

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

*Communications
Dashboard*

We now pronounce you “live” for flight!



David W. Scott

Dr. Cerese M. Albers
Presenter

Hugh S. Cowart

Andrew J. Nichols

Robert L. Roy

NASA - Marshall Space Flight Center, Huntsville, AL, USA

What Happened?

2010	2011	2012	2013	2014	2015	2016	2017	2018
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ISS NASA Payload (PL)
Crew Size & Loading Plans



25 crew PL
hours/wk

40-100 crew
PL hours/wk



YEE
Ha!

Payload Ops Integration
Prep for 4th Crew/HOT

NASA/ISS Program planning Increased
PL utilization in light of Commercial
Crew transport beginning in 2017



!!

Special Studies Teams
Hatched high level ops
concepts & tool needs

SSTs
continued to lower
levels of detail

Cadre Re-org, Procedures,
Sims, Trial Ops Weeks, etc.

Cadre members on
Agile product teams

Feb - Over 100 PL
crew Utilization
hours in 1 week!

POI Papers
on Using Social
Methods for Ops

SpaceOps	SpaceOps *	SpaceOps	SpaceOps
IEEE Aero	IEEE Aero	IEEE Aero	

CommDash
(CD) Development

CAT/CoLT 1.0 CAT/CoLT 1.0
↔ ↔
Rqmts Devel Design/Build
(Natural evolution of 10 years POIC ops)

Developed CD idea,
Prototyped UI
NASA IT Labs
Proposed
CD Testbed
as HOSC Initiative
Developed
High Level Rqmts,
Project not funded

Increased HOSC
Participation in SSTs

ATP Delivered Ops!
Apr May Oct

Major Components

To Do	5 Sprints
IM Ready	3 Sprints
Chat	4 Sprints
PD Status	3 Sprints
Dashboard	3 Sprints
FCT Log	3 Sprints

Other 4th Crew/HOT
Tools Development
(same timeframe as
CommDash)

TIPS – Timeline Integrated Product Summary
Shorten T/L Product Summary Prep - 4 hrs down to 25 min

Smart Search – “Amazon” for ops documentation
MSFC internal data sources accessible Oct '17
MSFC external sources (e.g., MCC-H) planned for Jun '19

