

Project Management Modeling Capabilities for Increased Submarine Production and Maintenance Throughput

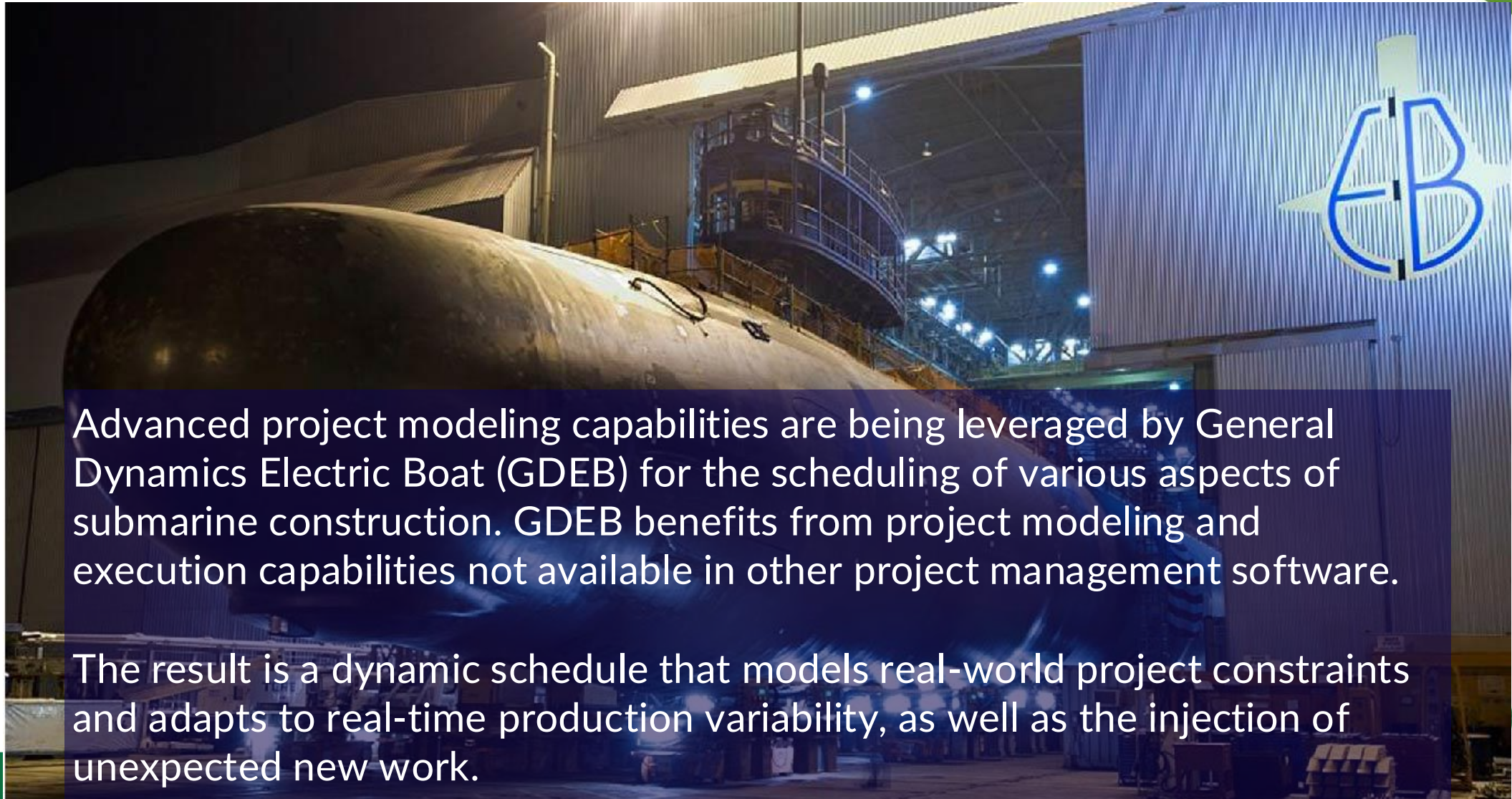
Project Controls Expo 2024

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 **Project Controls**
EXPO
Melbourne, Australia

General Dynamics Electric Boat Benefits



Advanced project modeling capabilities are being leveraged by General Dynamics Electric Boat (GDEB) for the scheduling of various aspects of submarine construction. GDEB benefits from project modeling and execution capabilities not available in other project management software.

The result is a dynamic schedule that models real-world project constraints and adapts to real-time production variability, as well as the injection of unexpected new work.

