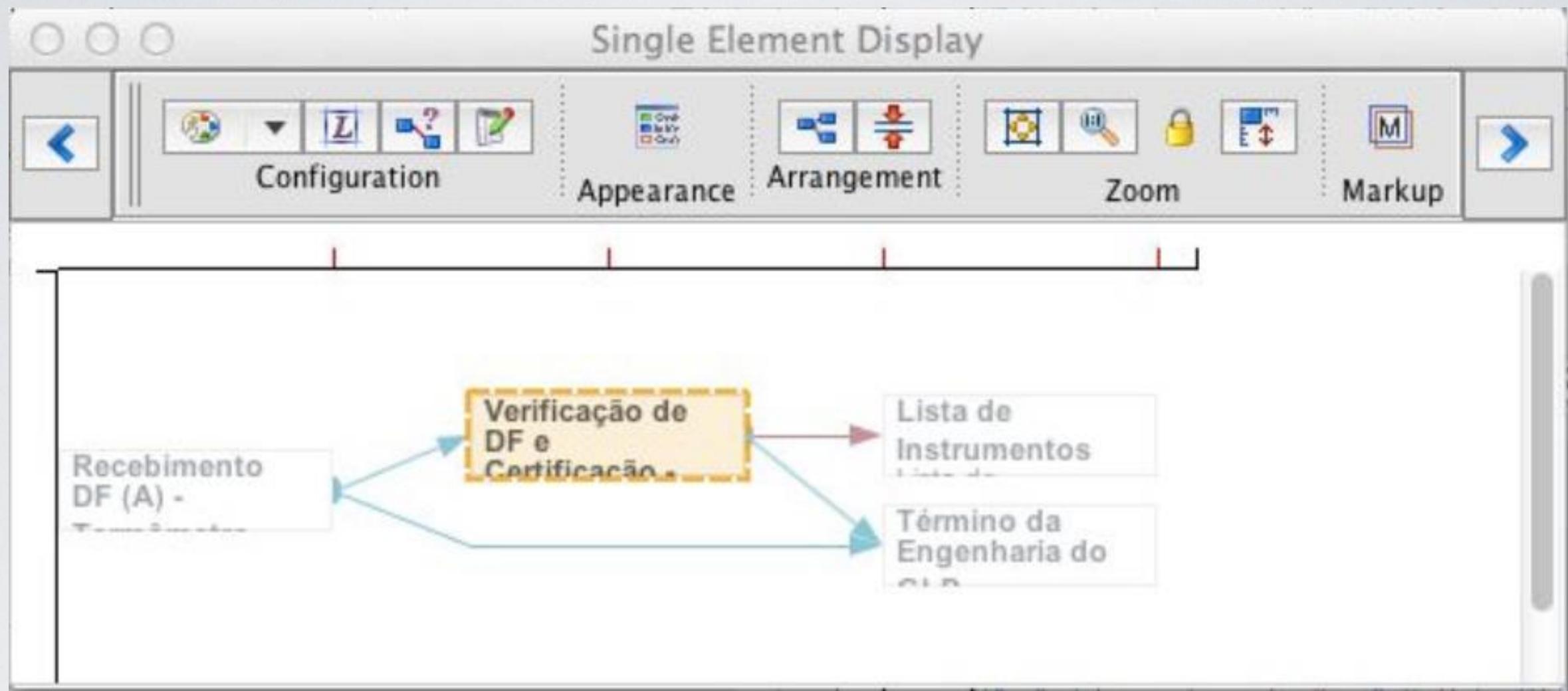
NETWORK DIAGRAM W/ MINI-MAP DISPLAY & SINGLE ELEMENT VIEW