Seeds



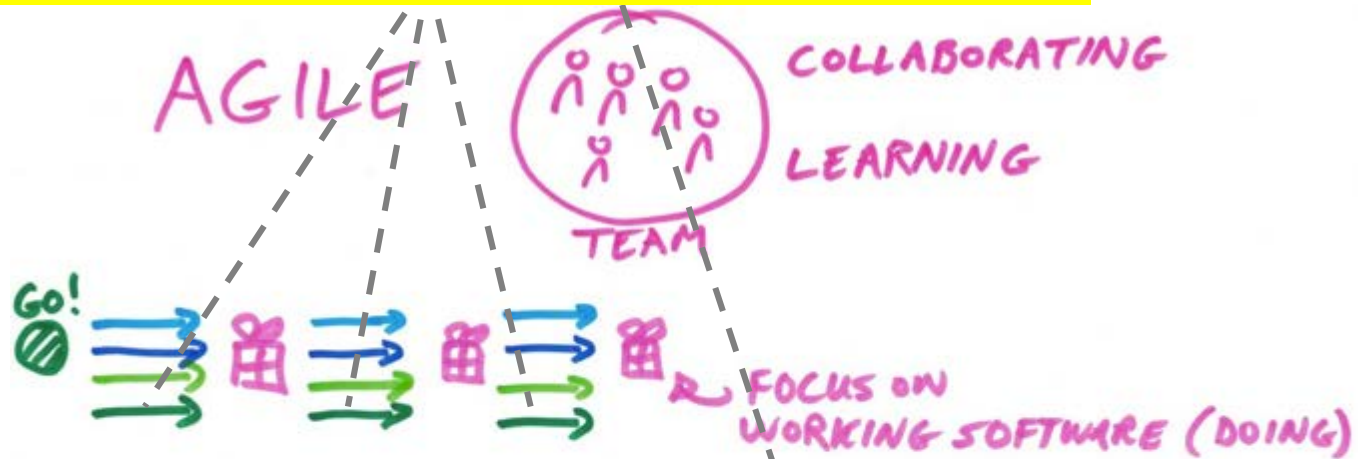
The Process

Hybridized Agile Software Development

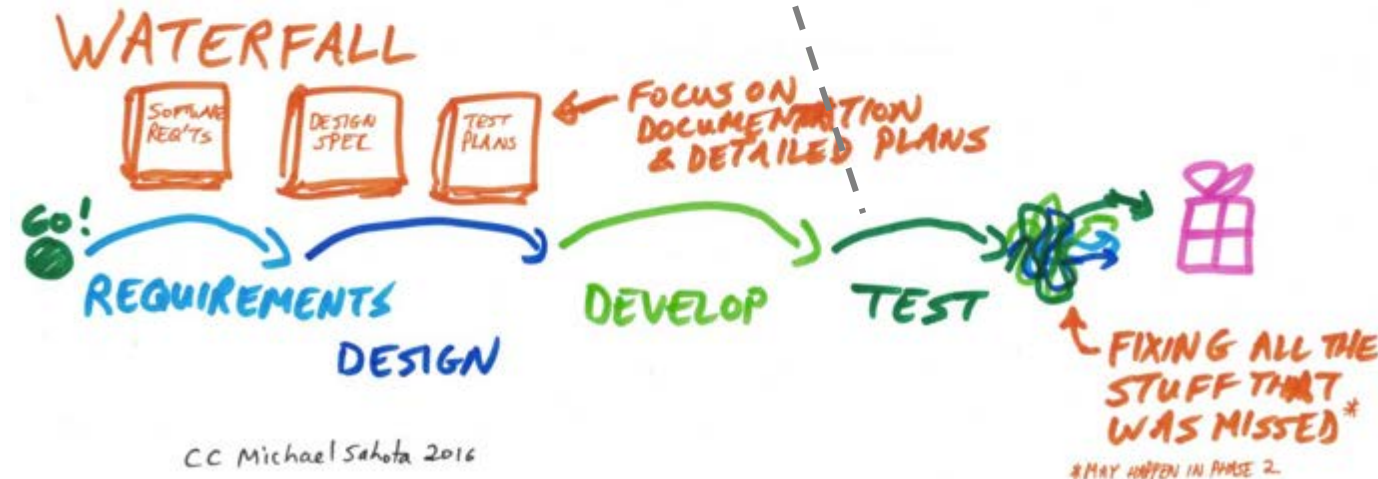
Agile and Waterfall Considerations for New Developments

(Especially in Dynamic or Relatively Uncharted Territory)

Discover, assess, and resolve *actual* issues/opportunities here, *not* here



- 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).

