ICAPS-UISP 2017

So you want to field your intelligent planning and scheduling system? Then suck it up!

June, 2017

Dick Stottler

Stottler Henke Associates, Inc.

Overview

- Background
- Principles of UI Design for Acceptance and Fielding of IP&S Systems
- Details for each principle
- Examples for each principle
- Some notes about future UI options
- Summary

Background

(Mostly obvious, but just in case …)

- Every domain/client/end-users are different
  - Vocab/concepts/algorithms/technical sophistication => UI
- Many domains are only semi-modeled
  - Both on-purpose (avoid eye-rolls) and because of errors
- User (Interface) efficiency / Good UI design is important
- Real World UI Design Heuristics
- Existing Work Flow/ConOps/Bureaucracy
- **The user will sense and perceive your IP&S system entirely through its user interface**
- "You can not automate me!" - Tom Overton, NASA KSC Mission Planning Office, 1990. Lots of initial skepticism!

UI Design Principles for IP&S System Acceptance (Decreasing Frequency/Importance)

- General Good UI Design Principles
- Explanations/Trust (see quote above)
- Go with the (work) flow
- Flexibility/Robust UI
- User Acceptance Requirements (See title above)
- Legacy System Integration
- Different domains = Different Conflict concepts
- User editing “final” product / replanning
- Special UI Challenges with truly distributed / mixed initiative planning and scheduling

General Good UI Design Principles

Use clients Vocab/Concepts/Symbology/Look/Reports

- Quick understanding
- Semi-Modeled domain (both on-purpose and errors)

Resource versus time (individual and pooled resources)

Task Analysis/Cog. Task Analysis: What need to do, What Decisions, What information needed for those decisions, Info. on screen, minimize mouse clicks

- Real users are often very sensitive to UI Efficiency!

Existing system – what do they like and hate about the UI?

See the actual work environment, response time frame

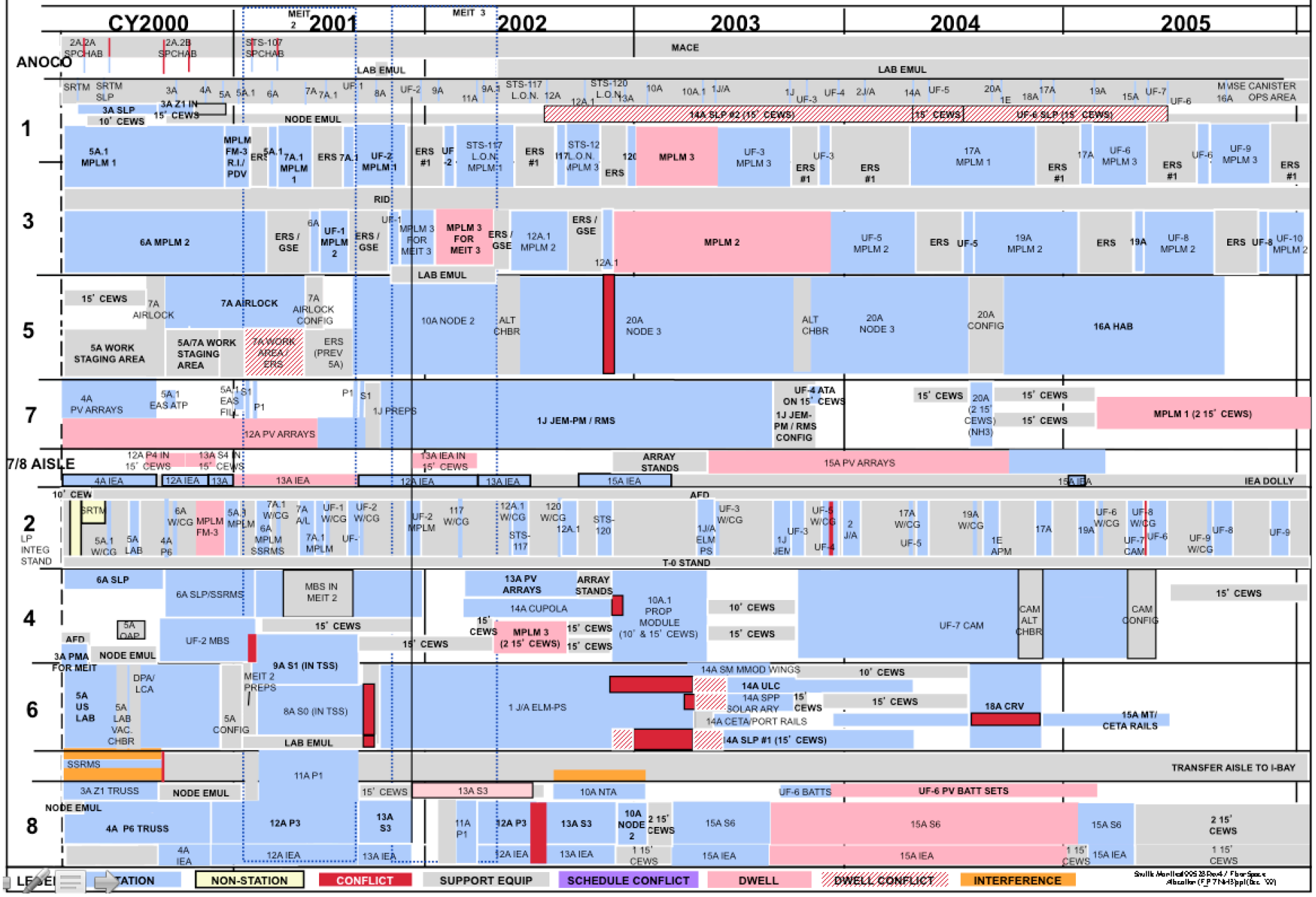
How long it's going to take / Progress bars / How automatic you make it

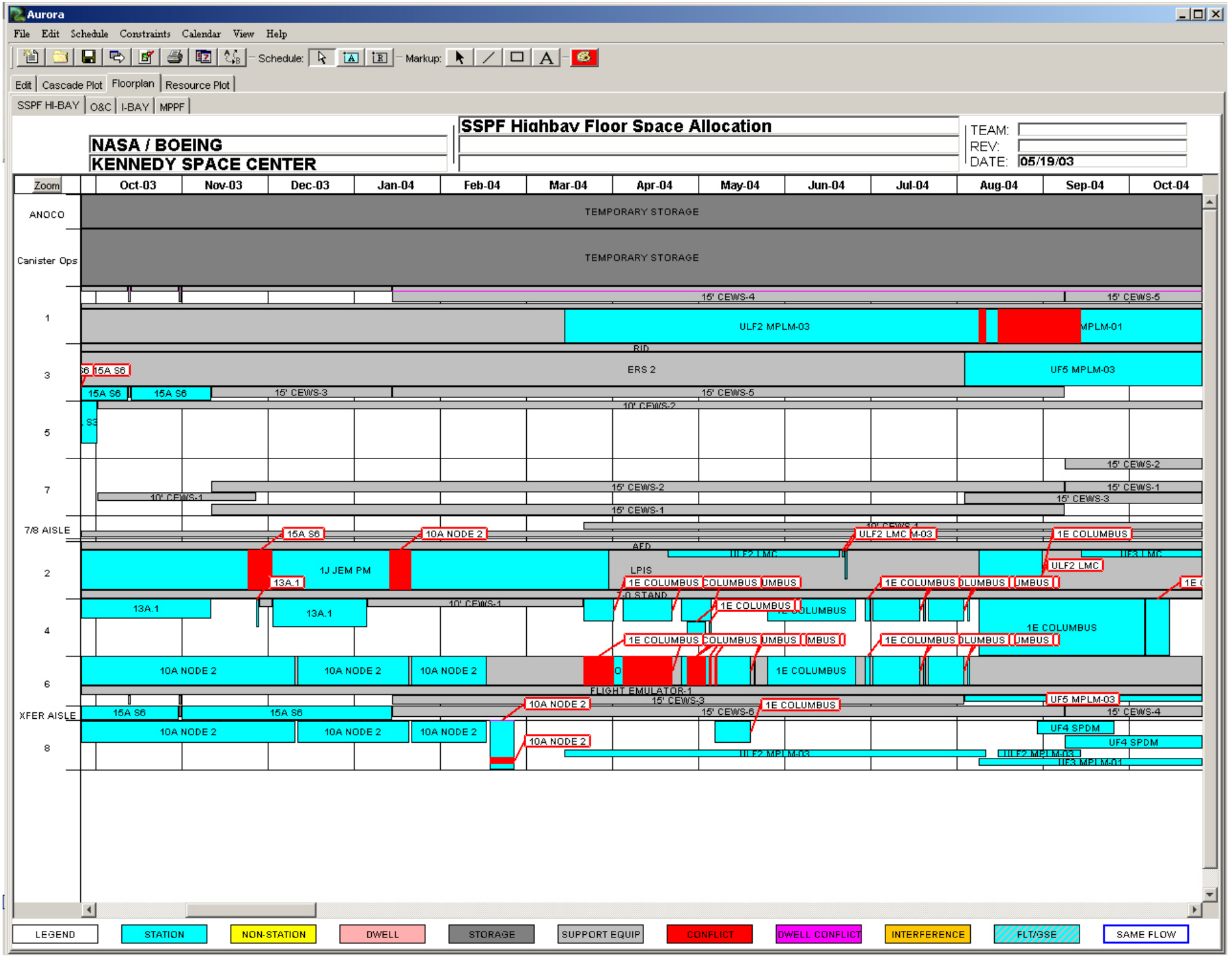
Talk to users at beginning and throughout, bounce story boards off them and preliminary versions.

NASA / *BOEING*
KENNEDY SPACE CENTER

SSPF Highbay Floor Space Allocation
(Shuttle Manifest Study Option 99C-13 Launch Dates)
(F/P 7 & 8 NH3, MEIT 3, 2J/A in O&C, SPP in VPF)