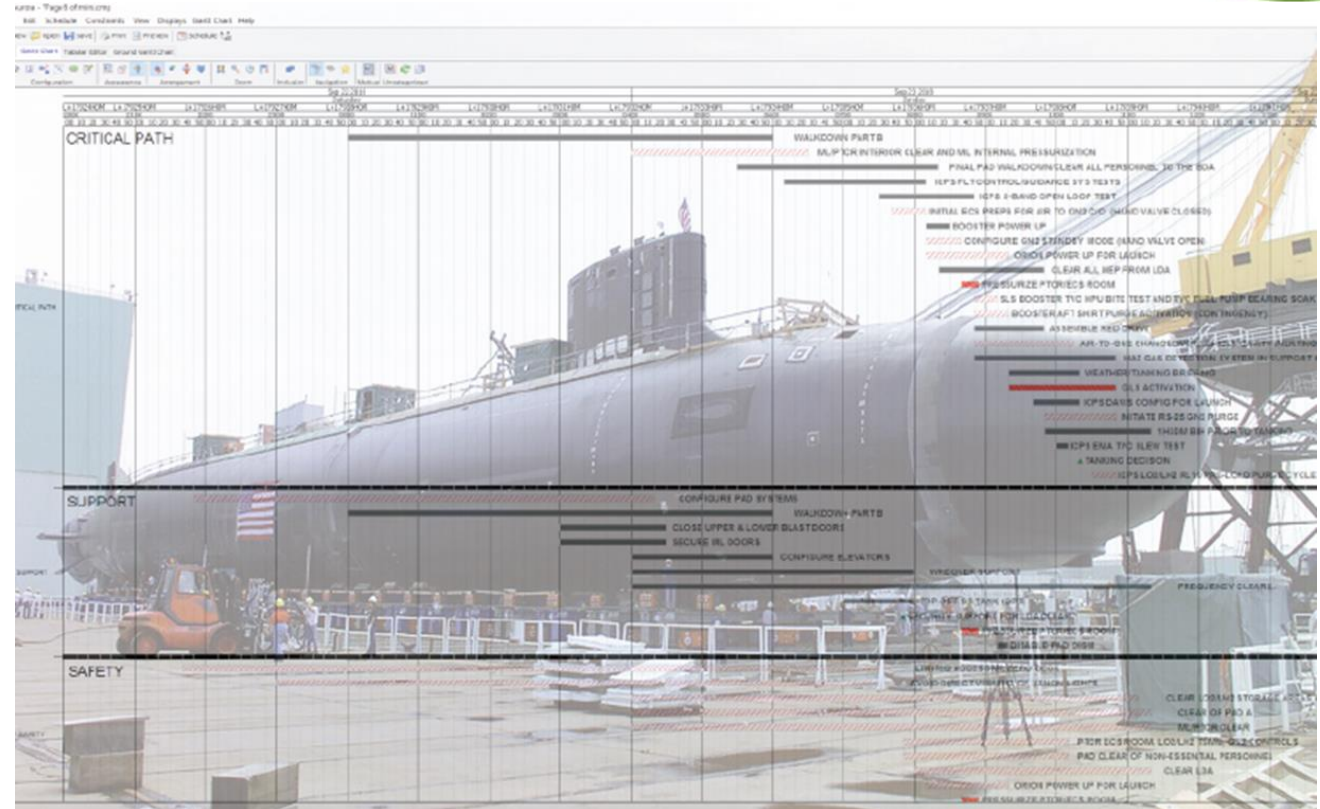
Submarine Maintenance

The US Navy used enhanced project modeling capabilities to schedule submarine maintenance operations at the Naval Submarine Support Facility (NSSF) in New London, Connecticut.



Old Methodology & 'October' Delivery

- Project properly modeled
- Detailed Schedule determined late March of following year for same 'October' delivery
- Actual delivery was early April



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
- 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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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

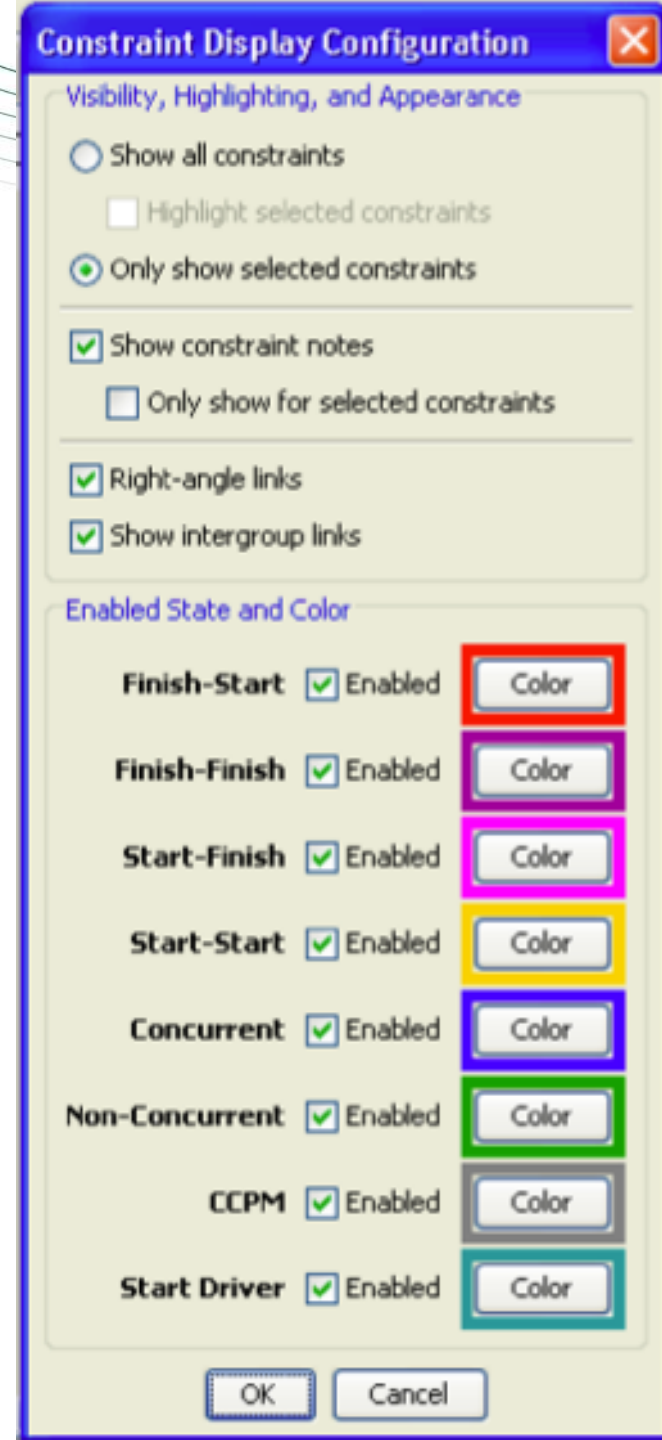
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Model to level of detail required