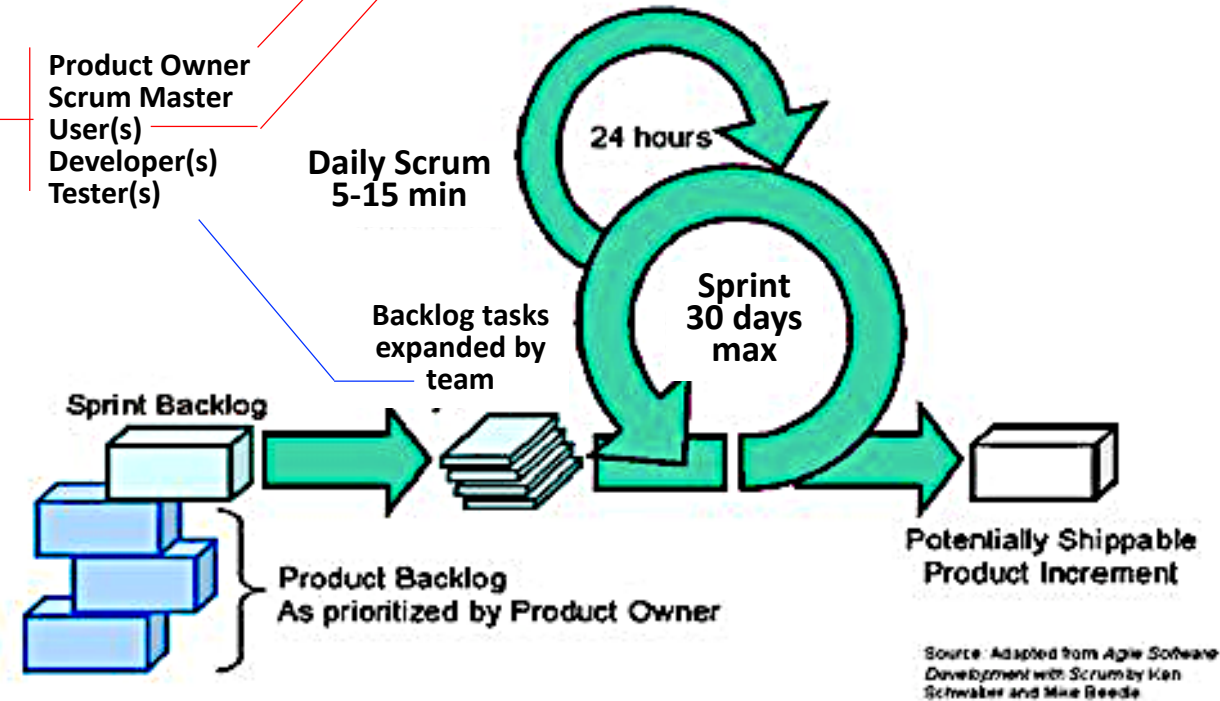
CC Michael Sahota 2016

Adapting Agile for PMOD “HOT” Tool Efforts

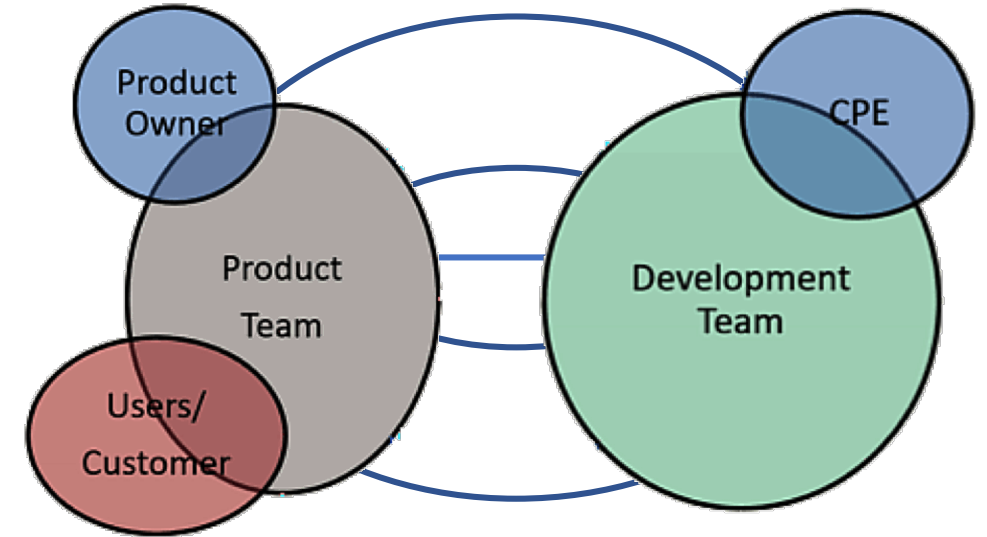
POIC software deliveries tightly bound to ISS config constraints

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)



Typical ASD: Single Product Development Team



PMOD ASD: Separate Yet Well-Coupled Product and Development Teams

- 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

Extensive details in SpaceOps 2018 paper “Hybridized Agile Software Development of Flight Control Team Tools for International Space Station’s Payload Operations Integration Center”

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?”



Hmmm...

The Product

Communications Dashboard Suite

CommDash Suite – “The Big Picture”

IMReady

Log / Entry: Zach Test Log / 437

Author: Howley, Ian

Category:

Created Time: 2017/179 21:06:50

Flags:

HOSC Time: 2017/179 21:06:51

Local Time: 2017/179 16:06:51

Payload:

Title:

Recurrence of CATS-SW-0002. All inhibits in place per B19-45 C

Log / Entry: Zach Test Log / 435

Author: Howley, Ian

GMT: 2017/177 17:47:23

Flight Control Team Log: 436

Title: THIS PORTION

Log / Entry: Zach Test Log / 435

Author: Howley, Ian

Category: Data Systems

Created Time: 2017/177 17:43:14

Flags:

HOSC Time: 2017/177 17:43:14

Local Time: 2017/177 12:43:14

Payload:

Title:

I will only be pushing THIS PORTION of s

I am writing words

Log / Entry: Zach Test Log / 433

Author: Howley, Ian

GMT: 2017/174 21:21:46

Flight Control Team Log: 434

Title: This is information for the FCTL

100000 entries

PD Status

PD Status

Task #

Task Title

Due Date

Creator

Assignments

0032-50

E-1 Timeline Review

2017/009:15:00:00

TCO

Active: IL, STOW, OC *, SIM DMC, SIM OC, SIM PAYCOM, SIM POD, SIM PRO, SIM STOWAGE, SIM TCO, TCO *

0036-50

Review FN

2017/012:00:00:00

POD

Complete: DMC *, PAYCOM *, PRO

0029-50

new and improved TASK

2017/026:04:15:00

POD

Active: OC, POD, POD-2, STOWAGE

0045-50

TEST 1.2.3

2017/119:00:00:00

POD

Complete: DMC, Marshall GC, PAYCOM, PRO, TCO *

0003-49

Test Task

2017/163:20:00:00

POD

Active: OC, POD

0011-51

Runbook Test

2017/181:00:00:00

PRO

Active: OC, PRO

0018-50

Test Task by Duplicated by C

PAYCOM

0029-48

Check Check

0030-48

Check Check

0031-48

E-1 Timeline Duplicate

2016/345:00:00:00

OC

Active: OC, STOWAGE

0006-49

Test To Do list to log

2017/164:00:00:00

OC

Active: OC

0009-51

lan's test To Do

2017/177:19:00:00

OC

Active: Marshall GC, OC, POD, PRO, TCO

0010-51

lan test 2

2017/181:11:15:00

OC

Active: OC, POD, PRO

pod

Monday Jun 19th 2017

2017:170:30:33:33 me:

Chat Chat Chat

Occupants: POD(ycalvert)

Text Chat

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

Darker green -> highest category, happens when "Ops Ready" is set (activity in-progress)

Title bar for Category; Collapse/Expand icon at left
Grid sorted first by Category, then by most current activity

Applications ▾

PD Status Display

OPS - OPS1 2016:293:15:21:05

Payload	PD Status	Ops Ready	PD Grd Sys Issue	Loop	Space to Ground			Video Downlink (HD or SD)				Comments
					S/G CHAN	S/G Config	Config in Place	D/L Source	D/L CHAN	D/L Restrictions	Config in Place	
On Console												
NanoRacks	On Console	✓		SCI 3	S/G 4	None		HD JEM	D/L 5	None		
Cold Stowage	On Console			SCI 4						Vid 12		
HDEV	On Console			SCI 3								
MERLIN	On Console			SCI 4								
TReK	On Console			SCI 4								
On Call												
Rodent Research	On Call			SCI 2						Vid 12 + R6		
Upcoming												
CATS	✗	Break Until 17:00		SCI 2								
SCAN Testbed	✗			SCI 1								
HREP	✗			SCI 5								
Manufacturing Device	✗			SCI 4								
SPHERES	✗			SCI 1								
CIR	✗											
Meteor	✗				S/G 1	PVT 2		HD NODE 1		R4		
VS-LK LIM-CHNG DACT	✗											
CATS-SAFE-OPS	✗											
HRF2-RACK-PWRUP CMD	✗											
MARROW-AIR-CLCT SUB	✗											
HRF2-RACK/PC-TRACK	✗											
HRF2-RC-TRACK	✗											
HRF-FBLD-DSPNCLT SUB	✗				S/G 4	PVT 5				R5		
HRF1-RACK-PWRUP CMD	✗											
Complete												

Space to Ground

S/G Channel	Configuration	Phone Patch	Enabled
S/G 1	PVT 2	✓	✓
S/G 2			
S/G 3			
S/G 4			

Context-sensitive dialog opens after clicking in cell

Space to Ground

S/G Channel	Configuration	Phone Patch	Enabled
S/G 1	PVT 2	✓	✓
S/G 2			
S/G 3			
S/G 4			

Context-sensitive dialog opens after clicking in cell

Red -> Event not associated with a payload in database.
Use dialog to make assignment

Map activity MD-HW-POWER?