TEAM: **M/SAT**
REV: **Basic**
DATE: **04/04/00**

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SSPF HI-BAY O&C I-BAY MPPF
NASA / BOEING
KENNEDY SPACE CENTER
SSPF Highbay Floor Space Allocation
TEAM:
REV:
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Zoom
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LPIS
1E COLUMBUS
ULF2 LMC
UF3 LMC
10A NODE 2
FLIGHT EMULATOR-1
UF4 SPDM
UF2 MPLM-03
UF3 MPLM-01
LEGEND
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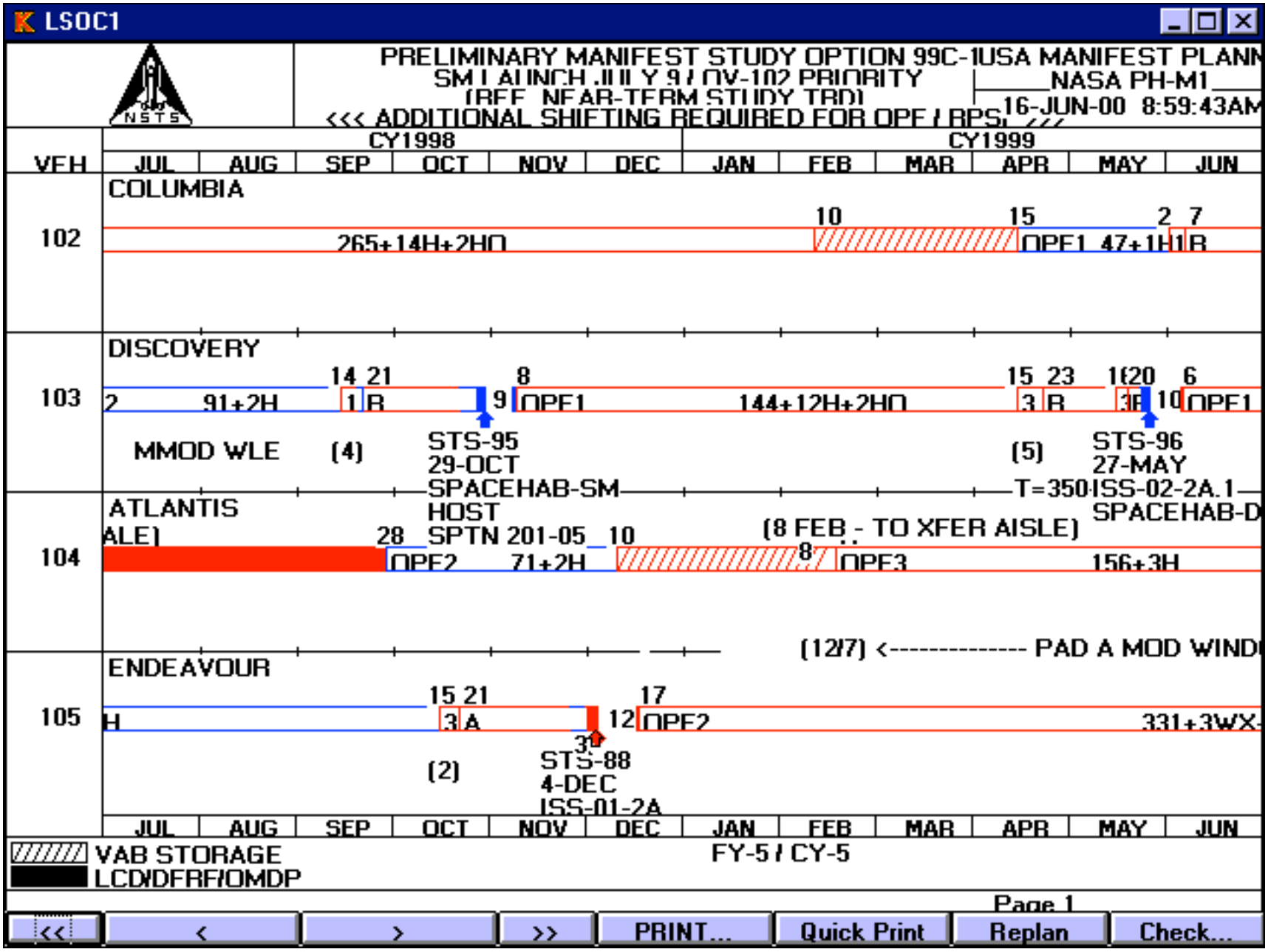
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PRELIMINARY MANIFEST STUDY OPTION 99C-1USA MANIFEST PLANN
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(REF NEAR-TERM STUDY TBD)
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Quick Print
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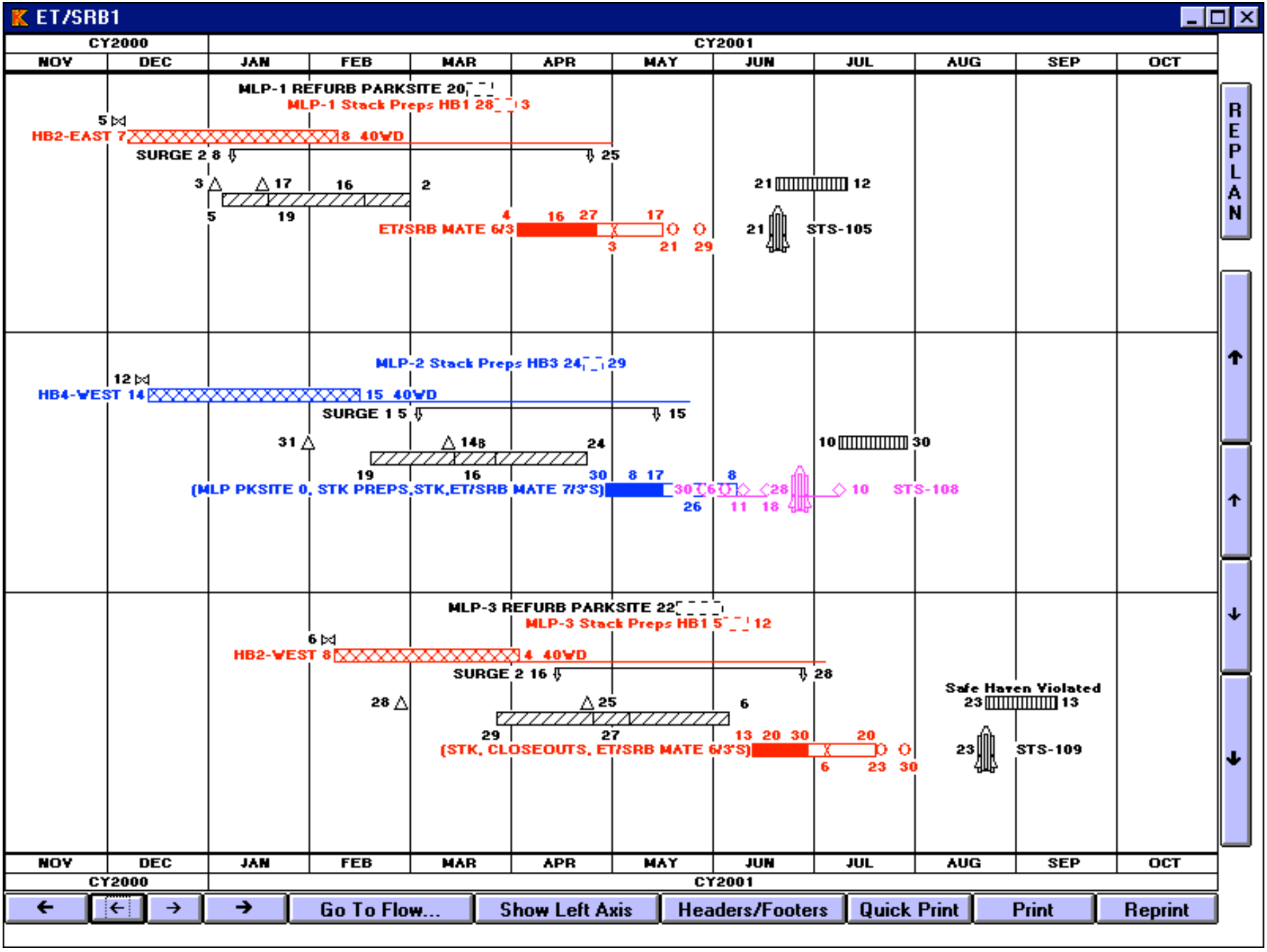
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MLP-1 Stack Preps HB1 28 3
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SURGE 2 8
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ET/SRB MATE 6/3
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12
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STS-105
MLP-2 Stack Preps HB3 24 29
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HB4-WEST 14
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MLP-3 Stack Preps HB1 5 12
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HB2-WEST 8
4 40WD
SURGE 2 16
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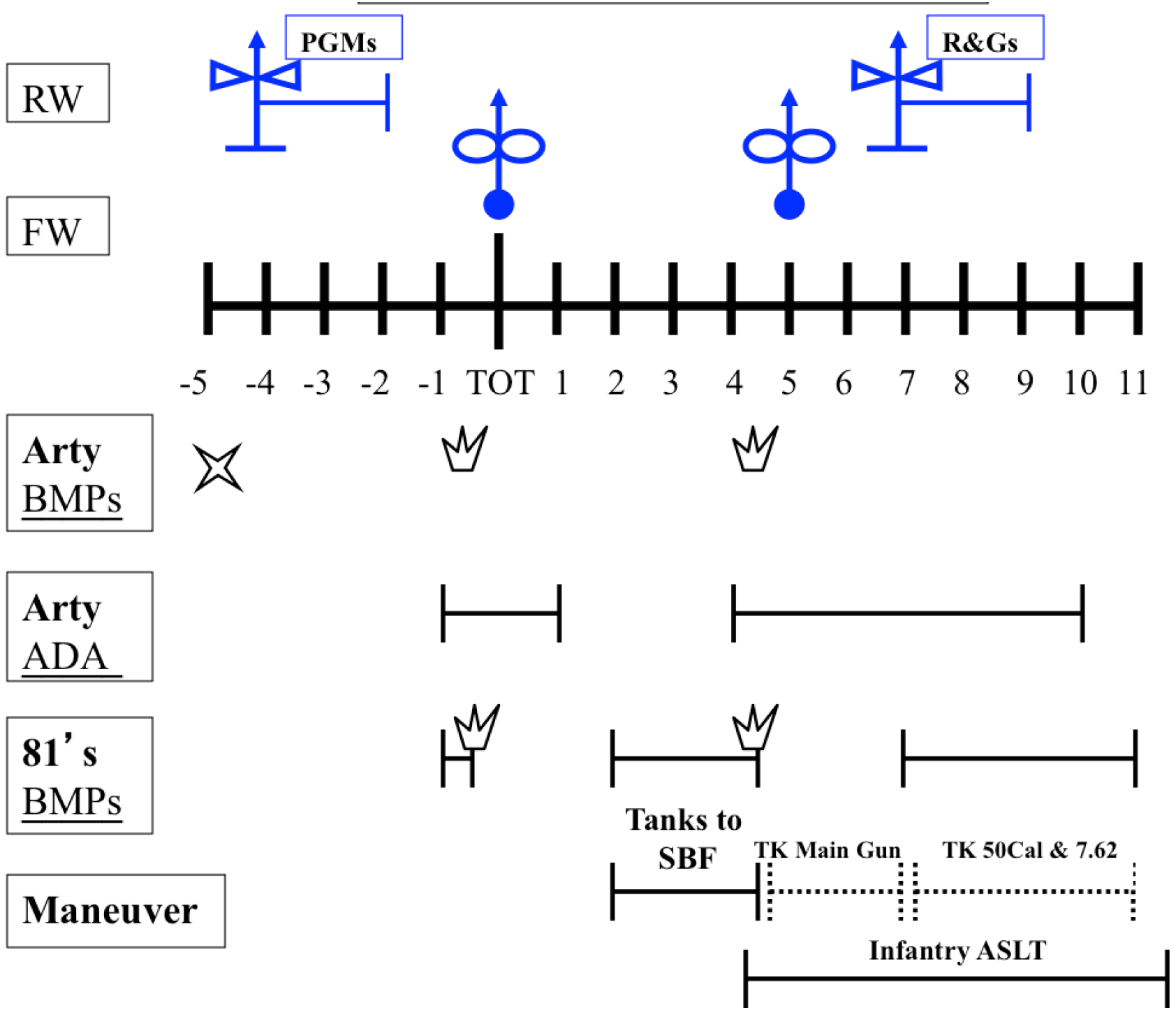
Reprint


RW
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PGMs
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Arty BMPs
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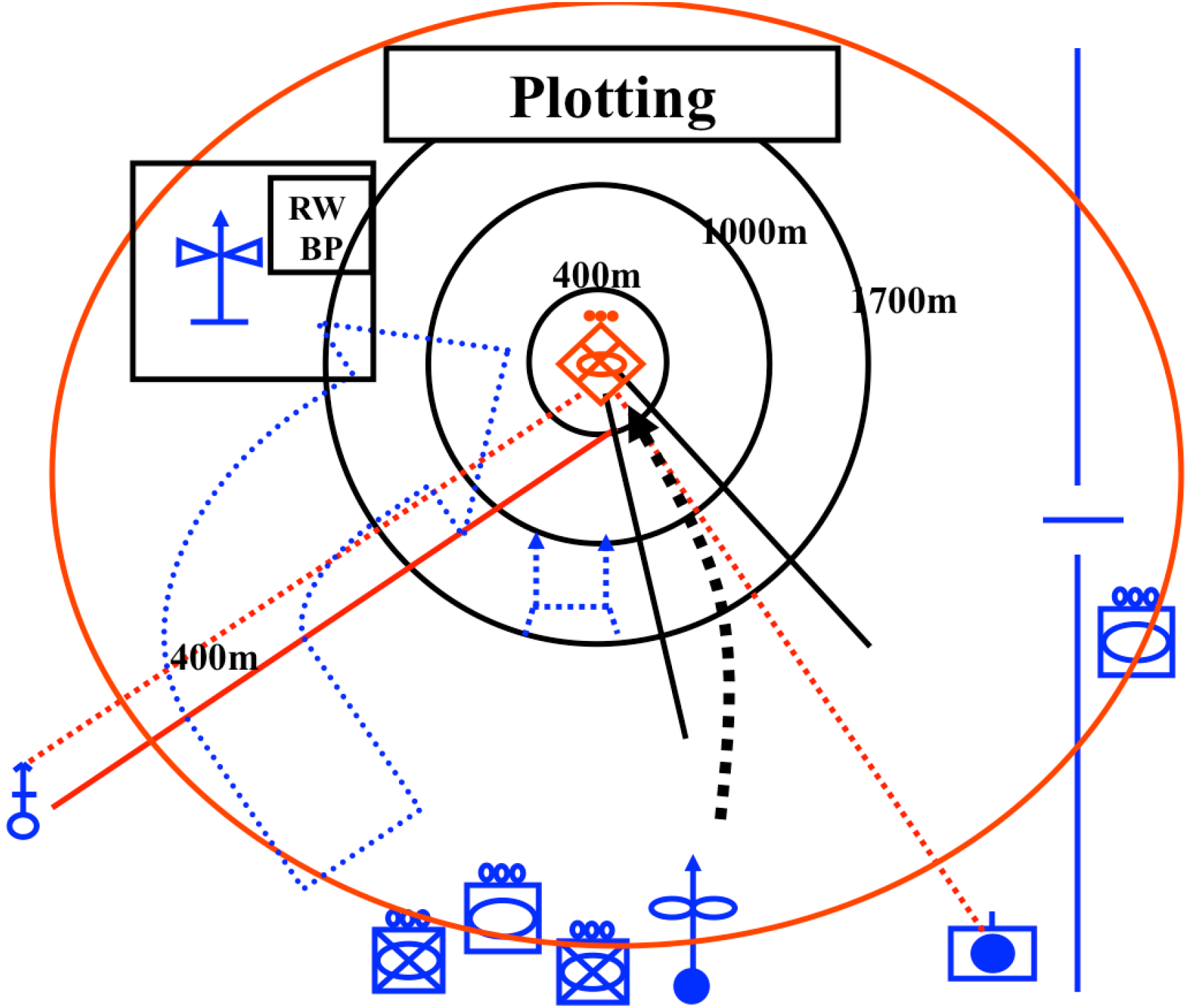
Tanks to SBF
TK Main Gun
TK 50Cal & 7.62
Infantry ASLT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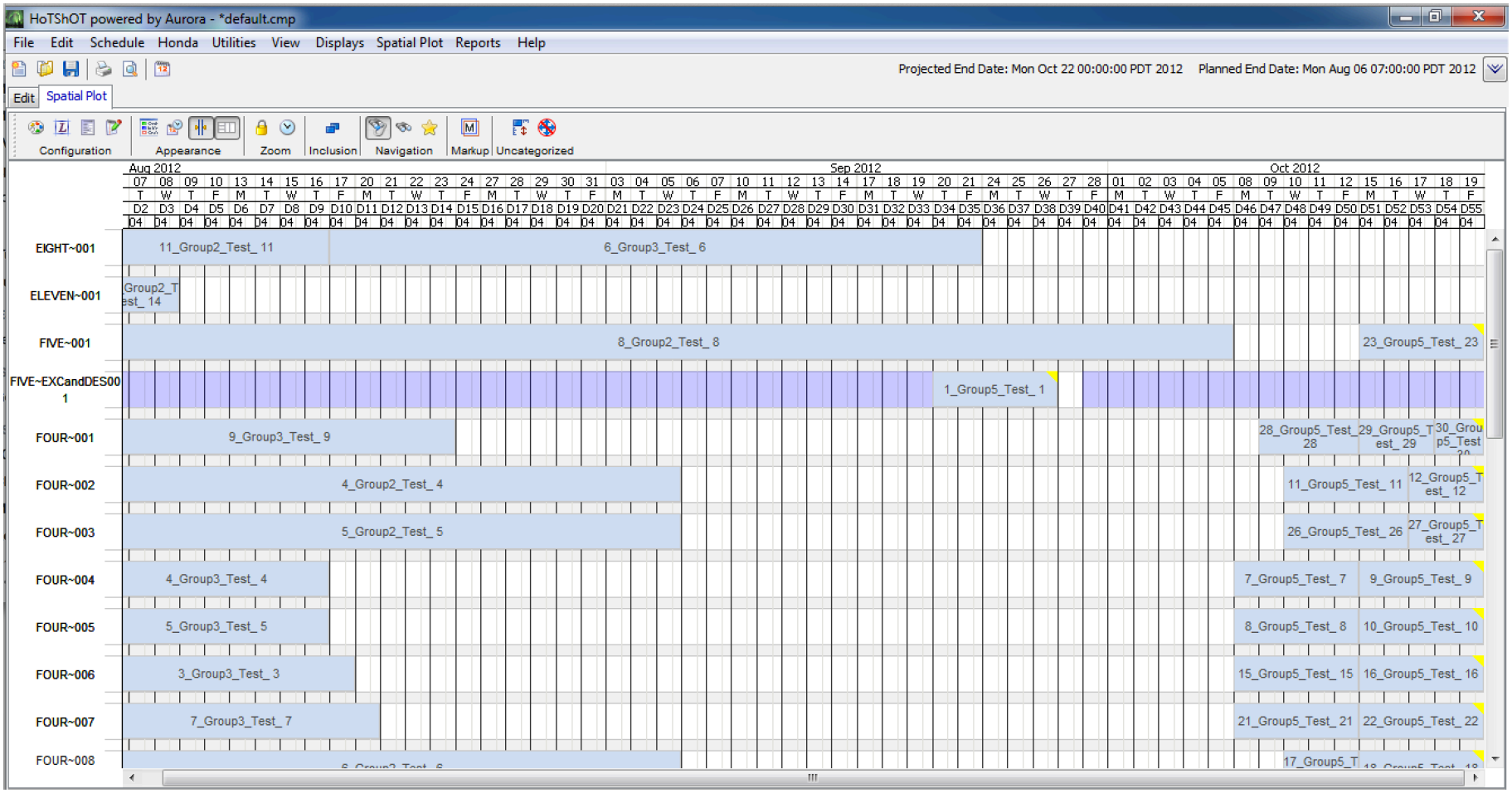
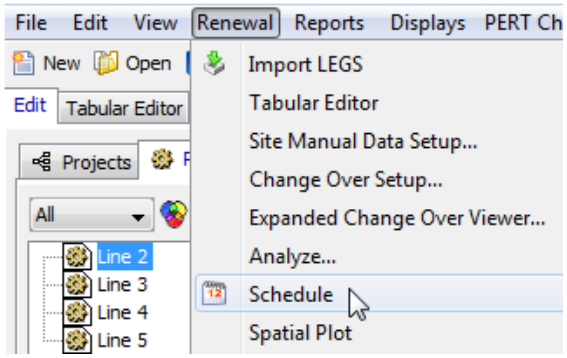
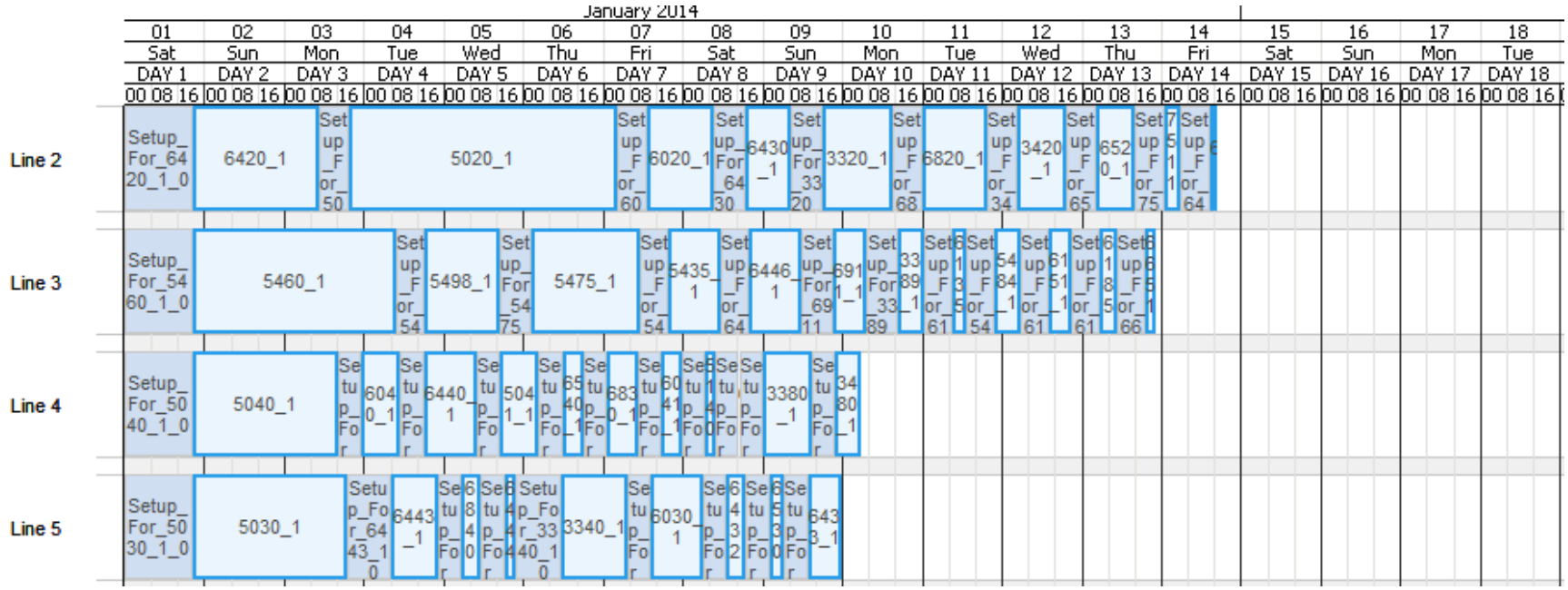
Honda Crash Testing Schedule

