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)
  • 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.
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**Notes:**
- 12/7 <-------- Pad A Mod Window
- 3X MMOD WLE
- 8 Feb - To Xfer Aisle
Honda Crash Testing Schedule
Pharmaceutical Manufacturing Schedule

[Image: Screenshot of a manufacturing schedule]
# Manufacturing Resource Schedule

![Image of a manufacturing resource schedule](image)

### Table

<table>
<thead>
<tr>
<th>Date</th>
<th>Resource</th>
<th>Task</th>
<th>Status</th>
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<tr>
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<td>FM_1</td>
<td>Task A</td>
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<td>Feb 02, 2008</td>
<td>M1_1</td>
<td>Task B</td>
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<td>M1_2</td>
<td>Task C</td>
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<td>Feb 04, 2008</td>
<td>M1_3</td>
<td>Task D</td>
<td>Cancelled</td>
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</table>
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

<table>
<thead>
<tr>
<th>explanation</th>
<th>The start date was affected by the flow start time, which set it to 03/01/2018 00:00</th>
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<tr>
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<td>The end date was affected by the parent flow's late end date, which set it to 04/01/2018 00:00</td>
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<td>The start date was affected by B--1, which set it to 03/04/2018 16:00</td>
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<td>The end date was affected by C--2, which set it to 03/31/2018 08:00</td>
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<td>The start date was affected by B--1, which set it to 03/05/2018 00:00</td>
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<td>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</td>
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<td>The end date was affected by ForwardSchedule, based on duration and start time, which set it to 03/05/2018 16:00</td>
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<th>explanation</th>
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<td>The end date was affected by the parent flow's late end date, which set it to 03/15/2018 00:00</td>
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<td>The start date was affected by B--1, which set it to 03/03/2018 18:00</td>
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<td>The start date was affected by B--1, which set it to 03/05/2018 12:00</td>
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<td>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</td>
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<td>The end date was affected by ForwardSchedule, based on duration and start time, which set it to 03/06/2018 04:00</td>
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<th>explanation</th>
<th>Setting bounding window to Thu Apr 20 00:00:00 CDT 2017 - Thu May 25 00:00:00 CDT 2017</th>
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<td>Setting duration to 20.0 based on DEF</td>
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<td>Update window to take latest actual into account</td>
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<td>Setting bounding window to Tue Apr 25 10:48:52 CDT 2017 - Thu May 25 00:00:00 CDT 2017</td>
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<td>Setting bounding window to Wed Apr 26 09:13:41 CDT 2017 - Thu May 25 00:00:00 CDT 2017 based on availability</td>
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<td>Setting assigned window to Wed Apr 26 13:54:00 CDT 2017 - Wed Apr 26 14:14:00 CDT 2017</td>
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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
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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Note: The table above shows the demand increase scenario for the week of Dec 21-28, 2012. The highlighted cells indicate the increased demand in various locations.
Viable Personnel Visualization

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

Scheduling Results:

- virtual team members missing training for audit (28 results)
- missing training for audit (1 results)
- missing training for edit (1 results)
- resource selection basis - fallback (1703 results)
- overdue logic - true (7163 results)
- resource selection basis - preferred (10691 results)
- resource selection basis - backup (2682 results)
- resource selection basis - floater (747 results)
- scheduling error - Case added to workgroup that was supposed to be complete for this auditor; will result in interleaving (14 results)

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- T995001A02 --- stripped --- 42
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- W301001A02 --- stripped --- 8
- W301001A02 --- stripped --- 9
- W301001A02 --- stripped --- 11
- W301001A02 --- stripped --- 10
- W332001A02 --- stripped --- 26
- W301001A02 --- stripped --- 12
- W301001A02 --- stripped --- 14
- W412001A02 --- stripped --- 10
- W406001A02 --- stripped --- 7
- W406001A02 --- stripped --- 16
- W301001A02 --- stripped --- 15
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 replanning
• 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.

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