Search Filter String

Payload

3D Printing in Zero-G

3DA-1 Camcorder

3DP

ABRS

ACE

ACE (LMM)

ACE-1 (LMM)

ACME

AEROSOL SAMPLERS

AMINE SWINGBED

AMINE SWINGBED PH

Payload	+	PD Status	Ops Ready	PD Grd Sys Issue	Loop	Space to Ground		
						S/G CHAN	S/G Config	Config in Place
▲ On Console								
NanoRacks		On Console	✓		SCI 3	S/G 4	None	
Cold Stowage		On Console			SCI 4			
HDEV		On Console			SCI 3			
MERLIN		On Console			SCI 4			
TReK		On Console			SCI 4			
▲ On Call								
Rodent Research		On Call			SCI 2			
▲ Upcoming								
CATS	✗	Break Until 17:00			SCI 2			
SCAN Testbed	✗				SCI 1			

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.

Video Downlink (HD or SD)				Comments
D/L Source	D/L CHAN	D/L Restrictions	Config in Place	
HD JEM	D/L 5	None		
		Vid 12		
HD LAB	D/L 2	Vid 12 + R6		

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)

Component	Description/Function	Primary Users, Characteristics, Insights
CommDash Suite	CommDash components and behaviors collectively	<ul style="list-style-type: none"> 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.
Dashboard	Executive (Launcher, Multi-Frame Display)	
Console Log Tool (CoLT)	Deployed 6 years prior to CommDash, may be displayed in Dashboard (see FCTL)	Templates feature (added as part of HOT development) used mostly by OC, PRO
FCT Log (FCTL)	<p>Special, shared CoLT log for pushing snapshots of position-specific CoLT log entries that may be of interest to the whole team.</p> <p>Dashboard can display FCTL separately from, or merged with. individual log</p>	<p>PAYCOM, PRO, Marshall GC</p> <ul style="list-style-type: none"> 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.
PD Status	PD Team and Voice-Video-Data readiness for FCT-managed activities – Now +/- 8 hours	<ul style="list-style-type: none"> 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
To Do List	Define/assign task assignments by position; store/show comments, completion status	<p>TCO (biggest user by far), APOM, DMC, POD</p> <ul style="list-style-type: none"> Timeline Reviews w/cadre, no comments via voice loop Internal planning team comm with back rooms
IMReady	Poll FCT on simple questions/statuses	<ul style="list-style-type: none"> Main uses - Console readiness, handovers, or big events.
Text Chat	Position-specific channels, custom channels and on-the-fly discussions, notifications	<ul style="list-style-type: none"> Reduces voice traffic

Cadre Position References in 3 rd Column	
Assistant Payload Ops Mgr	APOM (Backroom)
Data Mgmt Coordinator	DMC
Operations Controller	OC
Payload Communicator	PAYCOM
Payload Ops Director	POD
Timeline Change Officer	TCO
Payload Rack Officer	PRO
Marshall Ground Control	Marshall GC

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?