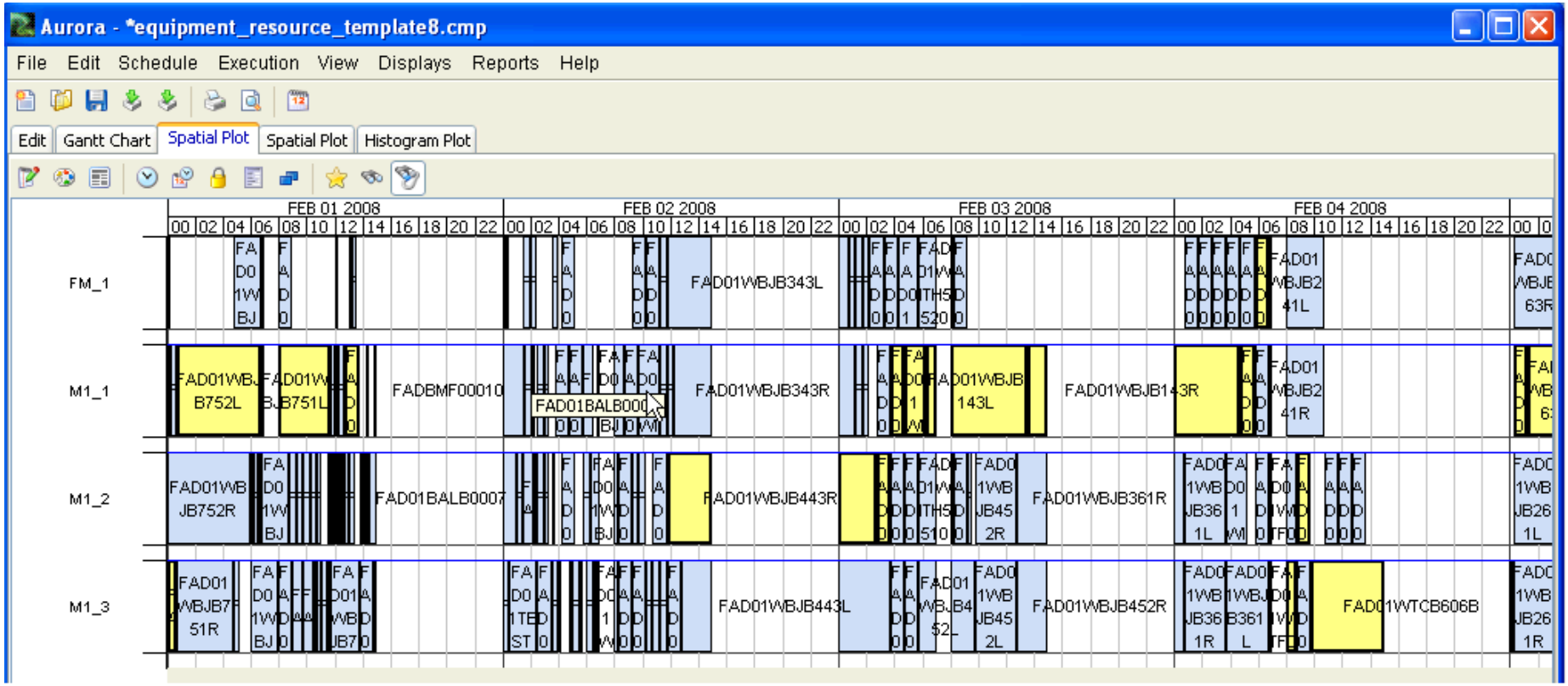


Pharmaceutical Manufacturing Schedule

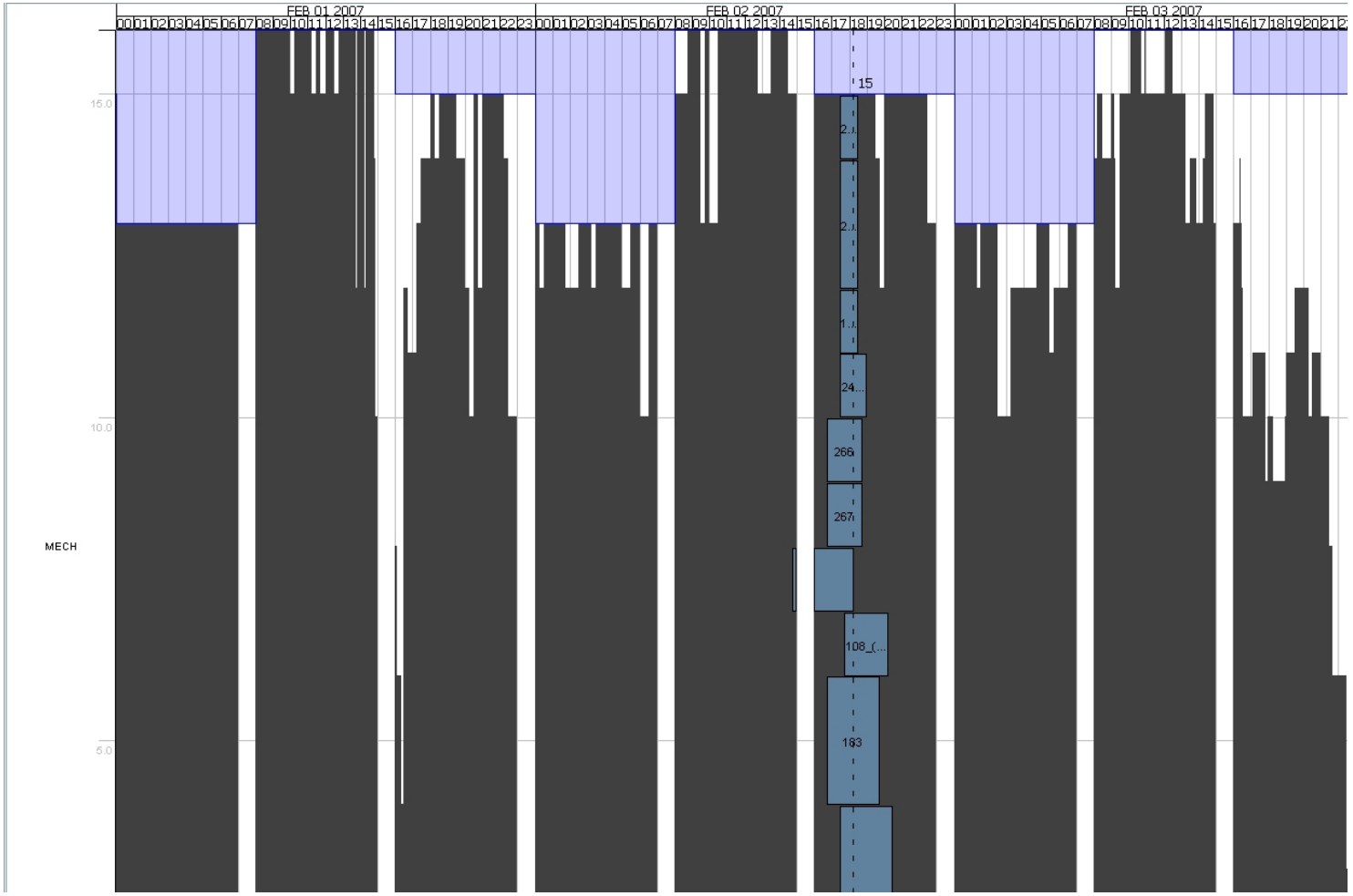




Manufacturing Resource Schedule



Histogram Exploration



Explanations/Trust (see quote above)

Why did it place the task here and not there?

Often software system is completely correct

Or possibly modeling error

But not initially believed

- “You can not automate me!”
- Human perception: “Main” versus “Minor” conflicts/constraints

Explanation Examples

explanation	The start date was affected by the flow start time, which set it to 03/01/2018 00:00 The end date was affected by the parent flow's late end date, which set it to 04/01/2018 00:00 The start date was affected by B--1, which set it to 03/04/2018 16:00 The end date was affected by C--2, which set it to 03/31/2018 08:00 The start date was affected by B--1, which set it to 03/05/2018 00:00 The start date was affected by ForwardSchedule, restricted by availability of Mech-2; waiting for A--2, which set it to 03/05/2018 08:00 The end date was affected by ForwardSchedule, based on duration and start time, which set it to 03/05/2018 16:00

explanation	The start date was affected by the flow start time, which set it to 03/01/2018 00:00 The end date was affected by the parent flow's late end date, which set it to 03/15/2018 00:00 The start date was affected by B--1, which set it to 03/03/2018 18:00 The end date was affected by C--2, which set it to 03/14/2018 12:00 The start date was affected by A--2, which set it to 03/05/2018 06:00 The start date was affected by B--1, which set it to 03/05/2018 12:00 The start date was affected by ForwardSchedule, restricted by availability of C; waiting for C--1, which set it to 03/05/2018 20:00 The end date was affected by ForwardSchedule, based on duration and start time, which set it to 03/06/2018 04:00

explanation	Setting bounding window to Thu Apr 20 00:00:00 CDT 2017 - Thu May 25 00:00:00 CDT 2017 Setting duration to 20.0 based on DEF Update window to take latest actual into account Setting bounding window to Tue Apr 25 10:48:52 CDT 2017 - Thu May 25 00:00:00 CDT 2017 Setting bounding window to Wed Apr 26 09:13:41 CDT 2017 - Thu May 25 00:00:00 CDT 2017 based on availability Setting assigned window to Wed Apr 26 13:54:00 CDT 2017 - Wed Apr 26 14:14:00 CDT 2017

Go with the (work) flow

Decentralized requesters / Centralized Schedulers

- Requests made by resource user organizations
- Resource manager schedule/deconflicts with suggested modifications which are sent to users for approval
- Users approve or further negotiate

Hierarchical Flow-Down

Phone vs E-mail vs Chat vs In-Tool vs External Tools

“Human” Annotations with initials

Sources of Data

Destinations/Transfer mechanisms of Schedule/Plan

- E.g. Primavera to transfer file to others

Import/Export to various formats

Work Flow (continued)

Human user – involved in real-time or deliberative P&S?

Scheduling frequency: 1 /year, 1/ month, 1/ day, 1/ hour, constantly (real-time)

Time to react: 1 second?, 1 minute, 1 hour, 1 day?

Number of tasks: Dozens?, 100s?, 1000s?, more?