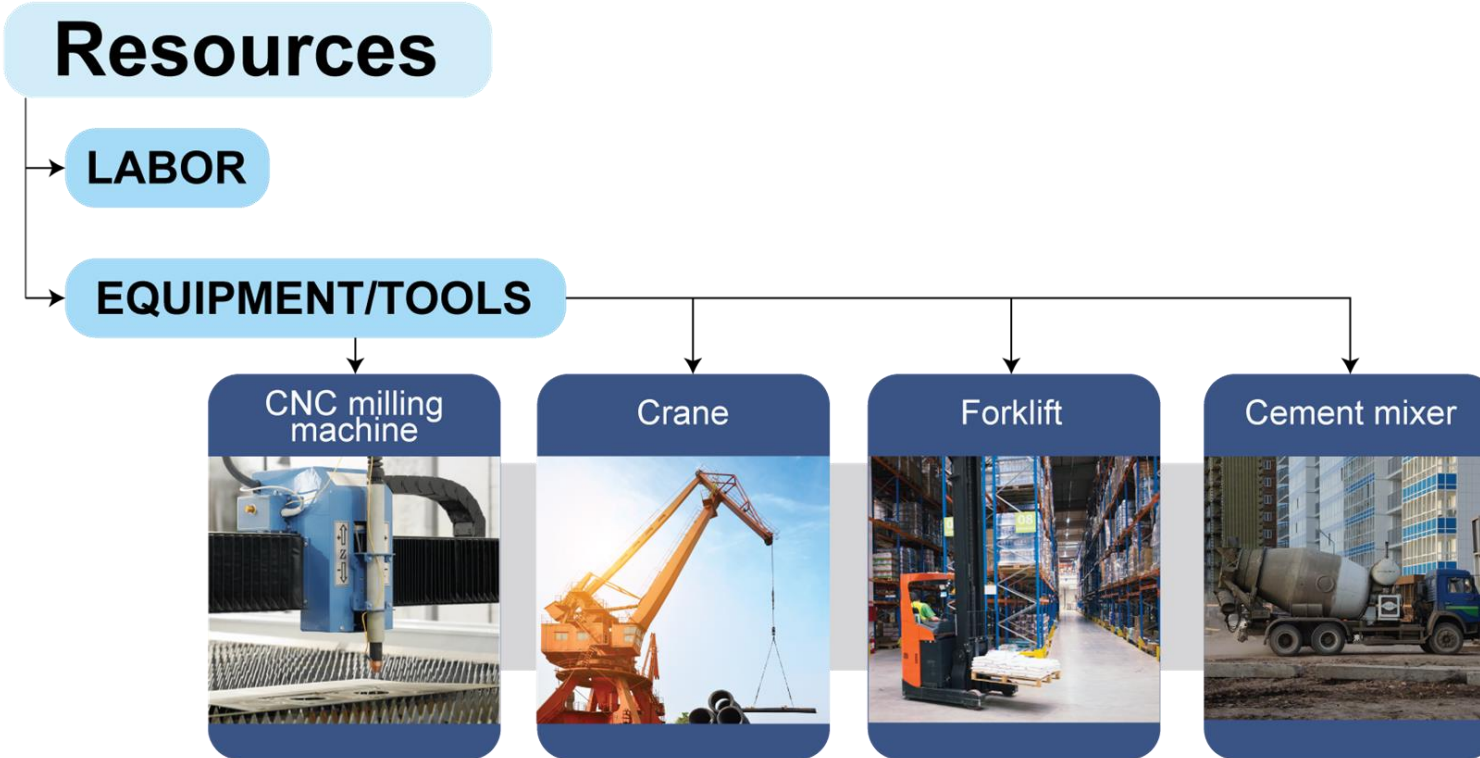
- Technical constraints (E.g., F-S, F-F, S-F, lags)
- Resources
 - Labor: Occupation, skills, certifications
 - Equipment, Tools (e.g., cranes)
- Usage constraints – e.g., tool can only be used for so many hours continuously &/or during a day.
- Spatial / physical space – e.g.,
 - job requires a certain 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