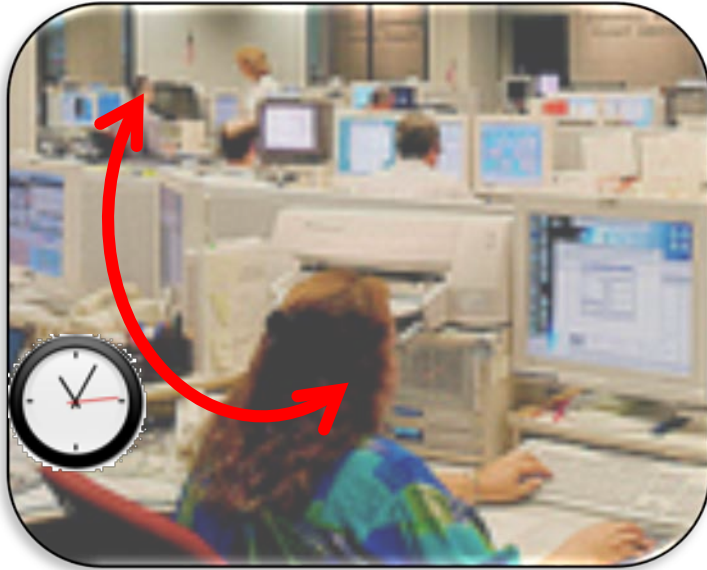


The Back-Story

Underlying Principles and Human Factors

Bedrock

Voice

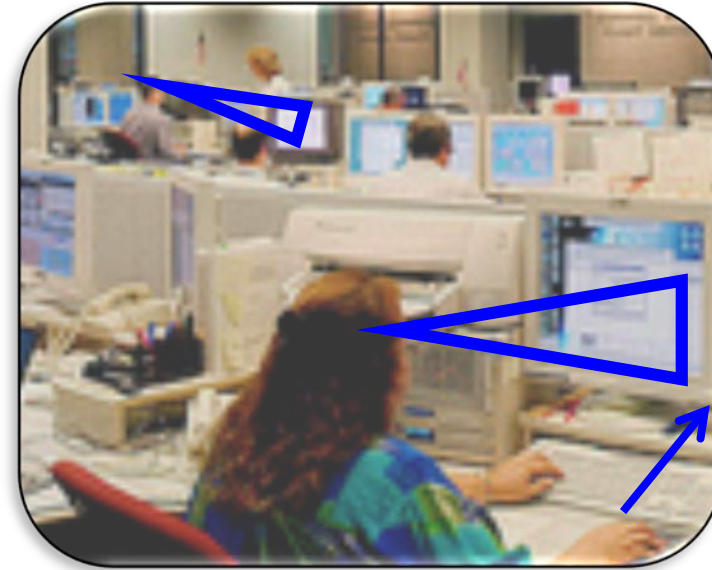


Serial

Fluid and quick
Expressive and humanizing

Fleeting – “Say again?”

Text/Graphics



Semi-Parallel / Parallel

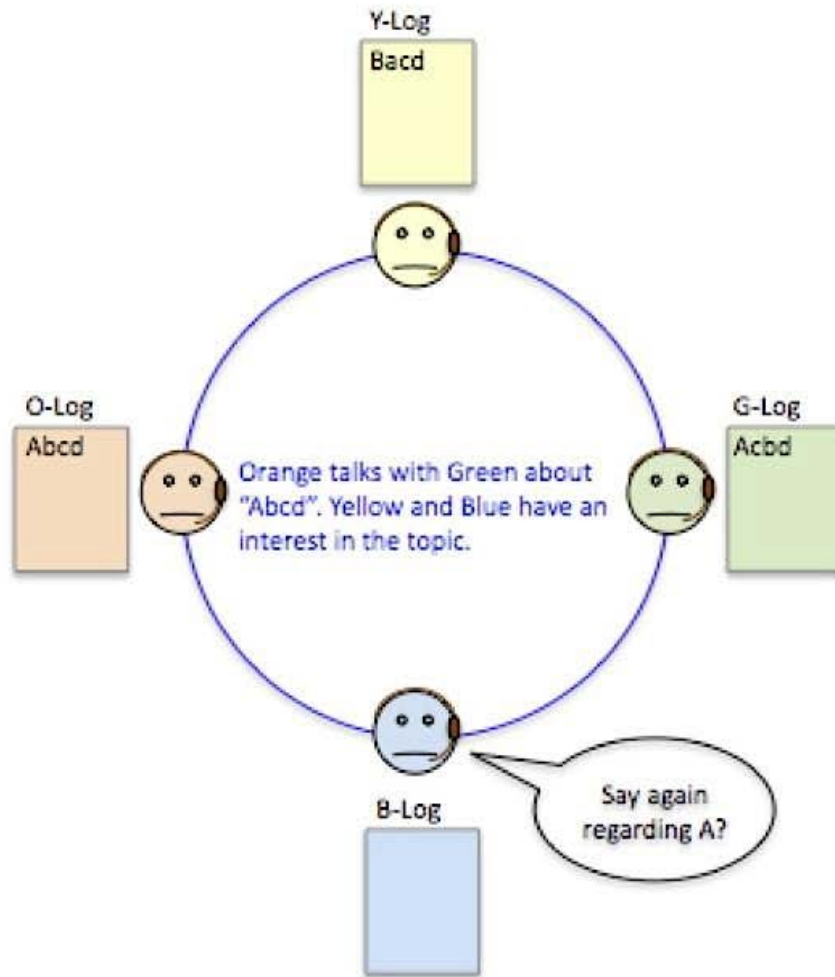
Visually persistent
Easy to review; linkable