Technical Sophistication of End Users, What they do on the fly (e.g. reconfigure for analysis or re-planning)

Flexibility/Robust UI

New Capabilities => New Uses => New UI needed: Make UI robust and flexible for unanticipated changes

- What-ifs
- Outer Loop Optimization (Automatic or Manual)
- Expansion of domains: 787 to Tankers; Long Term Shuttles to Short Term Shuttles and SRBs
- Typically constant stream of enhancements

Schedule/Data Analysis features / User Sophistication

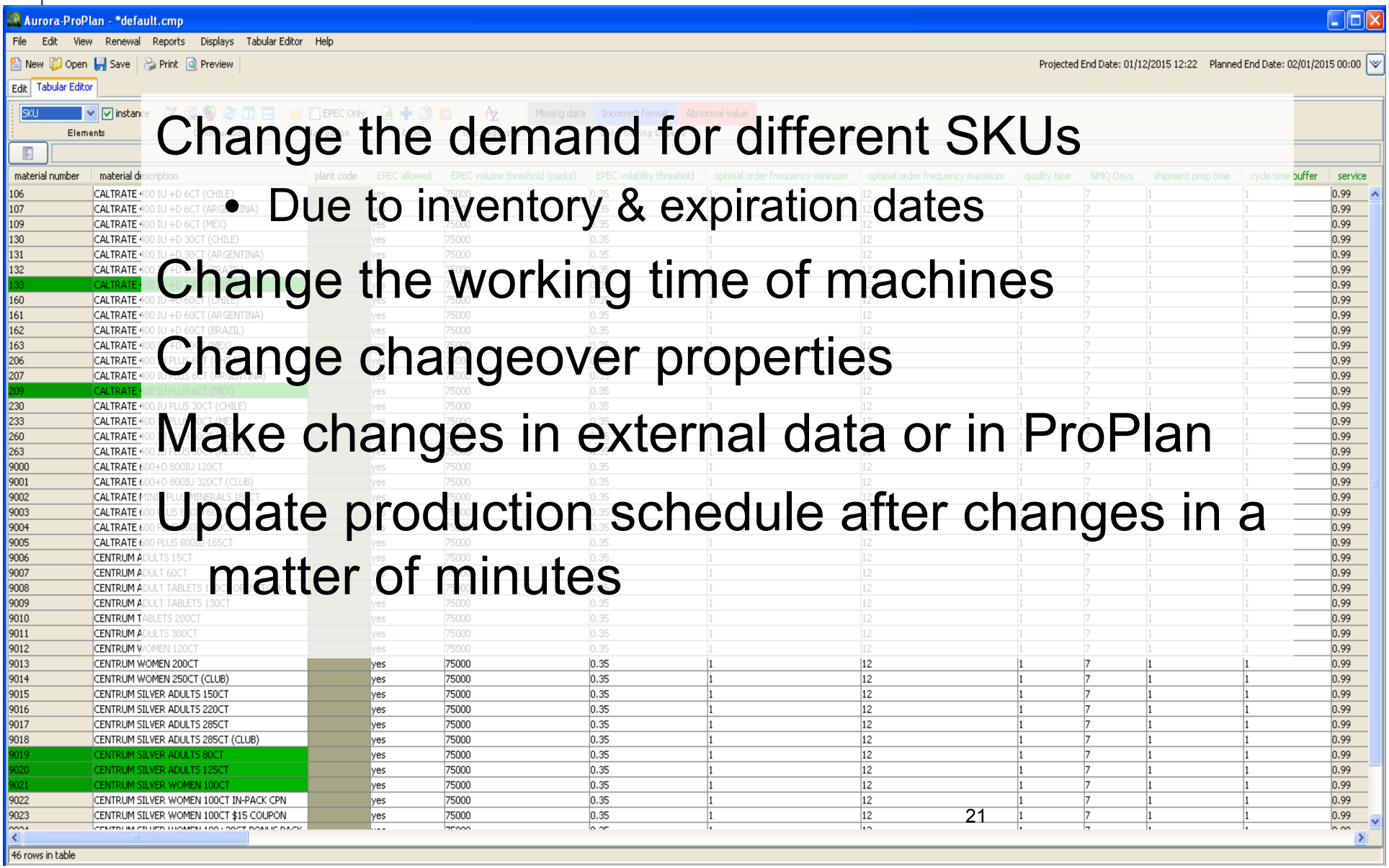
Lots of User Configuration Parameters (e.g. plot definition, filtering, colors, symbols) / User Sophistication

Keep UI completely separate from IP&S

UI Integration: Data Bus; Pub/Sub model

Threading Issues

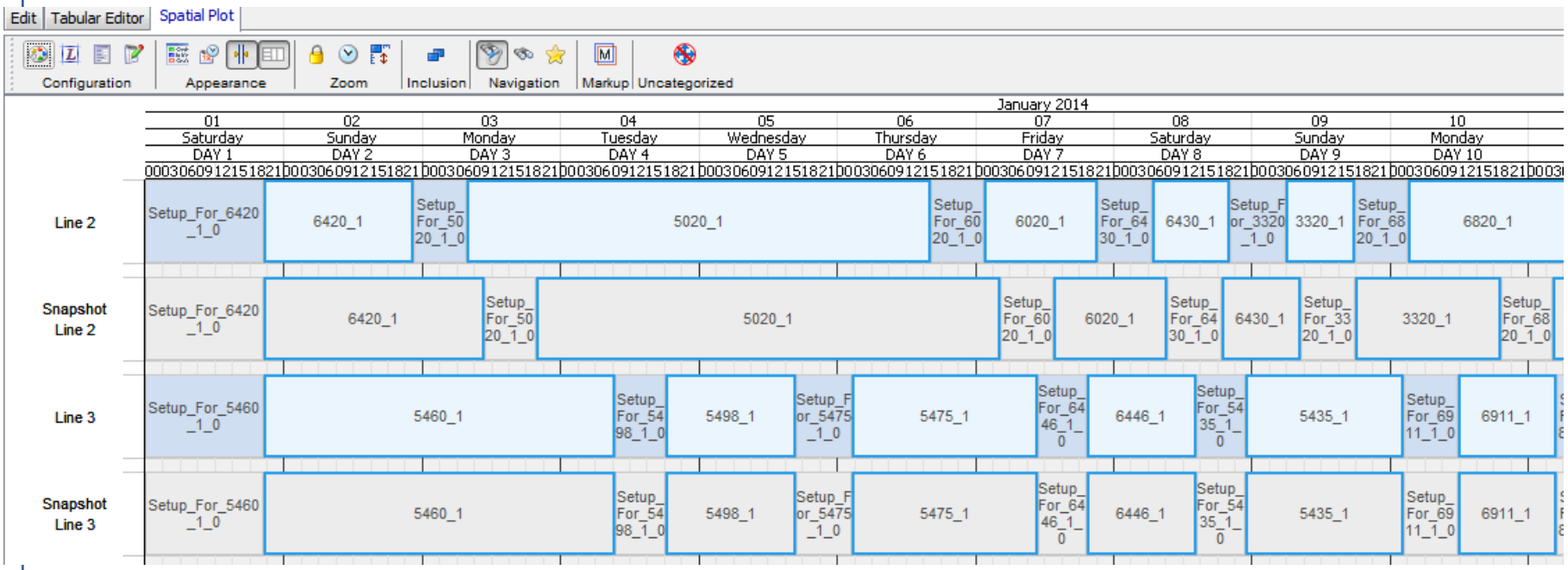
What-Ifs: Various Can be Performed



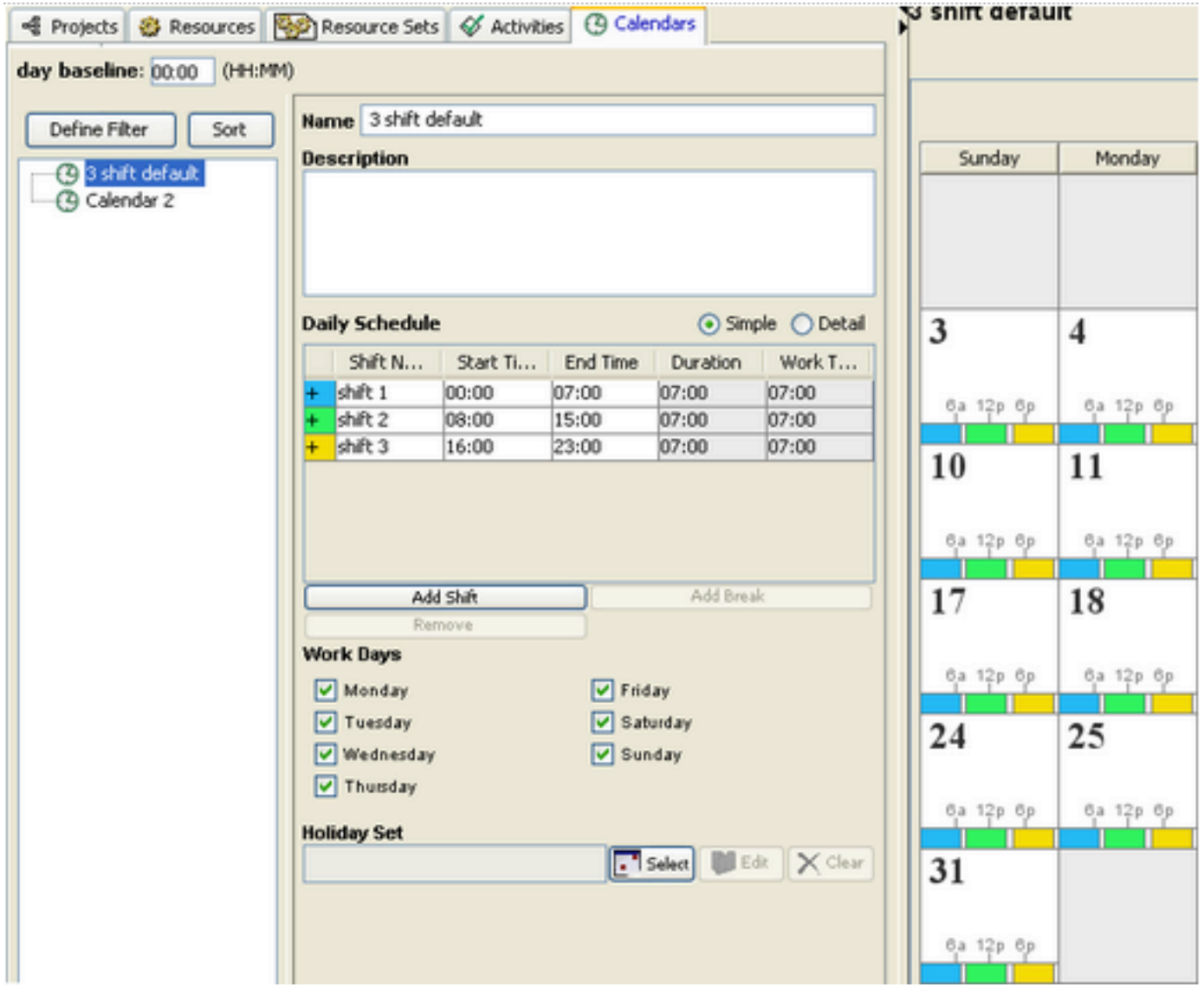
- Change the demand for different SKUs
  - Due to inventory & expiration dates
- Change the working time of machines
- Change changeover properties
- Make changes in external data or in ProPlan
- Update production schedule after changes in a matter of minutes

What-If Capabilities

The user can manually add/remove machines or change calendars to see the effect on the schedule.



