Marrying Social Media Approaches and Space Flight Control: Eight Years at SpaceOps

We now pronounce you “live” for flight!

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Andrew J. Nichols
Robert L. Roy

NASA - Marshall Space Flight Center, Huntsville, AL, USA
What Happened?

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<td>Developed CD idea, Prototyped UI</td>
<td>Proposed CD Testbed as HOSC Initiative</td>
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<td>Cadre Re-org, Procedures, Sims, Trial Ops Weeks, etc.</td>
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<td>Smart Search – “Amazon” for ops documentation</td>
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<td>Shorten T/L Product Summary Prep - 4 hrs down to 25 min</td>
<td>MSFC internal data sources accessible Oct ’17</td>
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<td>Increased HOSC Participation in SSTs</td>
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* - Simplify ISS Flight Control Communications and Log Keeping via Social Tools and Techniques – SpaceOps 2012 “Top 10%” paper
Seeds

("Elevator Pitch" from 2012 Application for NASA IT Labs Funding)
Hybridized Agile Software Development

The Process
Agile and Waterfall Considerations for New Developments
(Especially in Dynamic or Relatively Uncharted Territory)

• Minimum Success Criteria ensure essential functions are delivered
• Scope can change based on discoveries and to stay within resource budget
• Quality first (More focus on working software that provides value to customer than on merely complying with requirements verbiage)

• Fixed scope forces cost and schedule increases (or poor deliverable performance) if estimate is not close to reality.
• Complex, brand new, or UI-intensive settings exacerbate risk of tool being unusable at first release. Fixes/revisions may be delayed for a long time (if they happen at all).

Adapted from http://agilitrix.com/2016/04/agile-vs-waterfall/
Adapting Agile for PMOD “HOT” Tool Efforts

POIC software deliveries tightly bound to ISS config constraints

Typical Agile teams dedicated to one project, but PMOD team members must work on multiple projects

PMOD equivalents can’t meet daily (sit console, meetings, travel)

Product Owner
Scrum Master
User(s)
Developer(s)
Tester(s)

Backlog tasks expanded by team

Daily Scrum 5-15 min

Sprint 30 days max

Frequent internal Development Team meetings to identify and remove obstacles; iterative development and test cycle

Primary cross-team information flow occurs via the Product Owner (customer advocate) and Change Package Engineer (CPE) (project manager)

Pre-scheduled, discreet user evaluation periods built around PMOD console schedules

Ongoing, mid-sprint communication via tag-ups as needed among key team members


Adapted from https://it.pinterest.com/pin/303218987382547659/
Anecdote

About two years before PMOD made its first foray into ASD, during a casual hallway conversation an engineer suggested to a manager that a key benefit of Agile is that, because the developers and customer/users collaboratively discover the true requirements by experience and “hatch” the application and formal requirements together, the product is more robust and...

Engineer – “the end result is a happy customer.”

Manager (lightheartedly) – “Gee, no one’s ever levied a requirement on me for a happy customer.”

Engineer (likewise cheerful) – “Sir, isn’t that the ultimate requirement?”

Hmm...
Communications Dashboard Suite
CommDash Suite – “The Big Picture”

User can define layout of these in Config mode, and adjust frame boundaries in Run mode.
PD Status

PD Status consolidates payload configuration and readiness info into a common denominator, cross-discipline format. Grid is auto-populated and auto-sorted based on ISS timeline data from JSC's OPTIMIS tool. POIC cadre and PDs make updates as needed.

<table>
<thead>
<tr>
<th>Payload</th>
<th>Ops Ready</th>
<th>PD Grid Sys Issue</th>
<th>Loop</th>
<th>Space to Ground</th>
<th>Video Downlink (HD or ME)</th>
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</table>
| PD Status Display

- **Title bar for Category; Collapse/Expand icon at left**
- **Grid sorted first by Category, then by most current activity**
- **Darker green -> highest category, happens when “Ops Ready” is set (activity in-progress)**
- **Context-sensitive dialog opens after clicking in cell**
- **Red -> Event not associated with a payload in database. Use dialog to make assignment**

**Use dialog to make assignment**
As of April 2018, some info populates automatically or by quick pull-down menu, some by manual entry from appropriate console position(s). There are or will be significant opportunities for more automation.
Multiple Paths to Good Solutions
[ Current guidance, adapted from CommDash scenario training materials ]

- Different cadre teams may use the tools in a slightly different way. That’s OK! Do what makes sense!

- The key is to understand the underlying strengths/weaknesses of individual tools, then use them as you see fit. Uniformity isn’t the goal, efficiency is.

- Sometimes, multiple tools can be used in concert to accomplish a single task.
  - To Do list task created to review E-1 (Execution minus one day) plan
  - Chat used between individual console positions for an off-the-loops discussion of [topic]
  - To Do list task closed out with comments
  - TCO (Timeline Change Officer) provides a FCTL entry with all details of review plus resulting documentation that other positions pull into positional logs
## Insights from First Six Months of CommDash Operational Use (Sep 2017 – Mar 2018)