Slower to create than voice

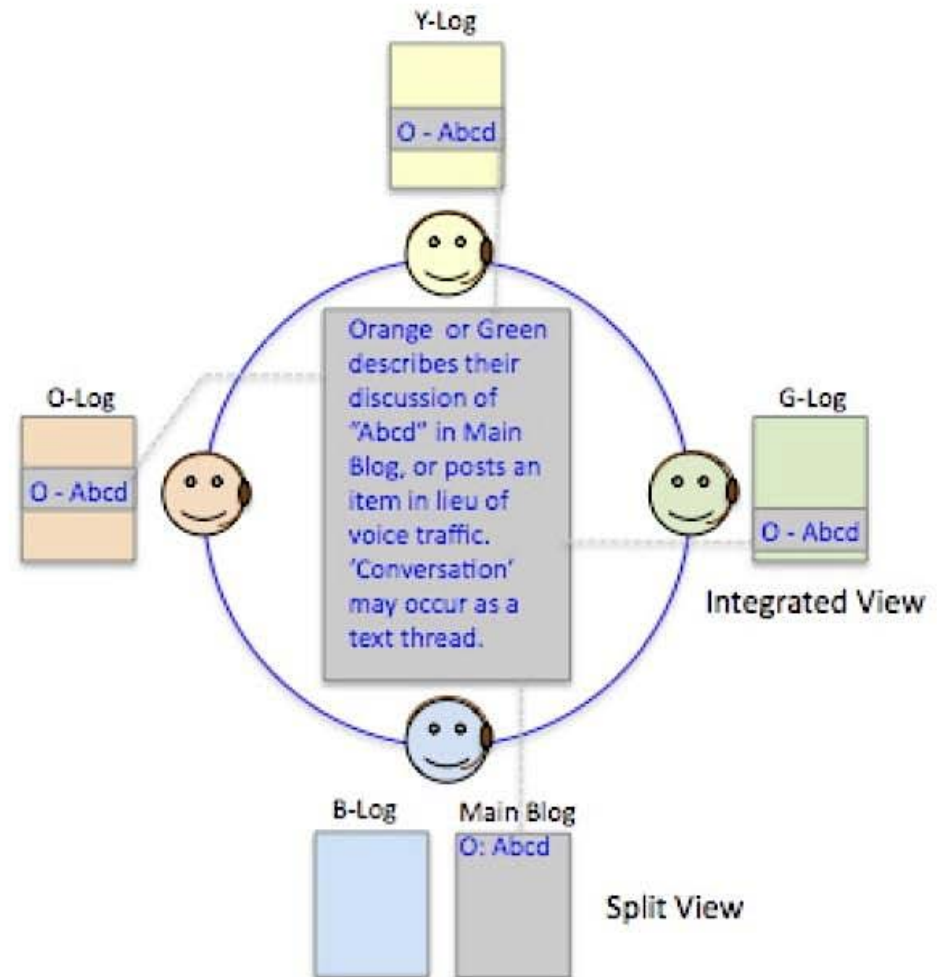
Bedrock 2

(Applies to more than just Console Logs)