Complete Calendar Support

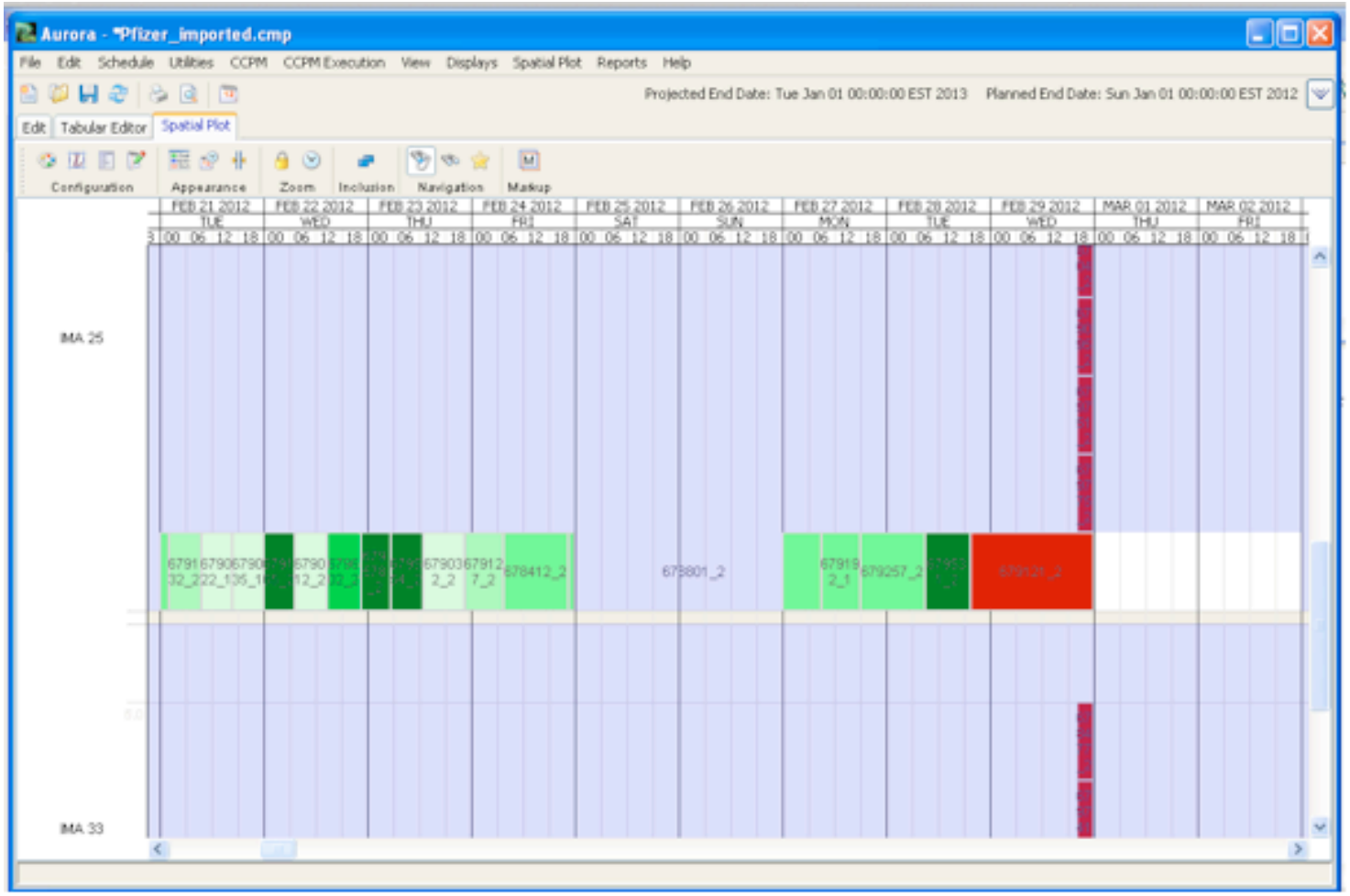


What-If: Same Demand 3 vs 2 Lines

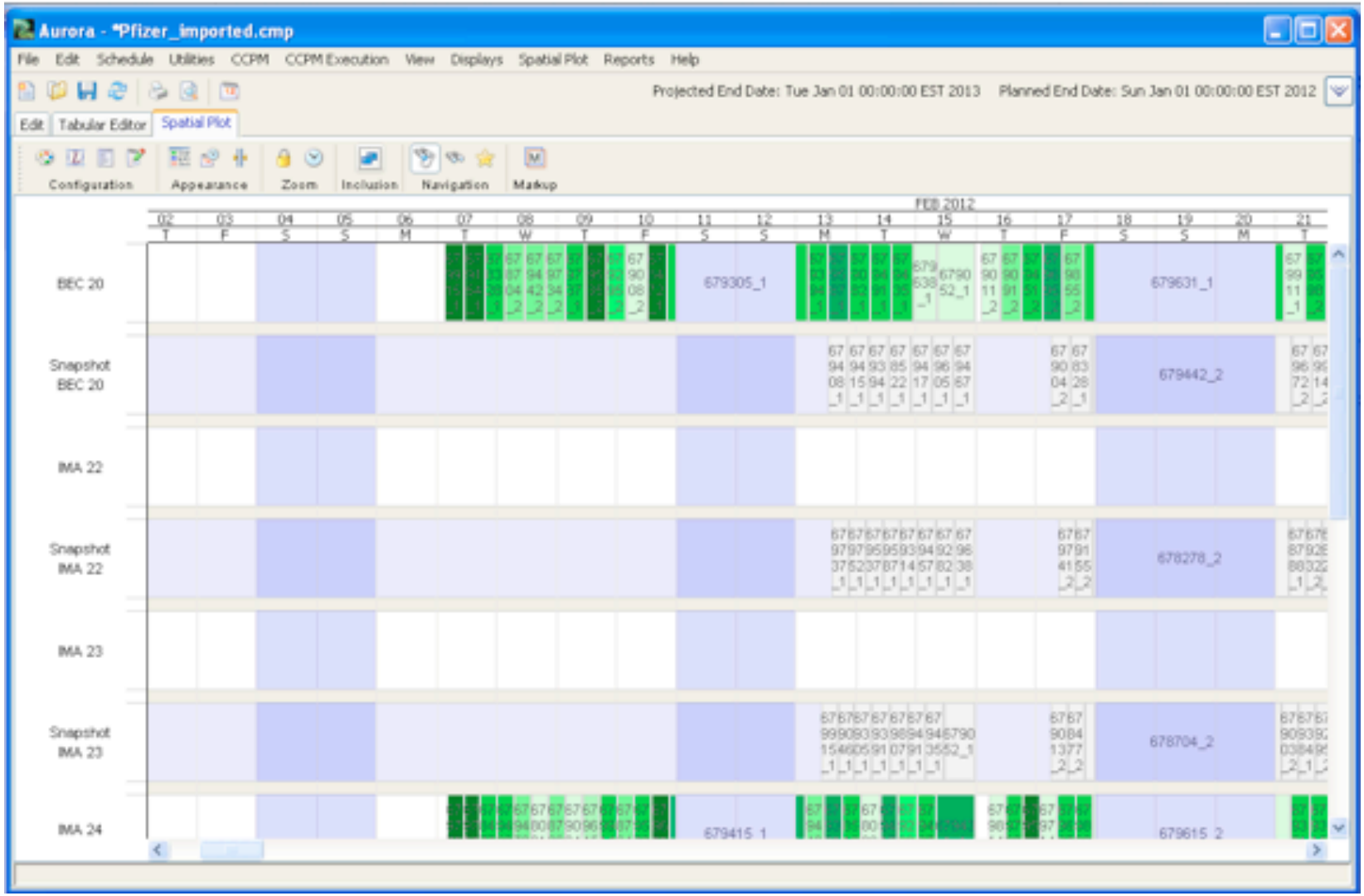
Conflicts

Conflicts will occur if there are not enough lines / machines

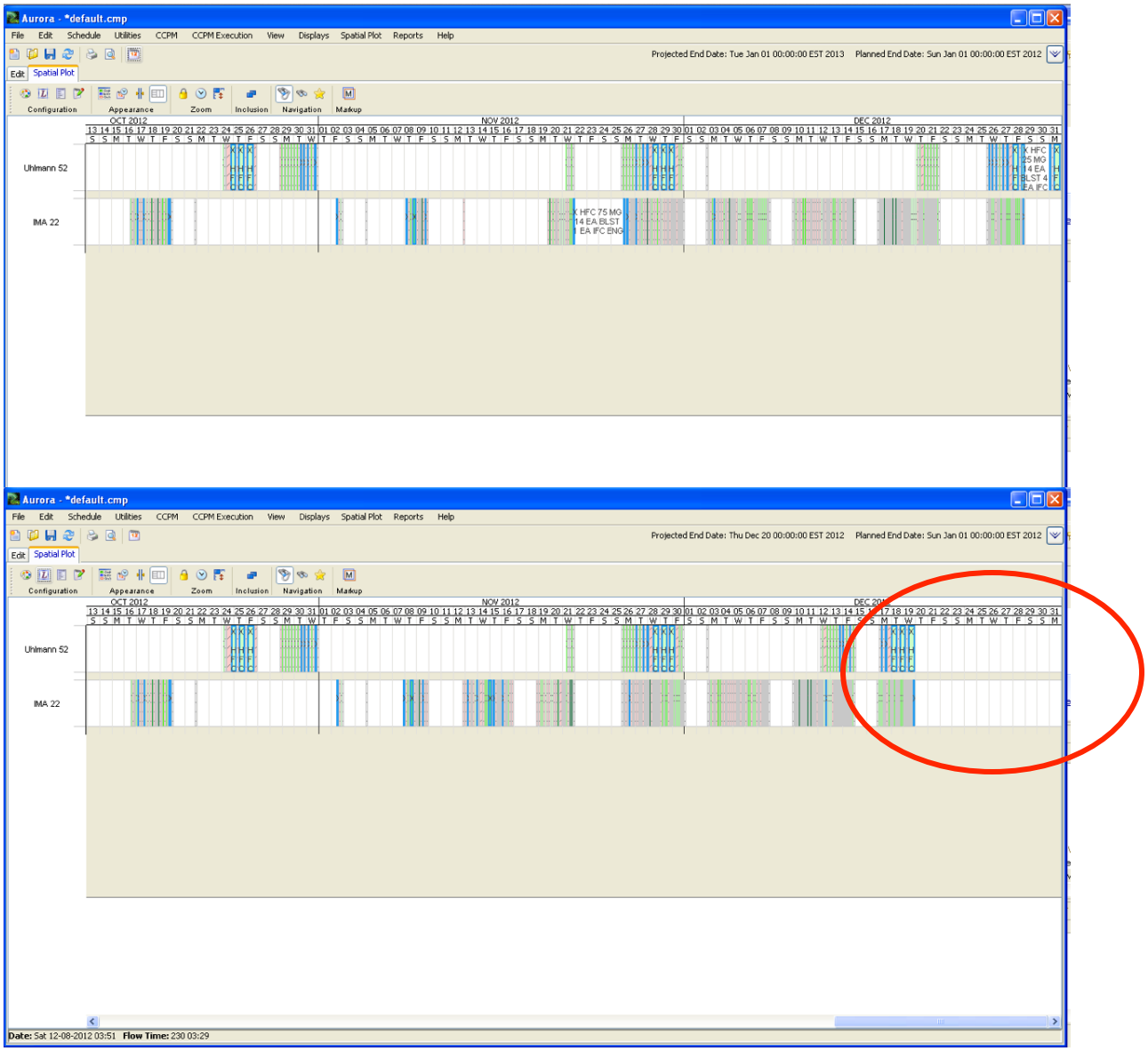
- Conflicts shown in red



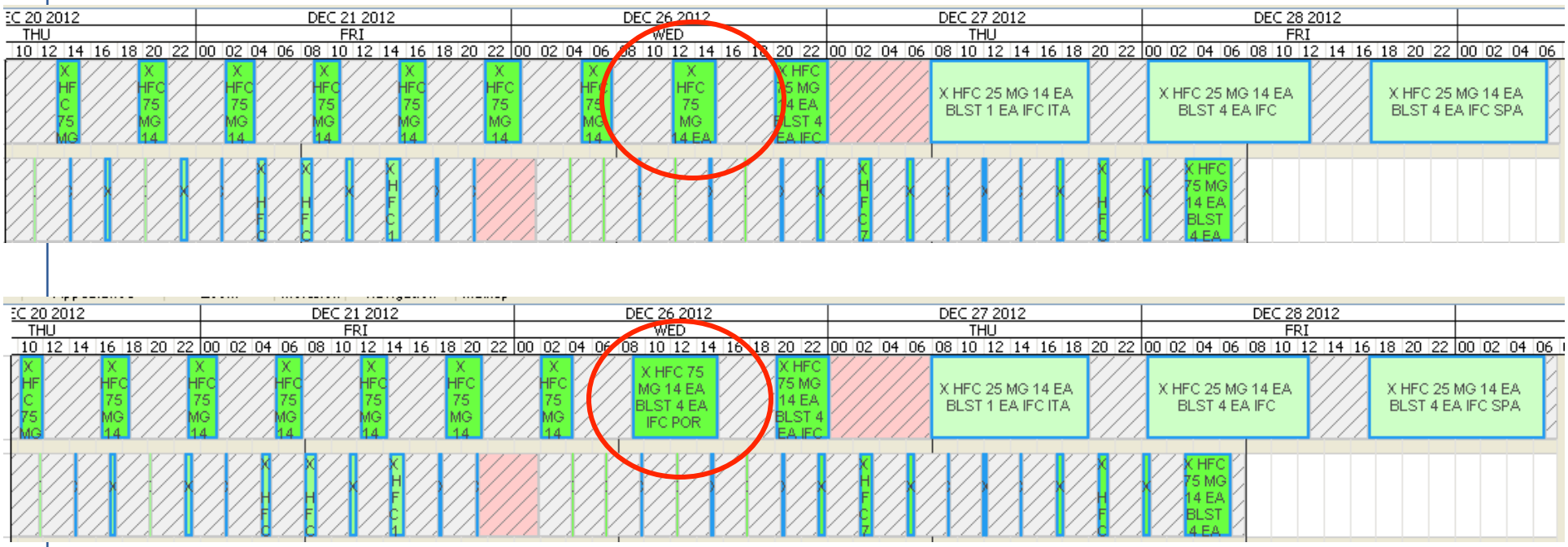
Removing Capacity Without Causing Conflicts