Equipment resources



Equipment substitutions

- Equipment down, know & use substitutes

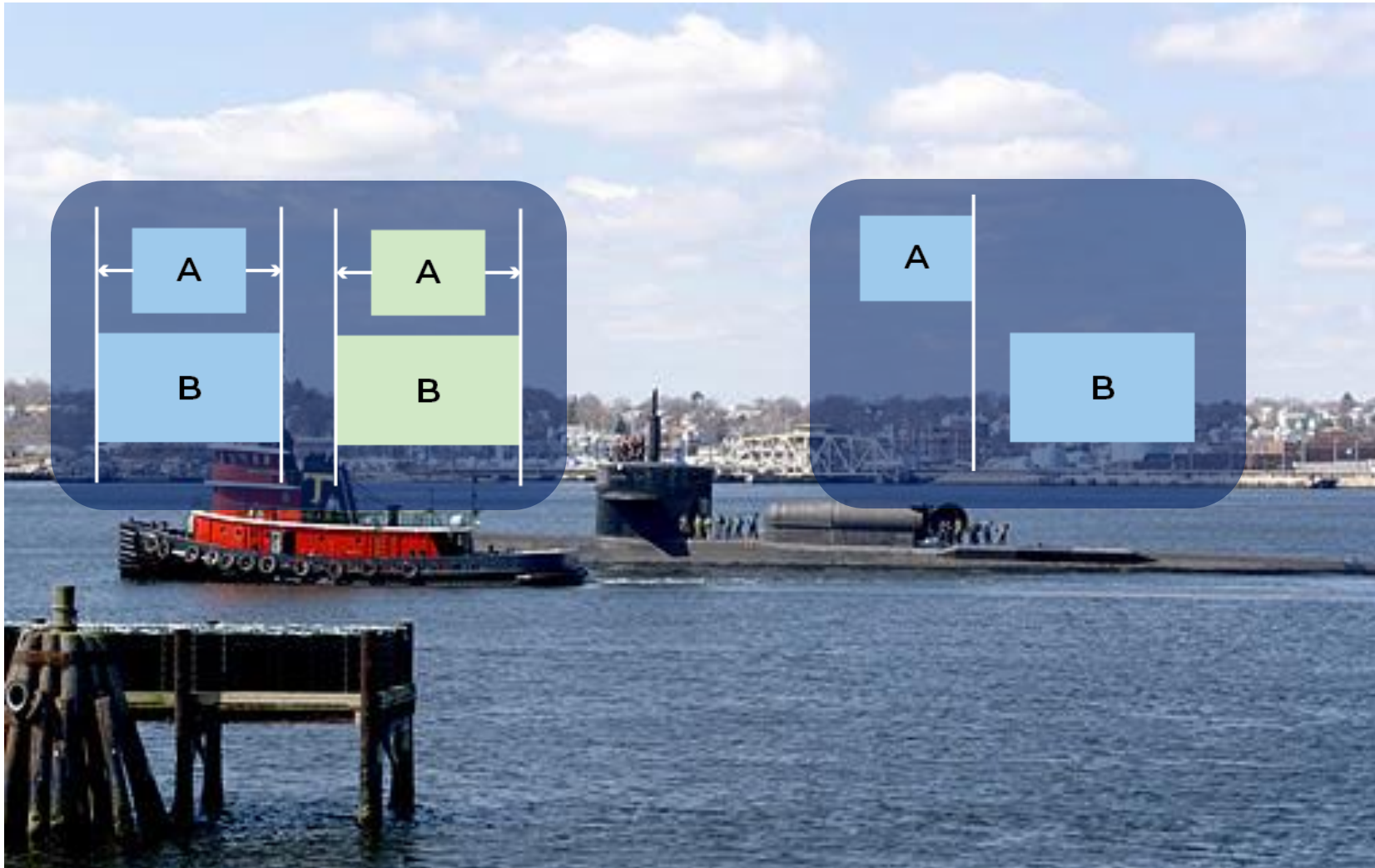


Equipment: Usage constraints

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



Concurrent & Non-Concurrent



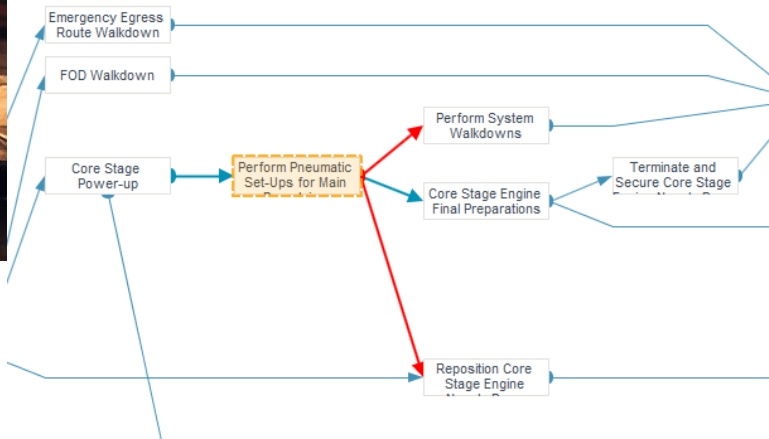
Spatial / physical space constraints

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 <= Start

Offset: 0

Max Offset:

offset calendar Select

Core Properties

Note:

Bridging Constraint:

Active:

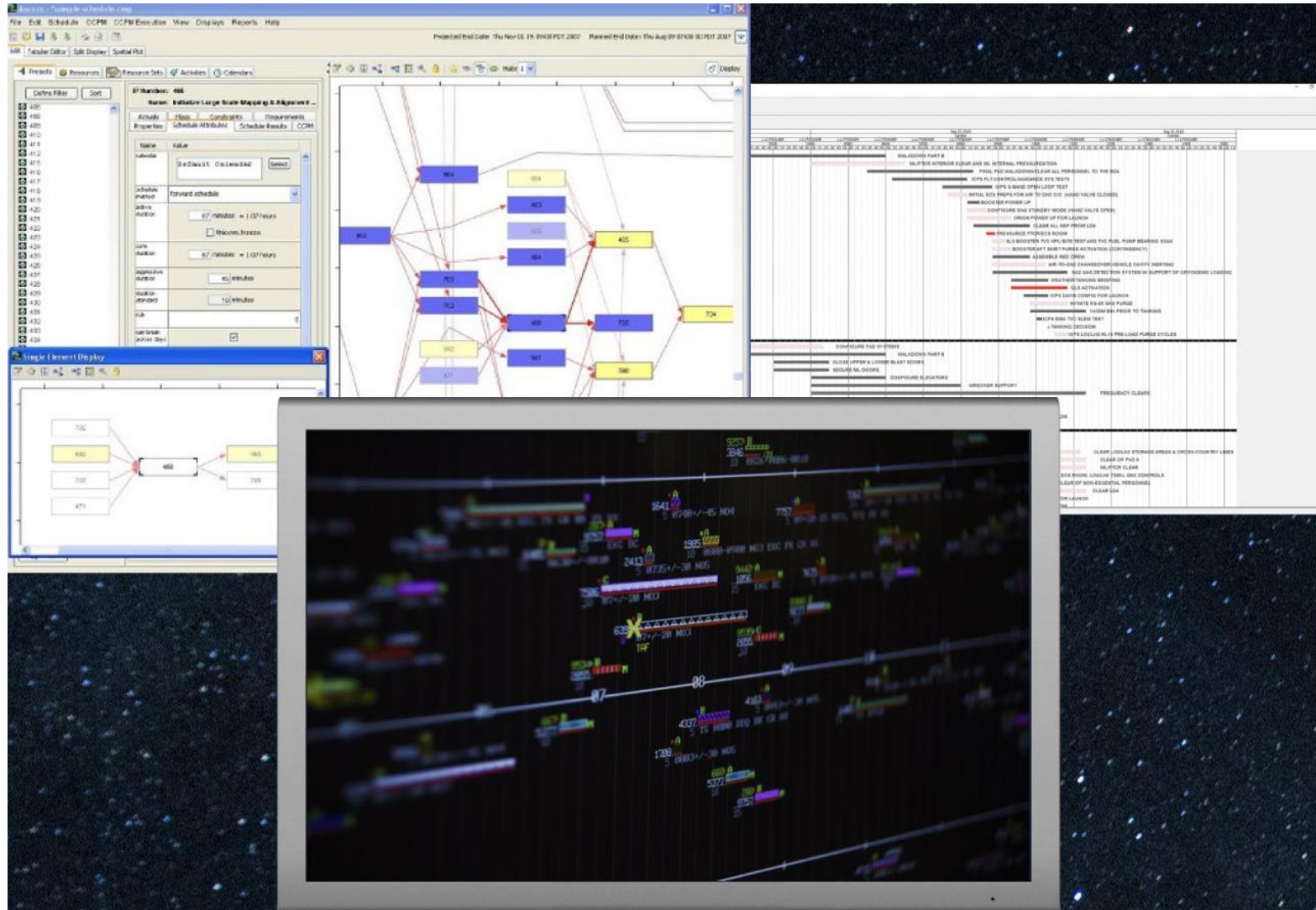
Close

Lessons & Results

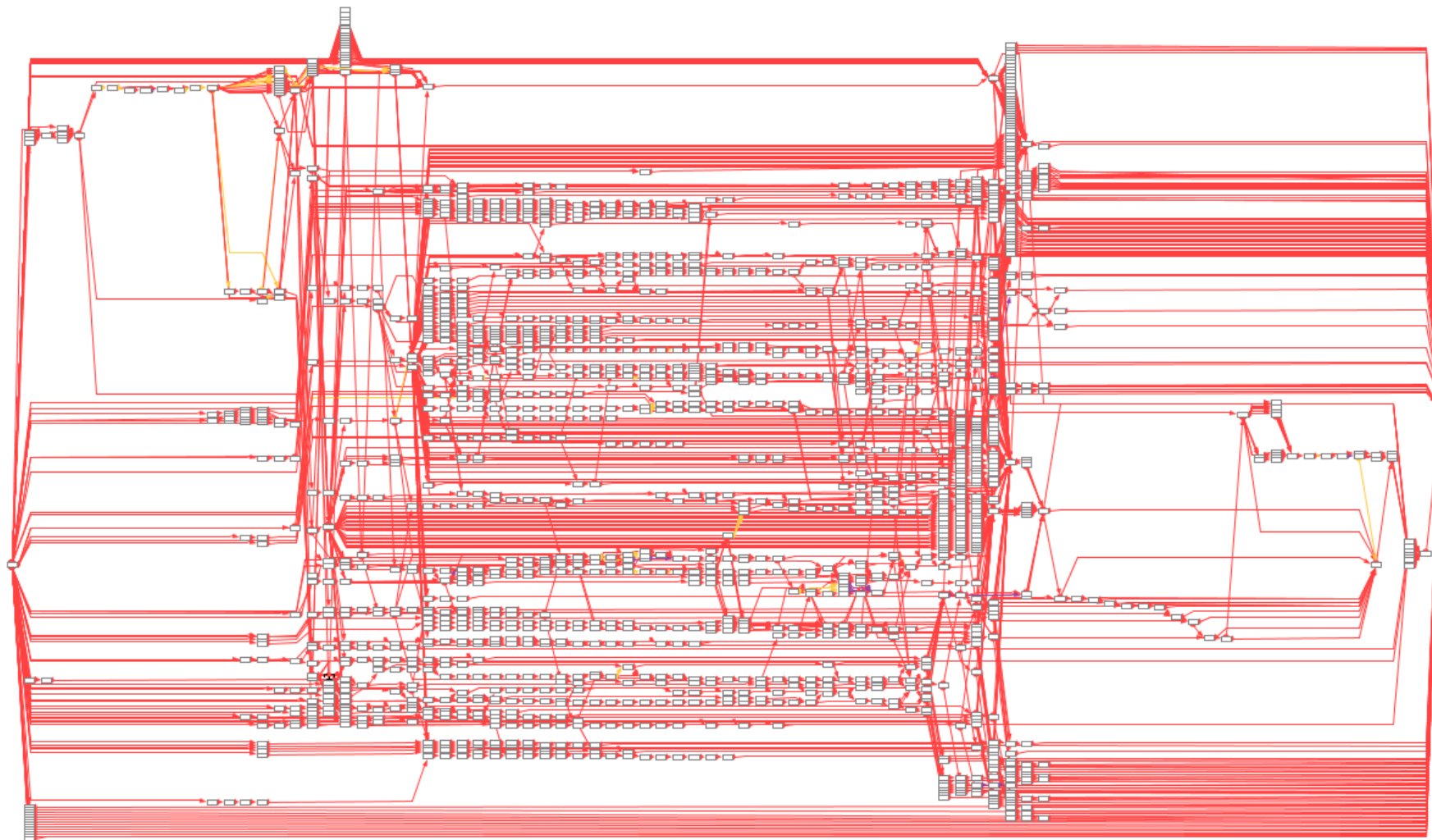