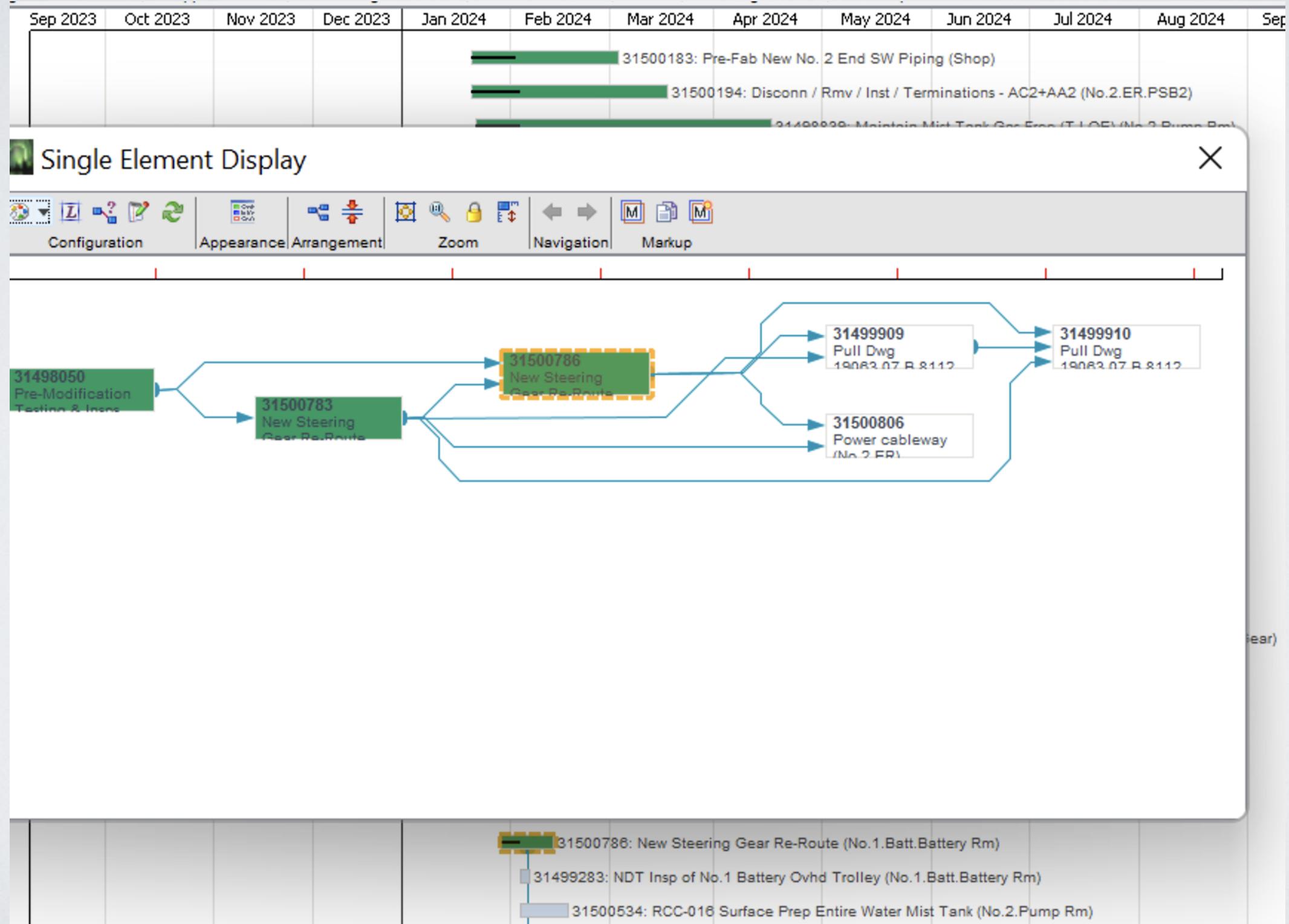
NETWORK DIAGRAM SHOWING SINGLE-ELEMENT VIEW OPTION



SINGLE ELEMENT DISPLAY



SINGLE ELEMENT DISPLAY FROM GANTT CHART



BURNDOWN CHART



EXPLAIN THE SCHEDULE

Name: Post-Operations for Hyper Servicing										
Property Search: <input type="text"/>										
Properties Details Geometry Duration Info Schedule Attributes Schedule Results CCPM Analysis Actuals Integrations Flags Constraints Requirements										
scheduled order	42									
explanation	<p>The end date was affected by the maximum flow time of 7300.00 days, which set it to 12/27/2033 00:00 The start date was affected by Hypergol Servicing for Booster Aft Skirt(s), which set it to 01/03/2014 00:00 The end date was affected by Establish Hazardous Control Area for Ordnance Ops, which set it to 12/25/2033 10:49 The start date was affected by Hypergol Servicing for Booster Aft Skirt(s), which set it to 01/04/2014 22:00 The start date was affected by ForwardSchedule, restricted by availability of Hazardous Pad-1; waiting for Pre-Ordnance Operations for Orion Pyro Safe and Test Panels, which set it to 01/05/2014 The end date was affected by ForwardSchedule, based on duration and start time, which set it to 01/05/2014 15:00</p>									