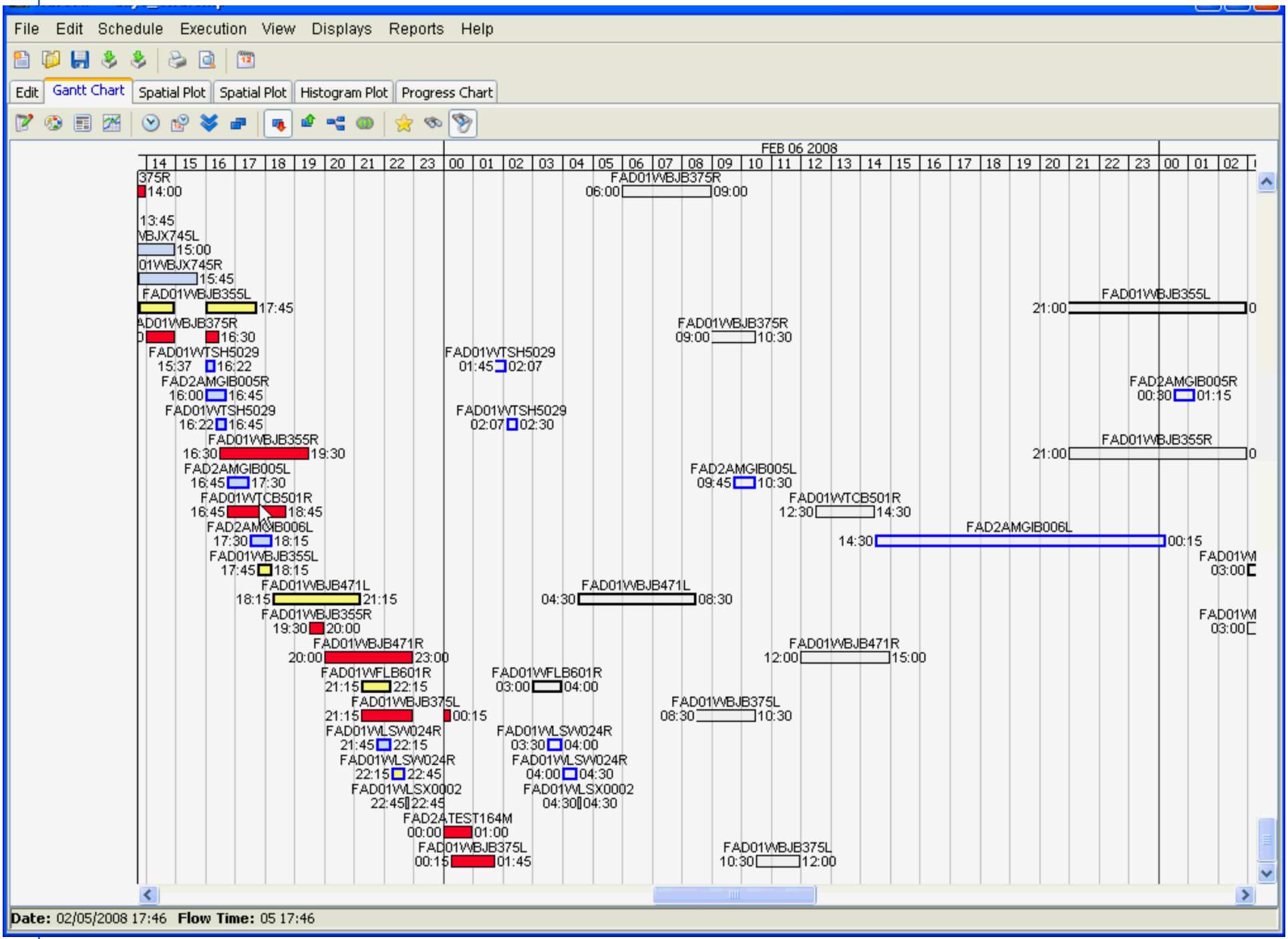


What-if: End of Year Shutdown



What-if: Demand Increase

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14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00 01 02
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FAD01WBJB355L 17:45
FAD01WBJB375R 16:30
FAD01WBJB375R 09:00 10:30
FAD01WTSH5029 15:37 16:22
FAD01WTSH5029 01:45 02:07
FAD2AMGIB005R 16:00 16:45
FAD2AMGIB005R 00:30 01:15
FAD01WTSH5029 16:22 16:45
FAD01WTSH5029 02:07 02:30
FAD01WBJB355R 16:30 19:30
FAD01WBJB355L 21:00
FAD01WBJB355R 21:00
FAD2AMGIB005L 16:45 17:30
FAD2AMGIB005L 09:45 10:30
FAD01WTCB501R 16:45 18:45
FAD01WTCB501R 12:30 14:30
FAD2AMGIB006L 17:30 18:15
FAD2AMGIB006L 14:30 00:15
FAD01WBJB355L 17:45 18:15
FAD01WBJB471L 18:15 21:15
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FAD01WBJB355R 19:30 20:00
FAD01WBJB471R 20:00 23:00
FAD01WBJB471R 12:00 15:00
FAD01WFLB601R 21:15 22:15
FAD01WFLB601R 03:00 04:00
FAD01WBJB375L 21:15 00:15
FAD01WBJB375L 08:30 10:30
FAD01WLSW024R 21:45 22:15
FAD01WLSW024R 03:30 04:00
FAD01WLSW024R 22:15 22:45
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FAD01WLSX0002 22:45 22:45
FAD01WLSX0002 04:30 04:30
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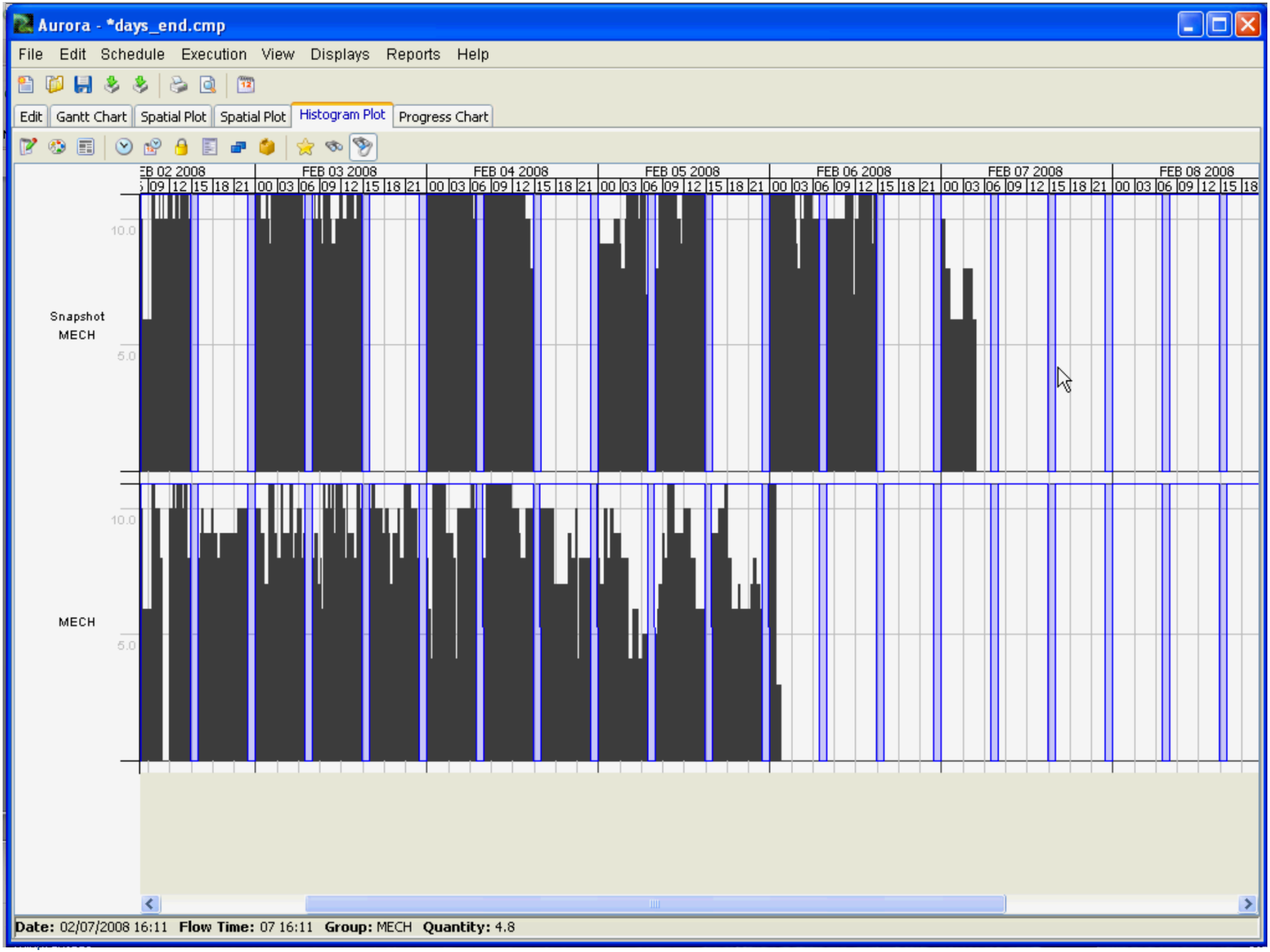
Date: 02/05/2008 17:46 Flow Time: 05 17:46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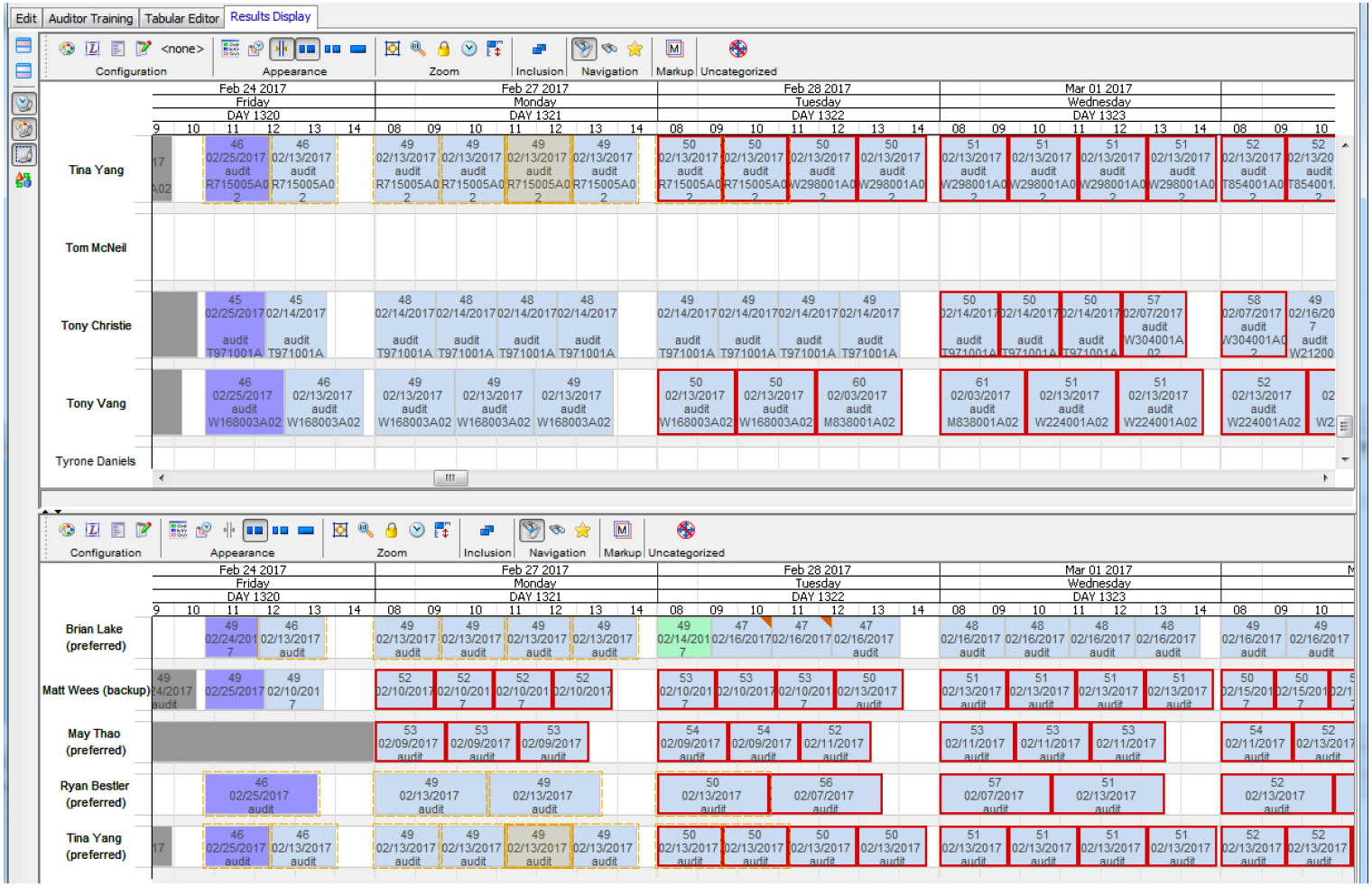
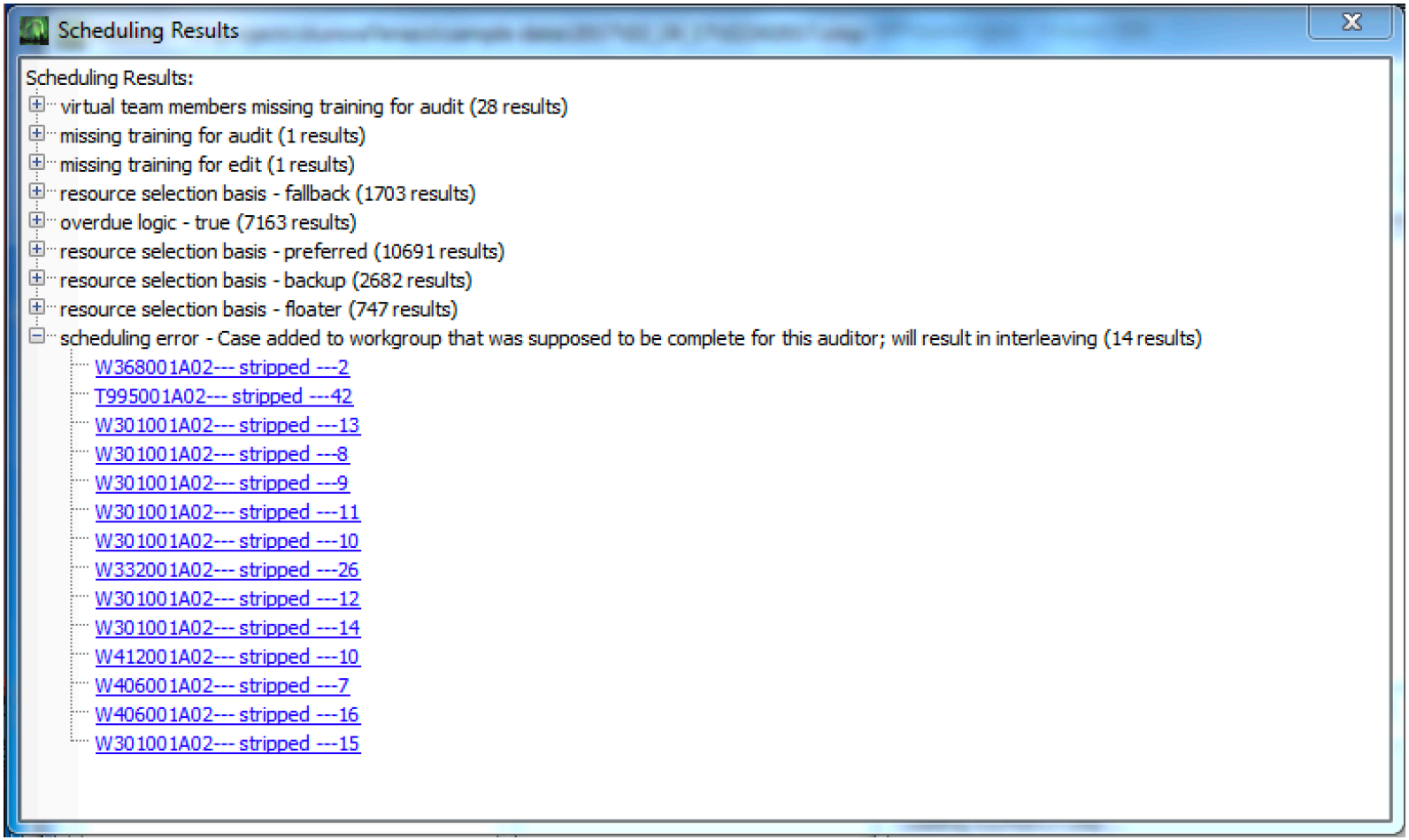
Date: 02/07/2008 16:11 Flow Time: 07 16:11 Group: MECH Quantity: 4.8

Viable Personnel Visualization

Small Acceptable Set (small range of possible personnel; two are working a different/late set of work)