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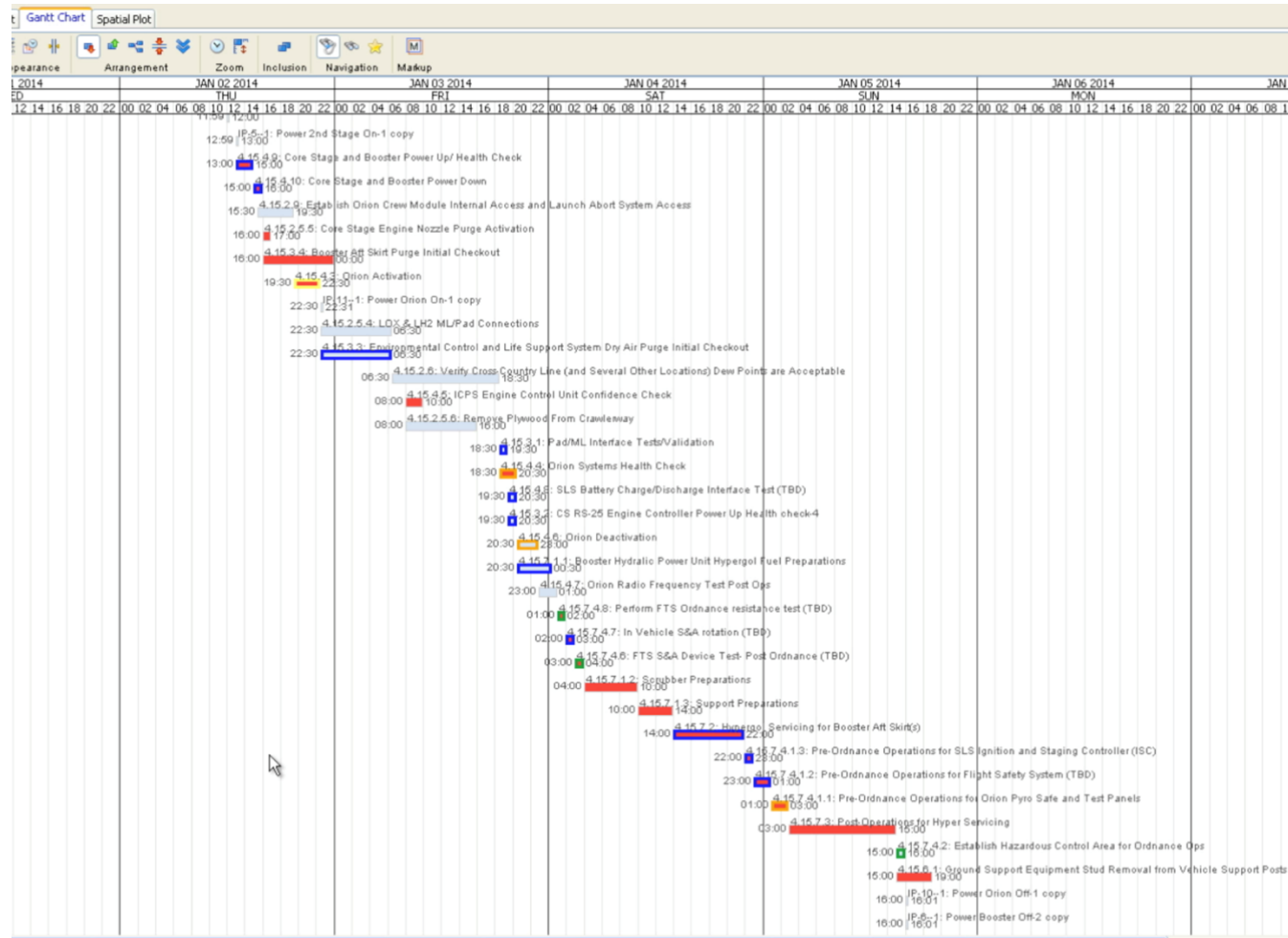
Reveal and explain the schedule