The start date was affected by the flow start time, which set it to 12/01/2017 00:00
The end date was affected by the maximum flow time of 7300.00 days, which set it to 11/26/2037 00:00
The start date was affected by [null-66](#), which set it to 12/27/2017 11:00
The end date was affected by [null-108](#), which set it to 10/29/2037 12:00
The start date was affected by [null-66](#), which set it to 01/06/2018 11:00
The start date was affected by ForwardSchedule, restricted by availability of [LWUA](#); waiting for [null-72](#), which set it to 01/16/2018 11:00
The end date was affected by ForwardSchedule, based on duration and start time, which set it to 01/17/2018 17:00

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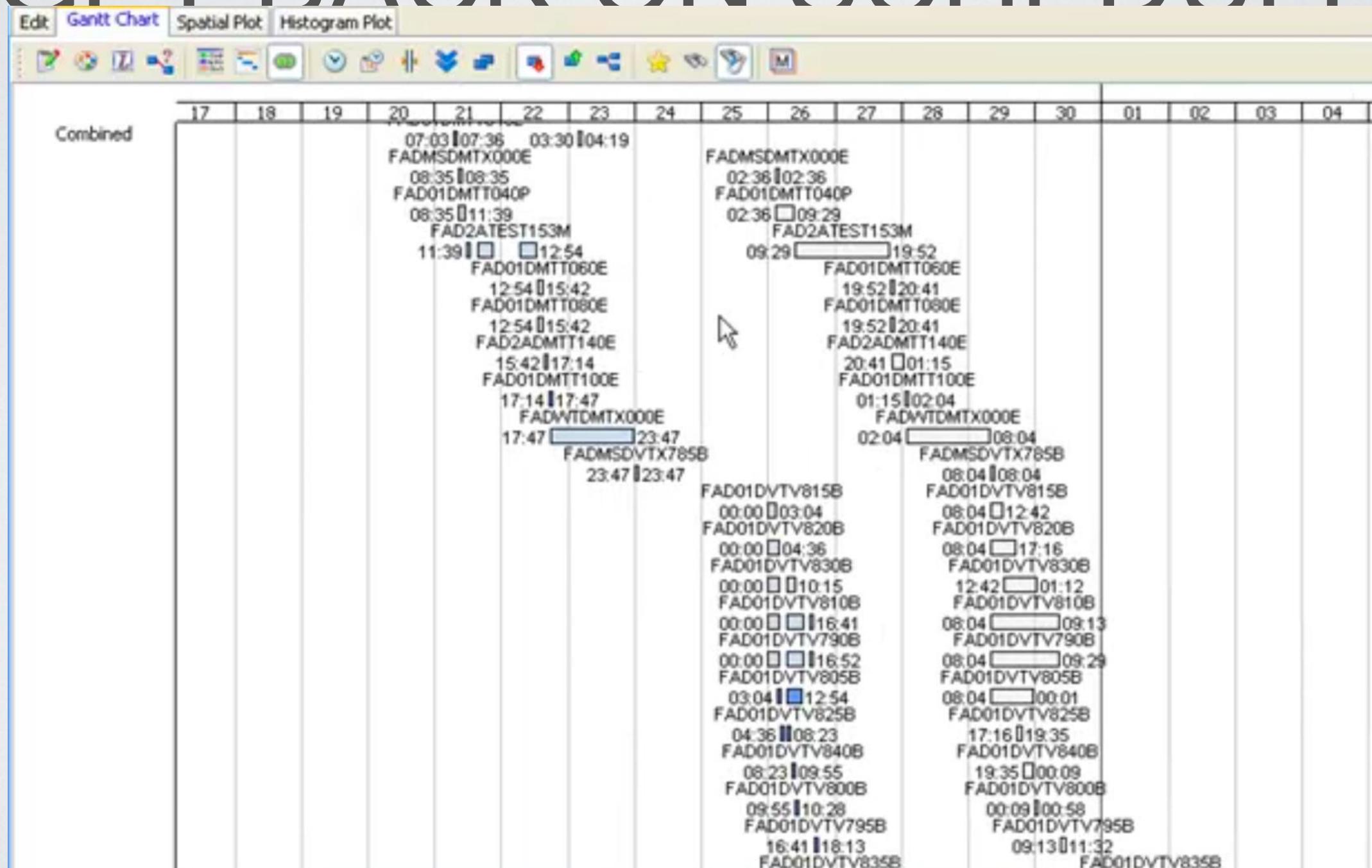
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EASY & FAST TO PERFORM SCENARIOS / WHAT-IFS