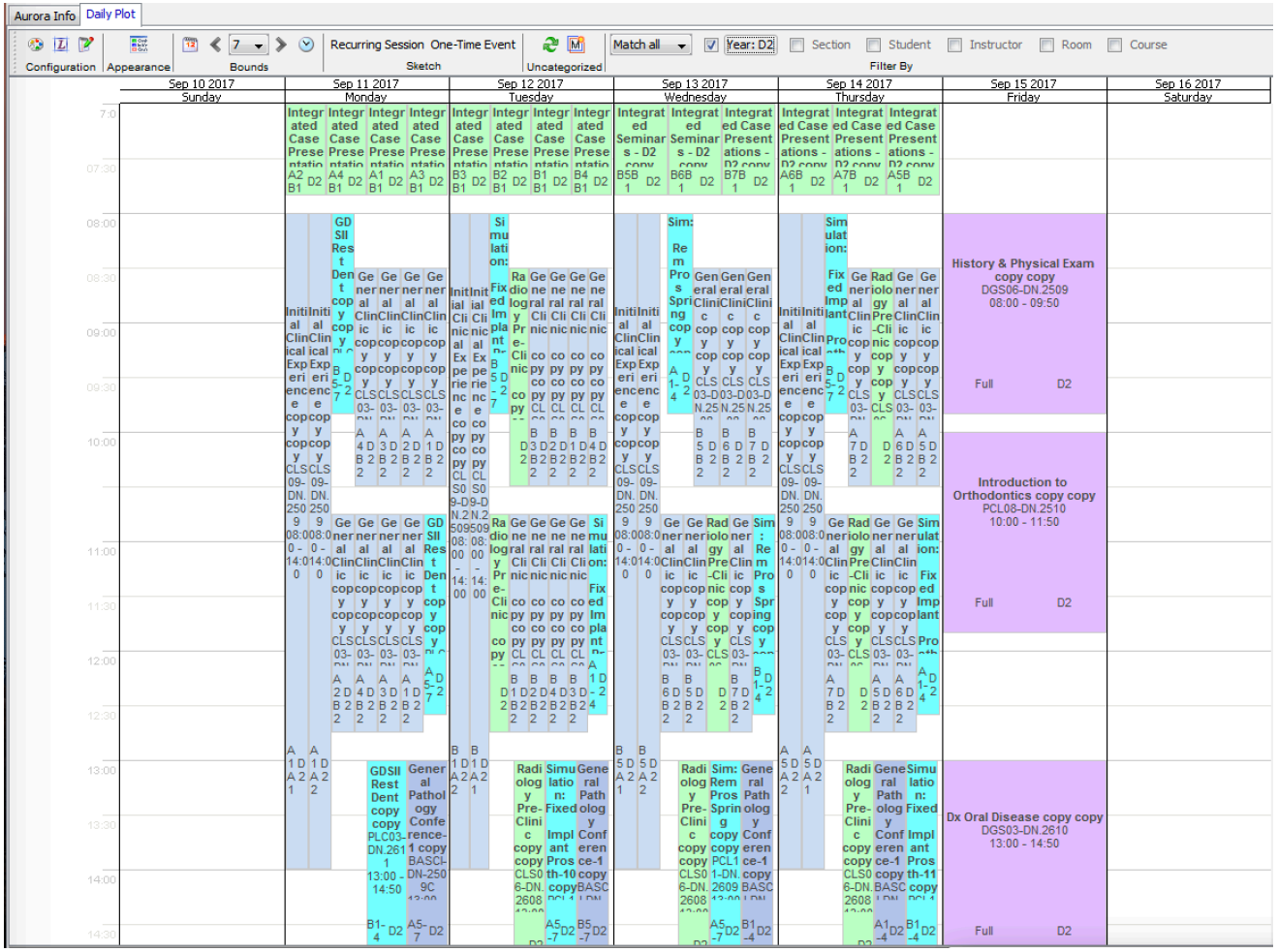


Issue Management – Schedule Report



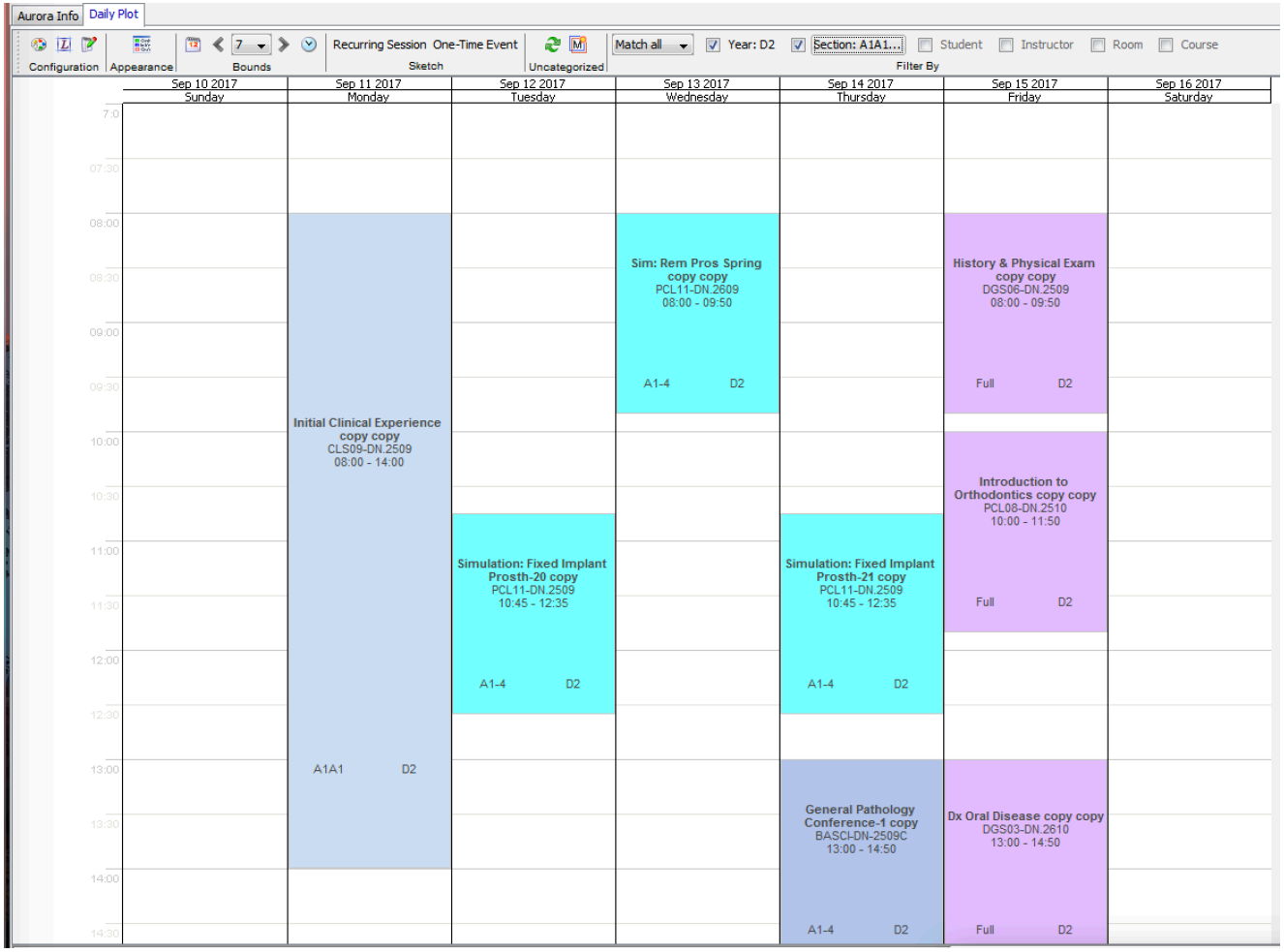
Calendar Plot

Easy configuration via common filter options – see upper right (currently filtered for D2)



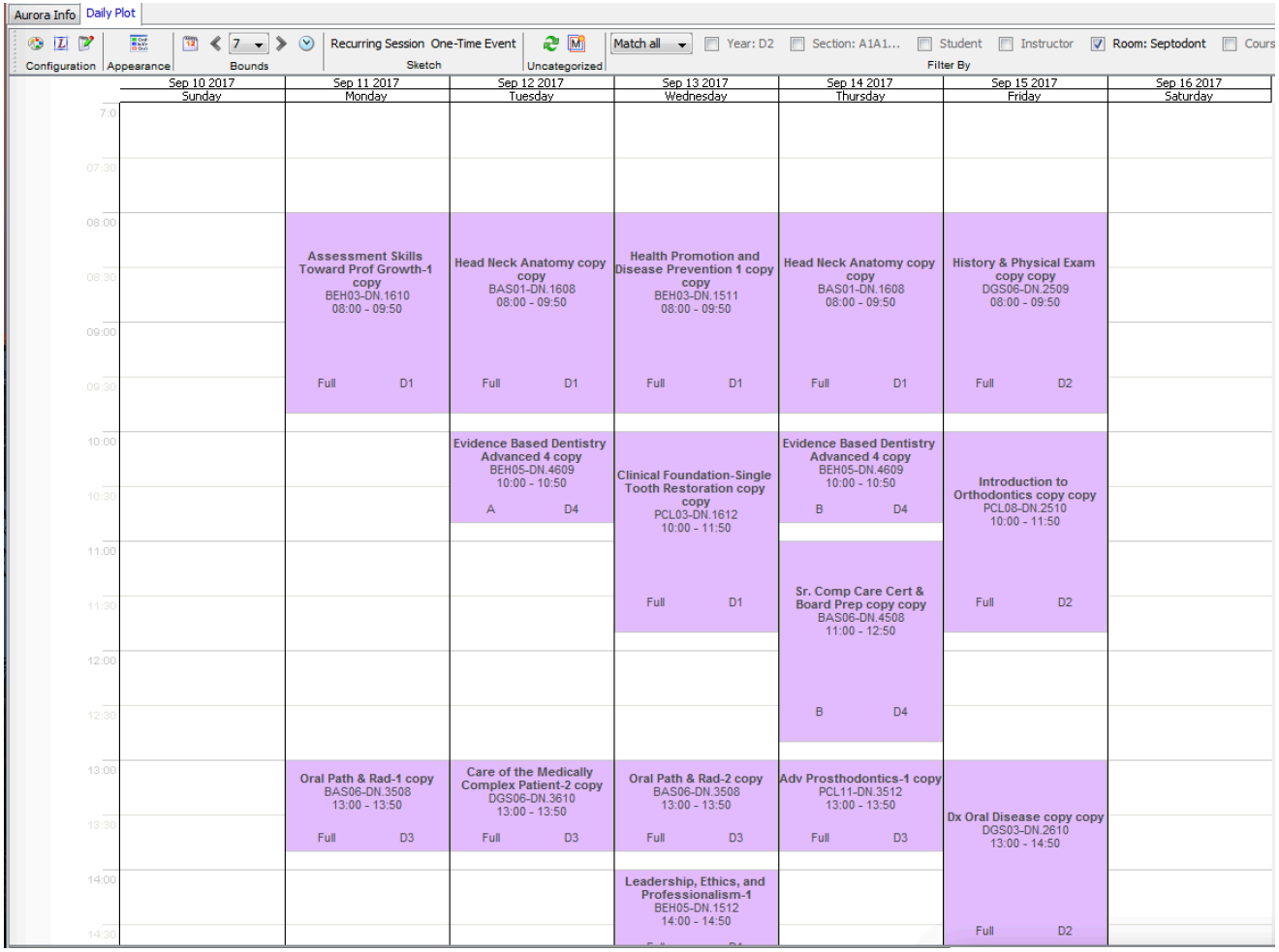
Calendar Plot

Added filter for section (shows schedule for one subset of students in the class)



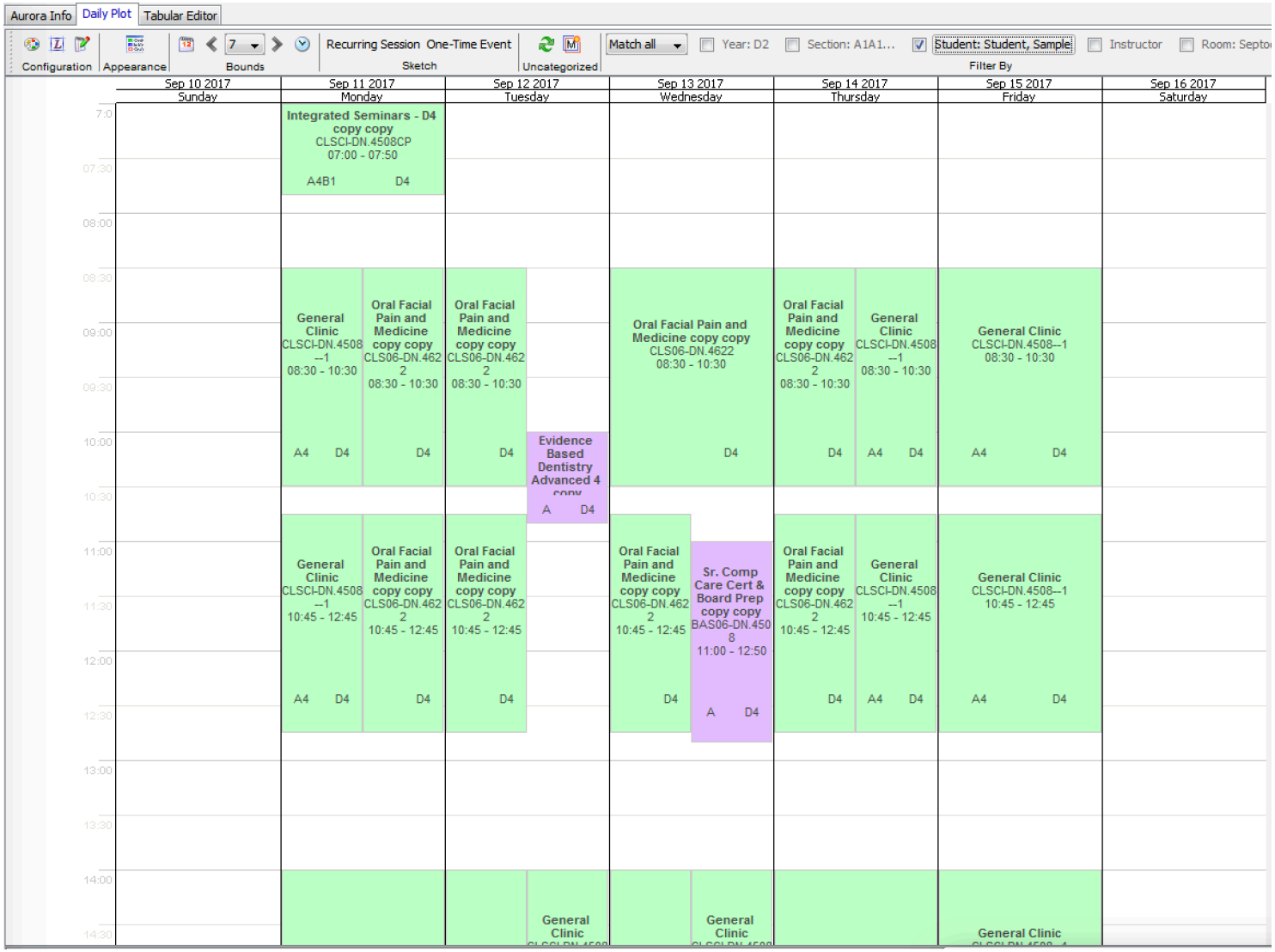
Calendar Plot

Same timeframe; filtered by room



Calendar Plot

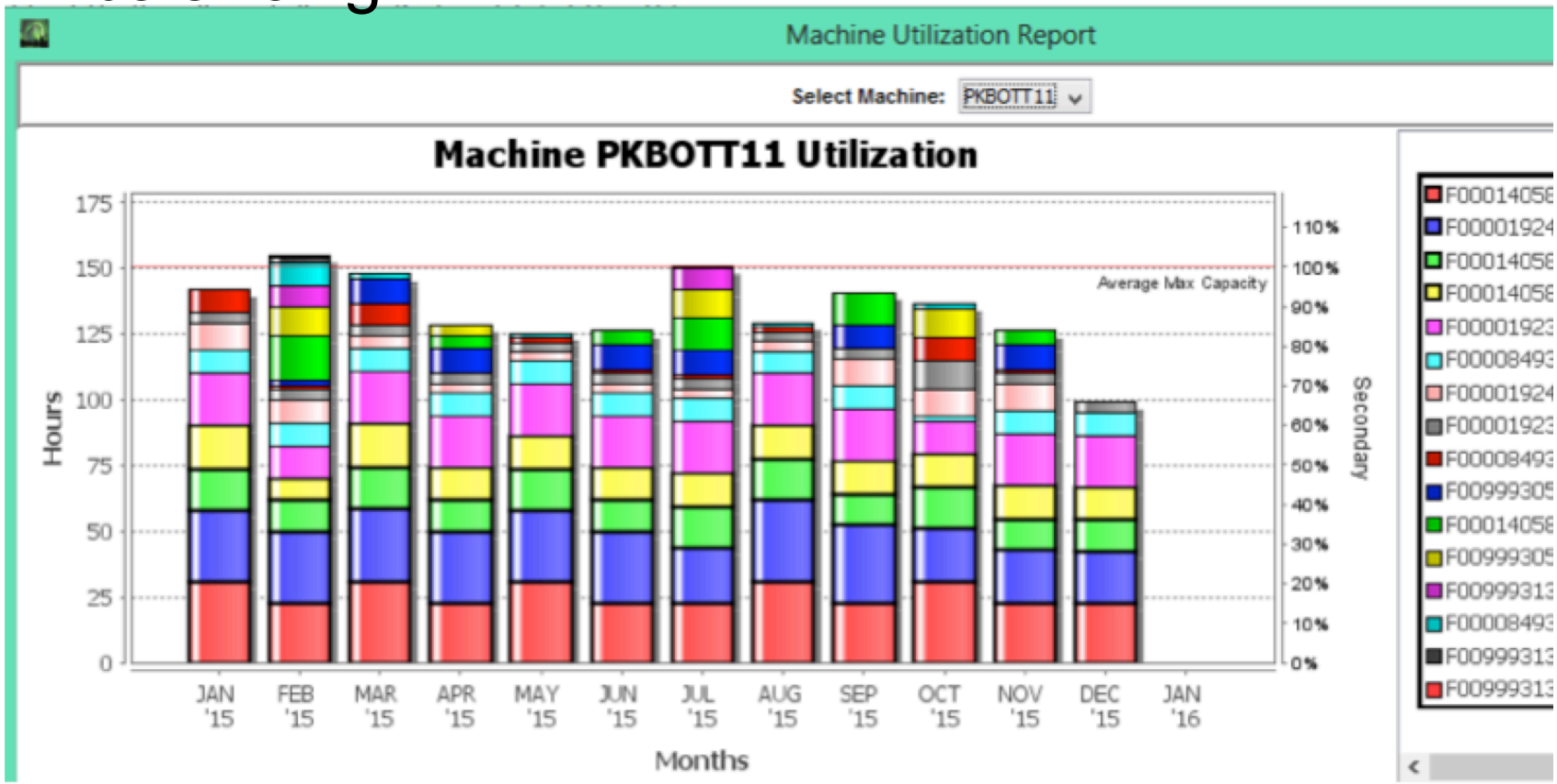
Same timeframe; filtered by student (overlapping allocations reflect “preemptions” where student is pulled from one experience to engage in another experience)