<table>
<thead>
<tr>
<th>Component</th>
<th>Description/Function</th>
<th>Primary Users, Characteristics, Insights</th>
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</thead>
<tbody>
<tr>
<td>CommDash Suite</td>
<td>CommDash components and behaviors collectively</td>
<td>• Less voice loop clutter - CommDash provides places for traffic that can be worked at slower pace. Since less stuff comes in by voice, it no longer feels like everything is clamoring for priority.</td>
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<tr>
<td>Dashboard</td>
<td>Executive (Launcher, Multi-Frame Display)</td>
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<tr>
<td>Console Log Tool (CoLT)</td>
<td>Deployed 6 years prior to CommDash, may be displayed in Dashboard (see FCTL)</td>
<td>Templates feature (added as part of HOT development) used mostly by OC, PRO</td>
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<td>FCT Log (FCTL)</td>
<td>Special, shared CoLT log for pushing snapshots of position-specific CoLT log entries that may be of interest to the whole team. Dashboard can display FCTL separately from, or merged with. individual log</td>
<td>PAYCOM, PRO, Marshall GC • Favorite CommDash tool across FCT, most widely used and accepted for day-to-day ops. • Has substantially improved coordination and saved time finding info by providing a single-source running real-time and historical location for console reports.</td>
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<tr>
<td>PD Status</td>
<td>PD Team and Voice-Video-Data readiness for FCT-managed activities – Now +/- 8 hours</td>
<td>• Cadre likes concept; many inputs are manual, so it’s taking time for folks to build input habits; trust in what’s displayed is growing</td>
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<tr>
<td>To Do List</td>
<td>Define/assign task assignments by position; store/show comments, completion status</td>
<td>TCO (biggest user by far), APOM, DMC, POD • Timeline Reviews w/cadre, no comments via voice loop • Internal planning team comm with back rooms</td>
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<tr>
<td>IMReady</td>
<td>Poll FCT on simple questions/statuses</td>
<td>• Main uses - Console readiness, handovers, or big events.</td>
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<tr>
<td>Text Chat</td>
<td>Position-specific channels, custom channels and on-the-fly discussions, notifications</td>
<td>• Reduces voice traffic</td>
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</tbody>
</table>

### Cadre Position References in 3rd Column

- Assistant Payload Ops Mgr
- Data Mgmt Coordinator
- Operations Controller
- Payload Communicator
- Payload Ops Director
- Timeline Change Officer
- Payload Rack Officer
- Marshall Ground Control

**From a POD email to the Project Team – “Just wanted to share my thoughts on the CommDash tool. I really like it! This tool is opening up lots of possibilities to increase the productivity of the front room via the to do list and the chat tool.”**

**Hmmm... Wasn’t there a story a few charts back about Agile and a happy customer?**
The Back-Story

Underlying Principles and Human Factors
Serial
Fluid and quick
Expressive and humanizing
Fleeting – “Say again?”

Semi-Parallel / Parallel
Visually persistent
Easy to review; linkable
Slower to create than voice
Bedrock 2
(Appplies to more than just Console Logs)

Isolation -> Divergence

Interleaving -> Sync

Discover and resolve overlaps and underlaps while they're small!
Why POIC Avoids eMail

Message buried in headers and index, easily lost or deleted

Why Chat Works Well

Cuts the clutter, Archived

Having a single instance of a conversation provides natural focus on "the right stuff."
Stovepipes, Specialty User Interfaces

Realization

Aggregators

CommDash Suite
We all do both, ‘cause we’re human, and both aid successful flight control.

Important to operate in balance, e.g.
Don’t overtax Sys 2 (decision fatigue)
Use Sys 1’s big picture & rapid response capability, with Sys 2 as a look before leap tool

*CommDash* provides respectful triggers

Where else to apply?...  Next-gen display design, perhaps?
Human Factors Engineering Context

Primary Human Factors Domains

- Physical
  - Room Layout, Traffic Flow
  - Seating/Standing
  - Individual Console Configuration
  - Human Computer Interface (HCI) (screen appearance, functionality, intuitiveness)
- Cognitive
- Organizational
  - CommDash ConOps
  - Agile Paradigm and Process
  - Enhanced Collaboration

Control Room Ergonomics

- CommDash Displays & Behaviors
- Human Computer Interface (HCI) (screen appearance, functionality, intuitiveness)
- Component/Workspace Layout
- Seating/Standing
- Individual Console Configuration
- Physical Environment
  - Lighting
  - Noise
  - Temperature/Humidity
The Home Stretch
Console Logs

“Brief Narrative of Significant Operational Events”

So many systems, so much generated/duplicated text

(Often copied in the name of thoroughness, until the forest gets lost in all the trees)

Couldn’t help being brief; hand can only move so fast, no instant playback

A path back to brief logs?

(Ancillary info outside the log, yet within easy reach. Design owes much to experiential discovery inherent in Agile.)
Hybridized Agile Software Development

H-ASD enables flexible, creative development while respecting:
- Flight schedule-based delivery requirements
- Project financial planning inertia
- POI personnel schedule & task demands

Developers & users side-by-side early on, then throughout project:
- Finds & fixes technical issues while relatively easy and inexpensive
- Reduces IV&V and acceptance hiccups
- Promotes mutual understanding of limitations and strengths
- Reaps benefits far beyond initial project
- Is FUN! (stress-reducer)

Cost estimate as 1st step in ASD project may induce:
- a) premature adoption of design approach, or
- b) cost variance later.

Suggest adding Pre-Project Sprint Zero

- Explore Problem & Solution Spaces, “Paper Prototypes”, Establish a Shared Vision
- Cost Est., Define Sprints
- Better $ & Sprint Defn
- 1st Partial Delivery
- 1st Partial Delivery
- Full Release
- Full Release
Smile!
Related Papers at Space Ops 2018

Hybridized Agile Software Development of Flight Control Team Tools for International Space Station's Payload Operations Integration Center!

*Cerese M. Albers*

Ph.D. PMI-ACP

30 May, 1400-1430, Lacydon

in GSE-07. GSE - New Challenges for Software Development and Maintenance

Innovative Development of a Cross-Center Timeline Planning Tool

*Ramon Pedoto, Cerese M. Albers, David Benjamin, James Reynolds*

29 May, 1700-1730, Notre Dame

In PS-02. PS – New Techniques and Planning Software II
On Our Way!

Thanks for Joining Us