Project network



Gantt chart color-coded per user desired criteria



Resource Contention: Visual

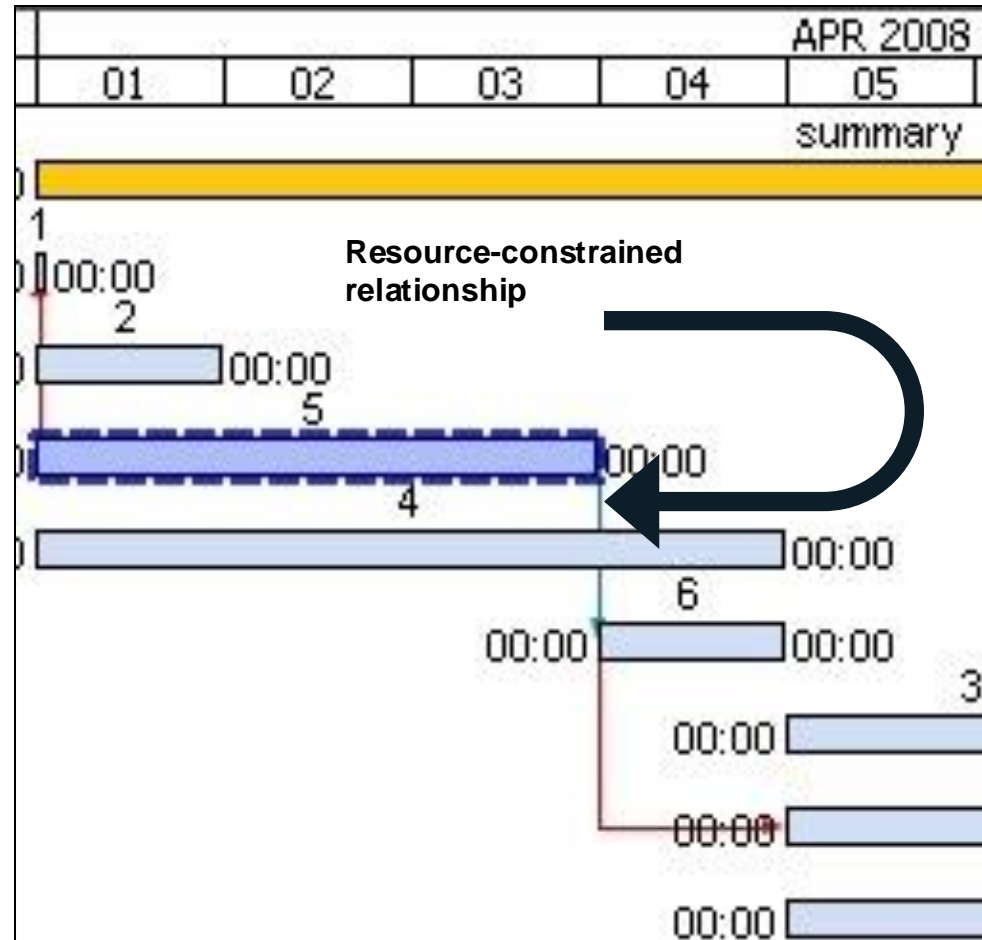
Viewing resource contentions

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

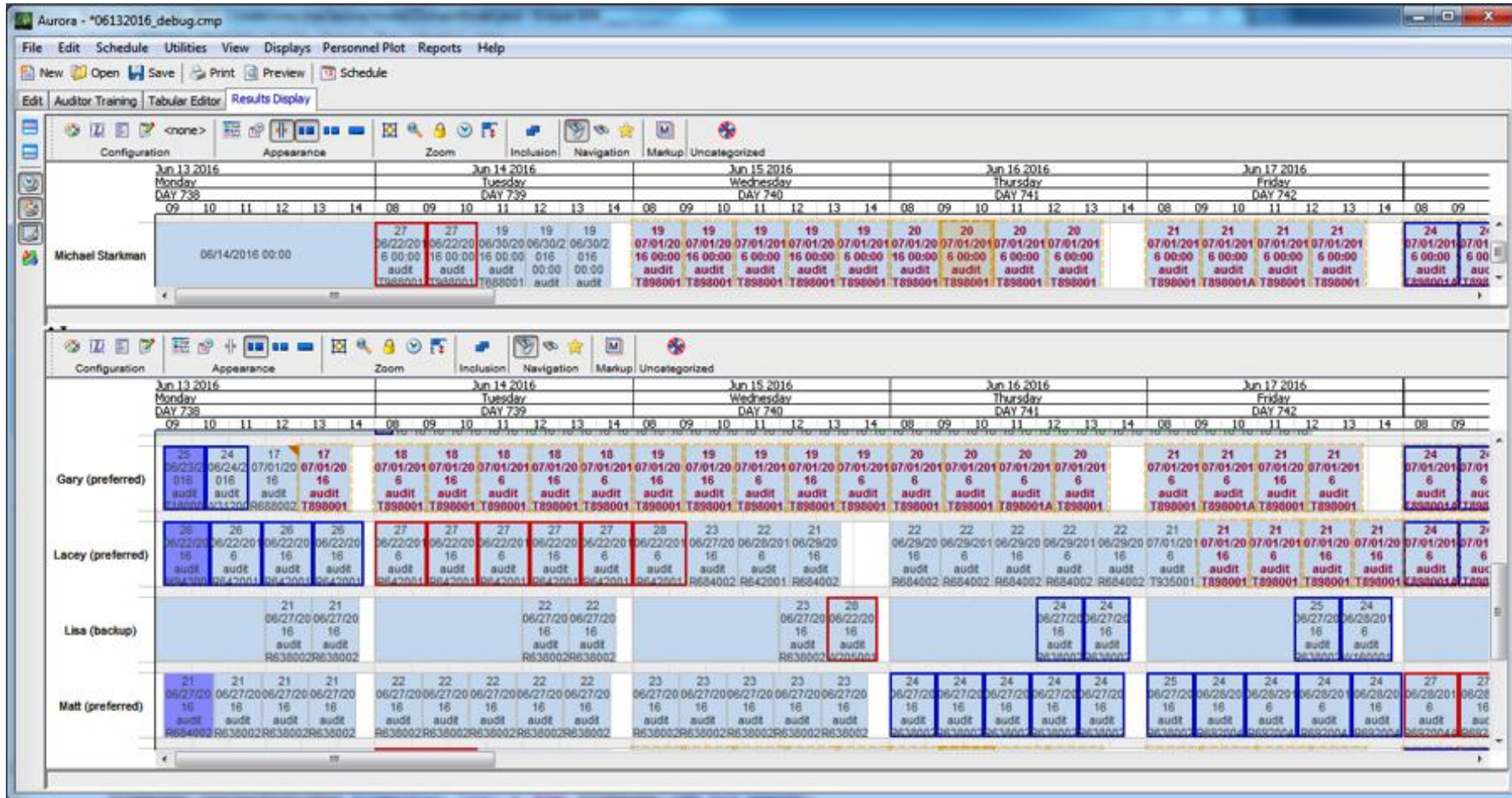
Task #	Resources Needed
2	1
3	2
4	2
5	2

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.

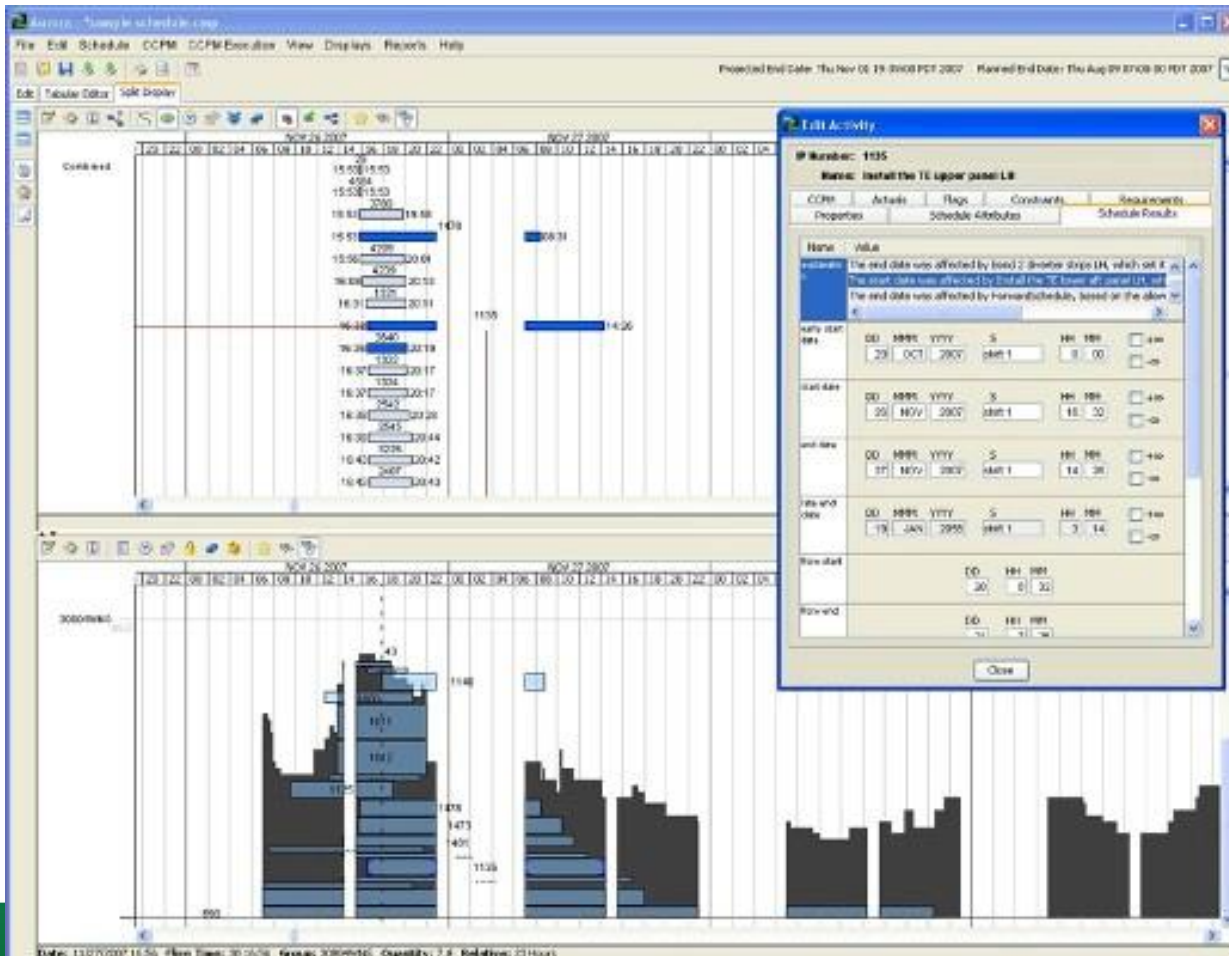
Aurora shows you this resource-constrained relationship with a blue-grey line between the two Tasks.