- Wall clock minimization to run a scenario critical so human schedulers will actually run them
- Provide ways to graphically compare results



WHAT-IF: WORK WEEKEND TO GET BACK ON SCHEDULE



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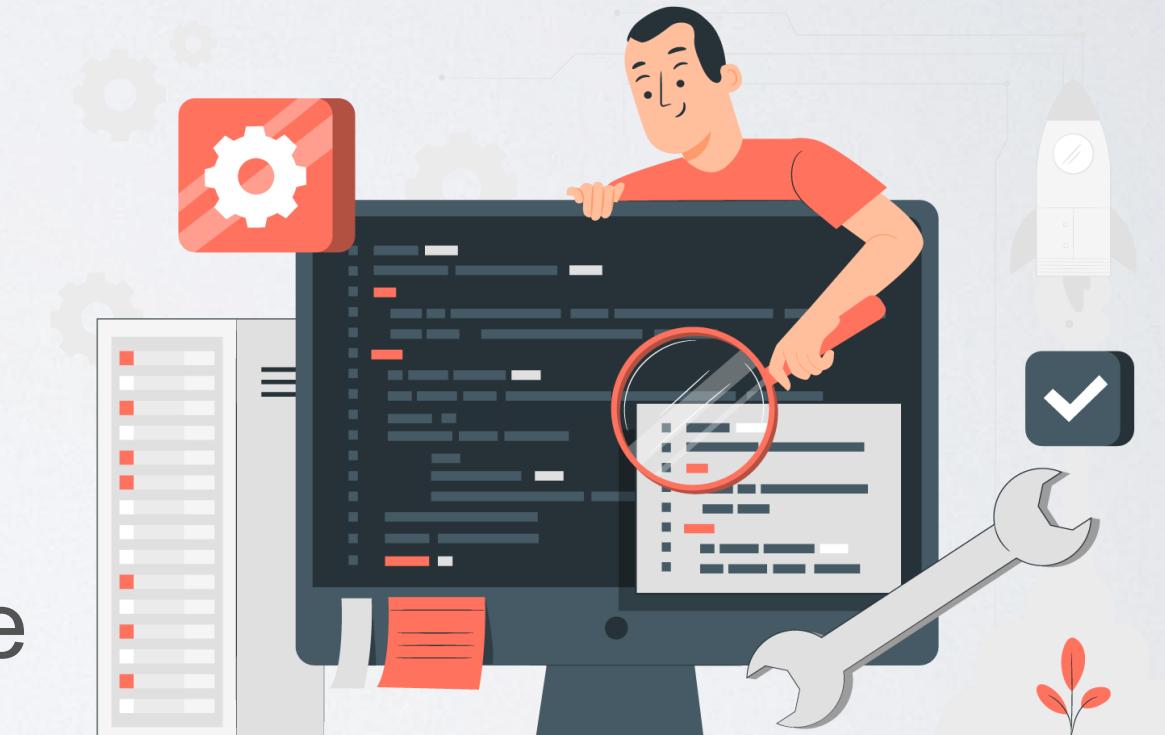
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BENEFITS OF SOPHISTICATED UNDERLYING SCHEDULER

- Results in a more realistic initial schedule
- Execution: Schedule is more flexible and better able to accommodate change.
- Schedule is “self-aware” of what tasks can most easily be moved. I.e., tasks store information about why it was placed (where it is placed).



SIGNIFICANT PRODUCTIVITY LOST DUE TO NON-REALISTIC PROJECT MODELING

- If current tool can not model the project model correctly, it can not execute efficiently.

QUESTIONS

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