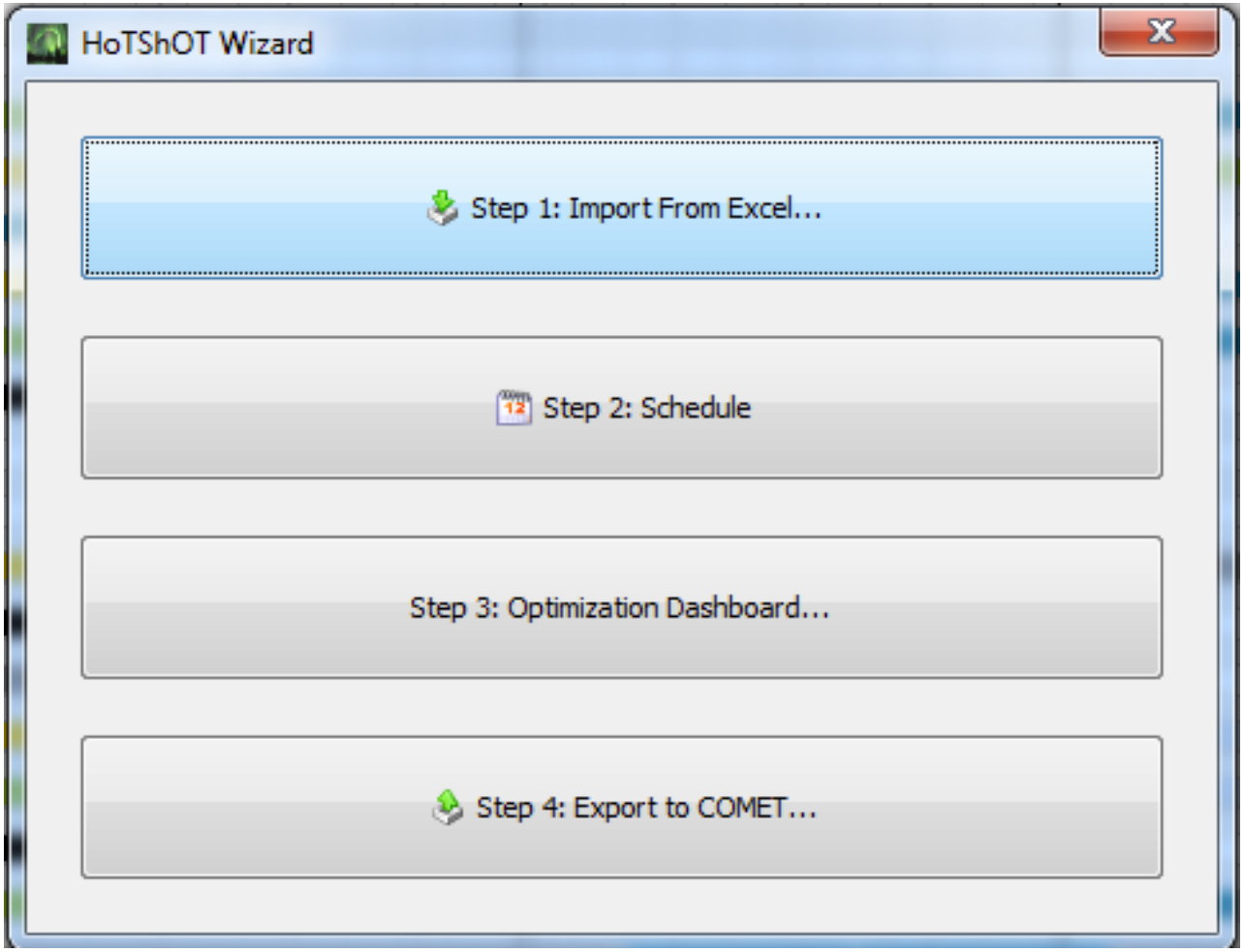
Pharmaceutical Manufacturing Machine Utilization Report

Shows overall utilization of products by line

Allows planners to see overall allocation and line balancing



Vehicle Crash Testing Wizard (very easy to use interface (especially for low frequency user tasks)



User Acceptance Requirements

Sometimes you just got to do it

Things you don't want to do, some push back then just do it

E.g. Artemis Interface / Never Used

Do you want to be right or do you want it fielded?

- Doesn't impact IP&S Algorithm (the thing you care about)

Examples

- Left versus bi-directional No-X constraints
- 1980s DOS style interface
- EXACT font/icon match on printed schedules

Legacy System Integration

May or may not be UI related

- I.e. a good alternative to data entry or to avoid re-implementing UI
- E.g. Primavera front-end/UI for NASA SLS & Construction Industry

E.g. Boeing's Automatic Dreamliner Scheduler

- CMAD, Boeing Data Warehouse
  - Official work statement and progress
  - Jobs/Characteristics, Calendars, Resources, Resource Requirements, Constraints
  - Many upstream data sources
- Velocity Shop Floor Management System
  - Upcoming Jobs/Assignments/Constraints
  - Many downstream data destinations
- Boeing's Schedule Editor
- JSS Underlying DB supplied by CMAD, used by Schedule Editor
  - User can have Aurora dump to JSS
- Oracle – flexible data dump

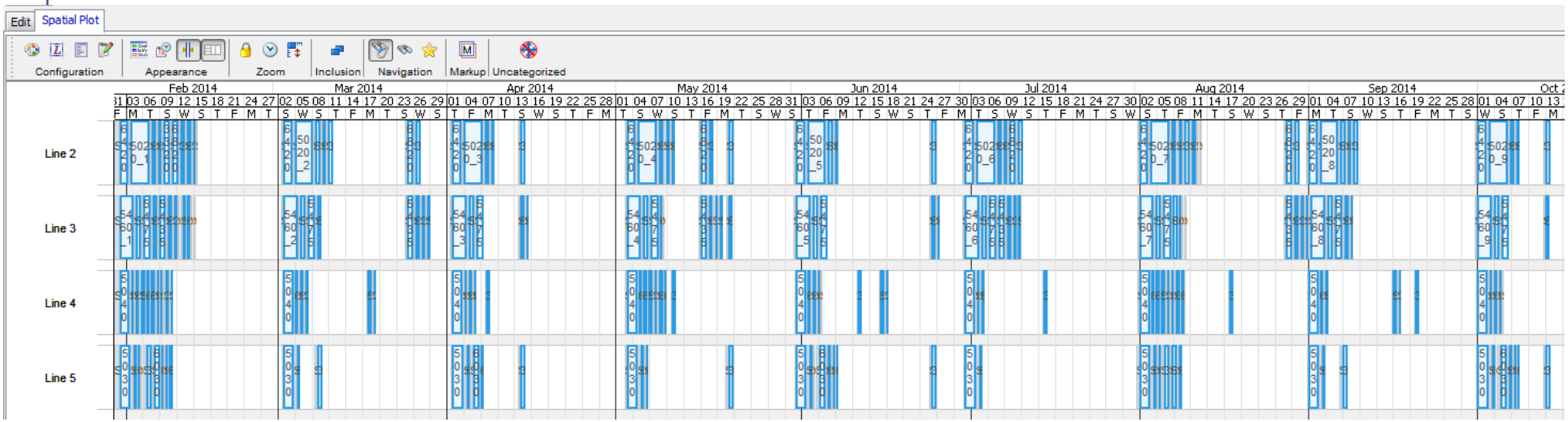
Pharma Intelligent Scheduling

Production Data (Vol. Reqs, Resources

→ Aurora-ProPlan

→ Production Schedule

→ Export (for execution)



Different Domains => Different Conflict Concepts => Different UI

Time: Rigid (e.g. Shuttle Processing) vs Flexible/Padded (e.g. Sat. Support Prep.) vs Likely Slip (HW deliveries)

Resources

- Individual: Required (Antenna) vs Optional (Secure Voice)
- Real-Valued: Padded (e.g. Floor Space) vs. Rigid (Electrical Power)
- "Over" shareable (E.g. Bandwidth, won't need all, all of the time)

Representations/Displays of Conflicts: Overlaps/Colors

Politics; Sometimes Schedules are Political Documents

"Editing": Forcing versus Leaving / Show Conflicts or Not

Human perception: "Main" versus "Minor" conflicts/constraints

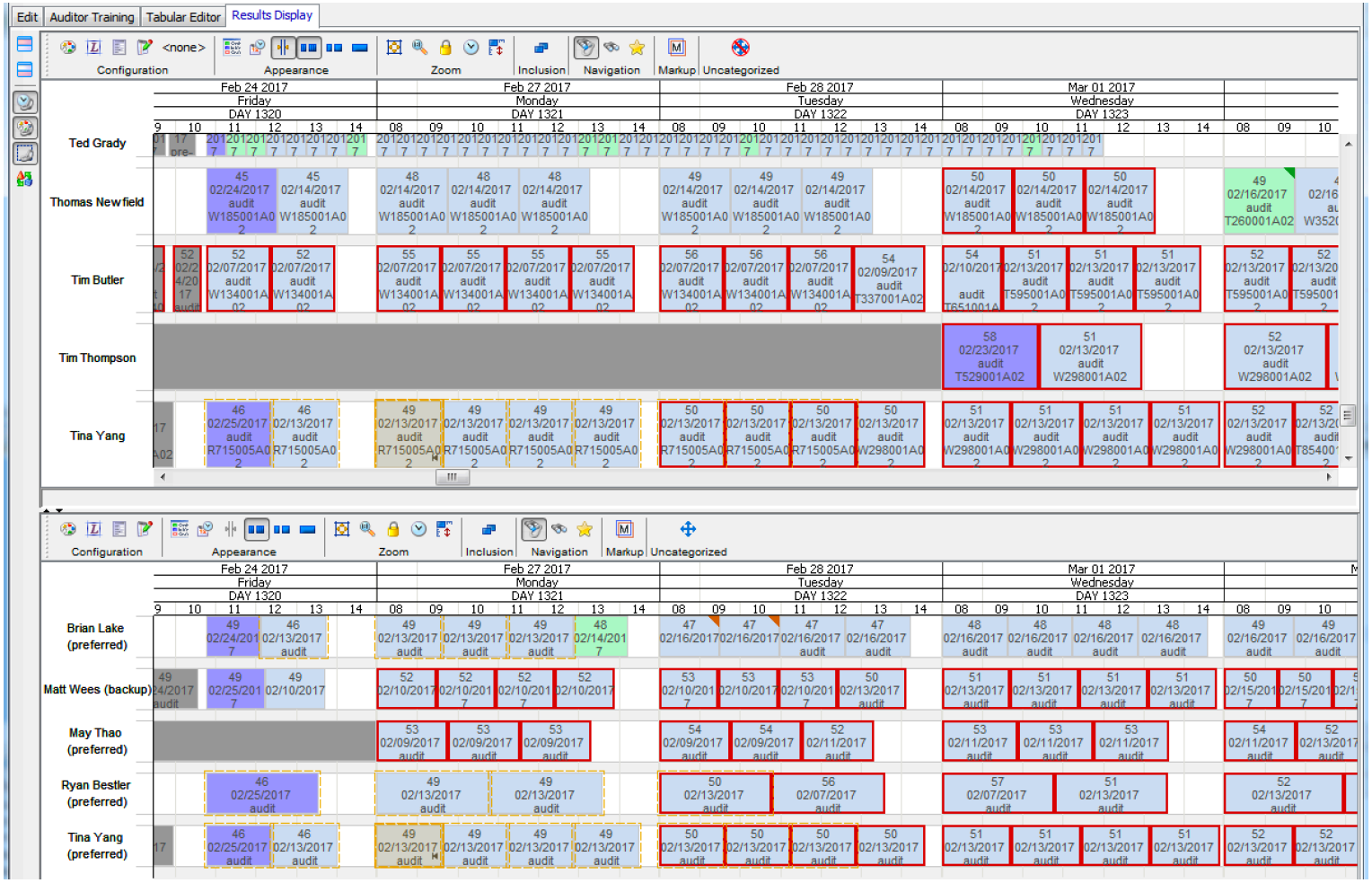
Every domain is different, likely different algorithms and definitely different UIs (optimized to the specific domain)

User editing “final” product / replanning

- Recall on-purpose semi-modeled domain
  - Therefore result will be suboptimal
- Allowing for user editing of the results, then re-planning
  - Question: To honor or not to honor edits
  - Replanning “around” the user change
  - Implicit/explicit time/resource scope of replanning
  - Absolute vs “relative” freezing of user edits
  - Which user edits to keep vs undo by replanning
- Major impact on user efficiency/acceptance
  - Possible (partial) solution to “ask” at time of edit
  - Visual Indication of what will “stick”

Selected activity was dragged, schedule was updated

(note pin icon)



Special UI Challenges with truly distributed / mixed initiative planning and scheduling

Obviously will have an edit-lock system

Distributed editing can interact badly with relaxing (to resolve conflict) (E.g. “Forcing”) and/or widely-impacting constraints (E.g. No X in a row at the same site constraint)

Resolving same conflict from different sides of it

Consistency globally and in User’s perception

Autonomous schedule updating

Human tolerance to change, partly time-until based, but not completely / ~Arbitrary changes can cause distress

- Err on the side of leaving things alone
- Point to where task “moved” to (time/resource/display)

Future IP&S UI Work

New modalities (e.g. voice, VR)

Careful – efficiency!!!

(Few or one) words faster than clicks/drags

- E.g. Click support and say “Hula-B”

Make two steps in series be done in parallel

- E.g. Say “B” as you move to Hula

60 to 90 days digital skills 100% decayed away

- “Show me how to do X” (E.g. create a mission impact report)

“What’s the bandwidth at Hula” (for novices)

VR – 3D representation/moves instead of 2-D

Summary

"It enables us to generate complex schedules in a few hours, compared to days or weeks required by our previous scheduling systems." - **Tom Overton**, NASA KSC Mission Planning Office, **1993**.

- General Good UI Design Principles
- Explanations/Trust (see quote above)
- Go with the (work) flow
- Flexibility/Robust UI
- User Acceptance Requirements (See title above)
- Legacy System Integration
- Different domains = Different Conflict concepts
- User editing "final" product / replanning
- Special UI Challenges with truly distributed / mixed initiative planning and scheduling