Team assignment display



Split view showing Gantt chart same time slice as histogram, showing activities constituting resource need for one time instance



Explain the schedule

Name: Post-Operations for Hyper Servicing

Property Search:

Properties Details Geometry Duration Info Schedule Attributes **Schedule Results** CCPM Analysis Actuals Integrations Flags Constraints Requirements

scheduled order	
4	
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</p> <p>The start date was affected by Hypergol Servicing for Booster Aft Skirt(s), which set it to 01/03/2014 00:00</p> <p>The end date was affected by Establish Hazardous Control Area for Ordnance Ops, which set it to 12/25/2033 10:49</p> <p>The start date was affected by Hypergol Servicing for Booster Aft Skirt(s), which set it to 01/04/2014 22:00</p> <p>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</p> <p>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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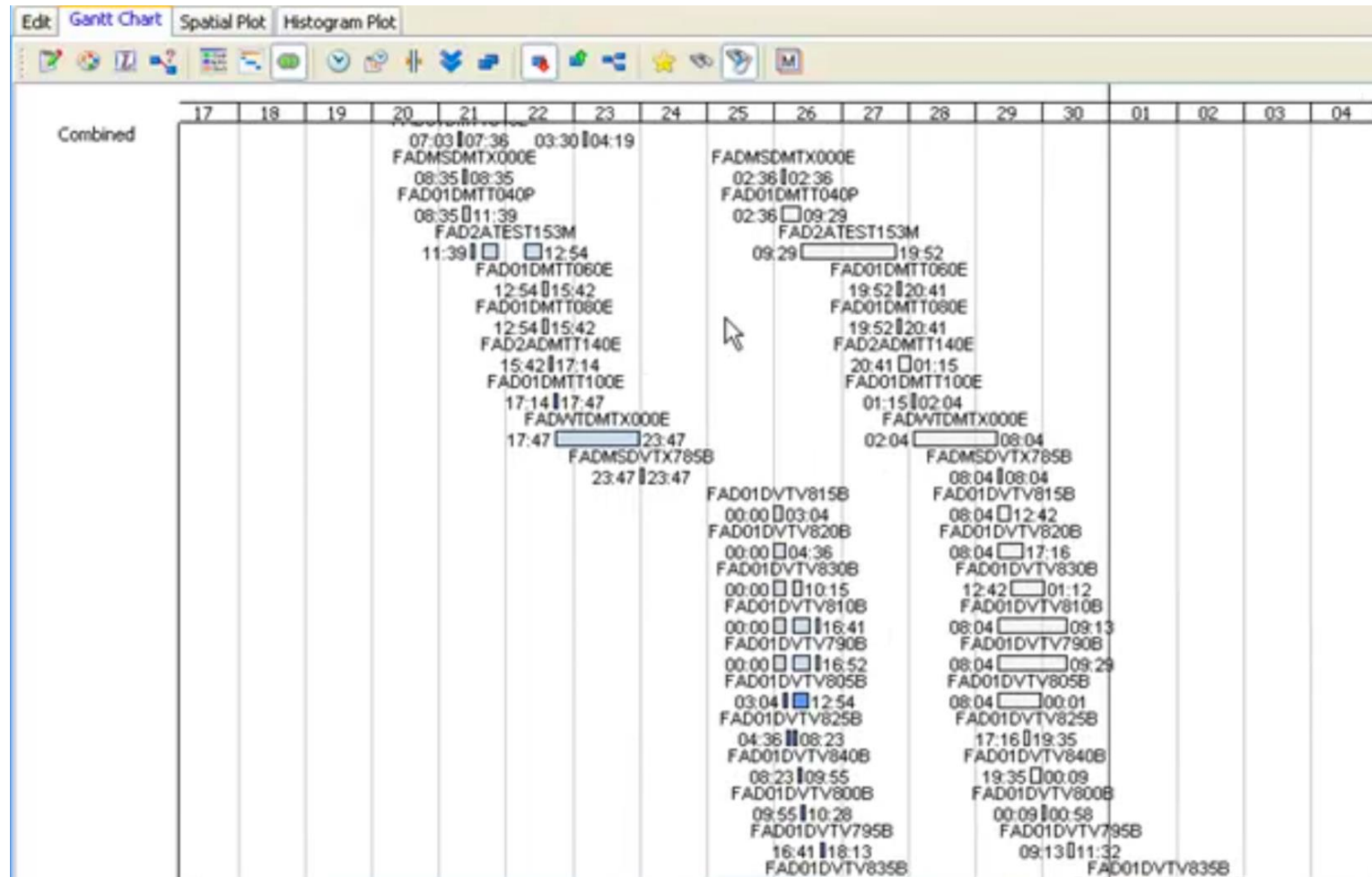


Easy & fast to perform scenarios / what-ifs

- 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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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.

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THANK YOU



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