Isolation -> Divergence



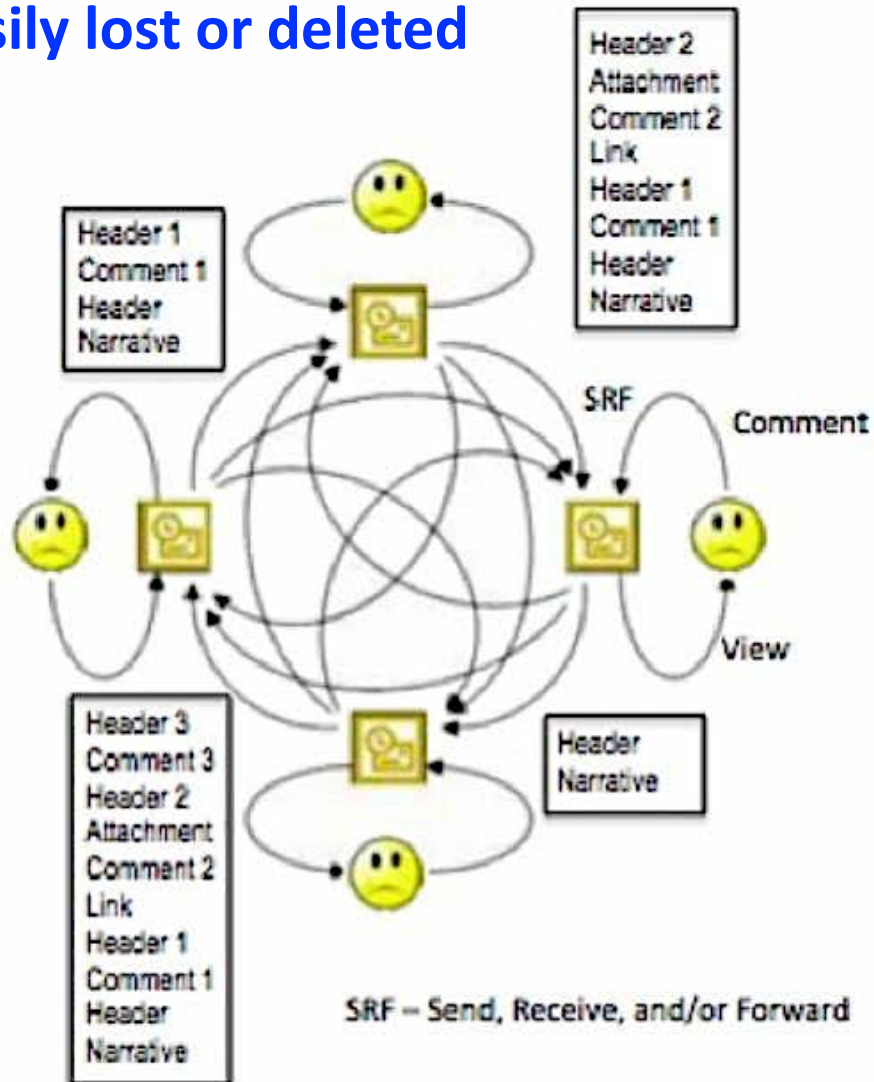
Interleaving -> Sync



Discover and resolve overlaps and underlaps while they're small!

Why POIC Avoids eMail

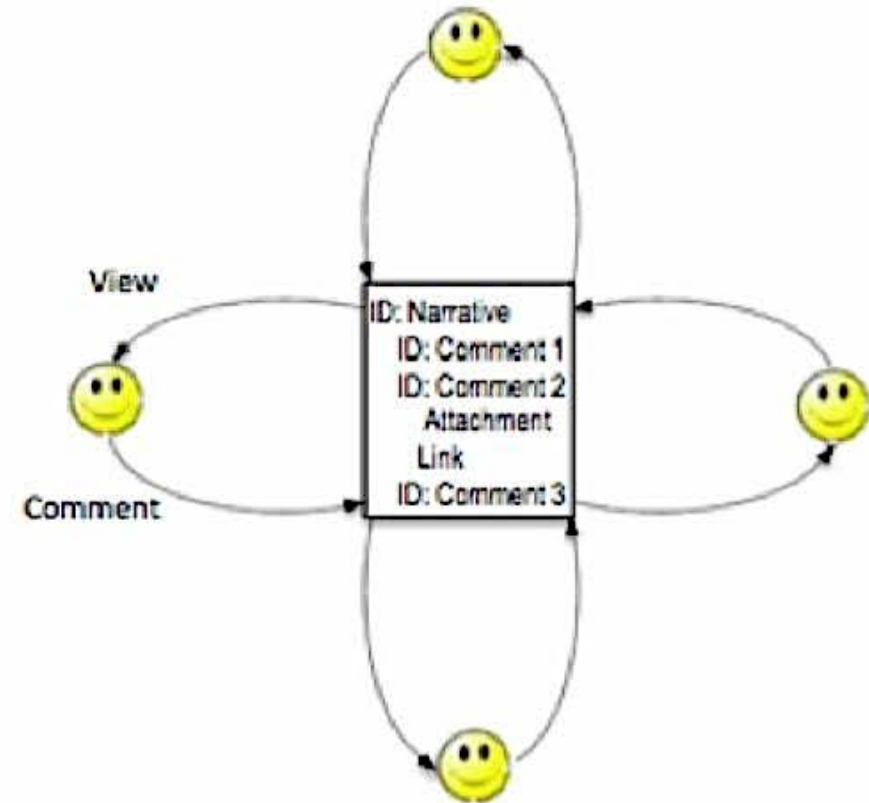
Message buried in headers and index,
easily lost or deleted



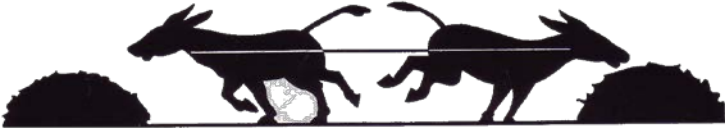
Having a single instance of a conversation provides natural focus on "the right stuff."

Why Chat Works Well

Cuts the clutter, Archived



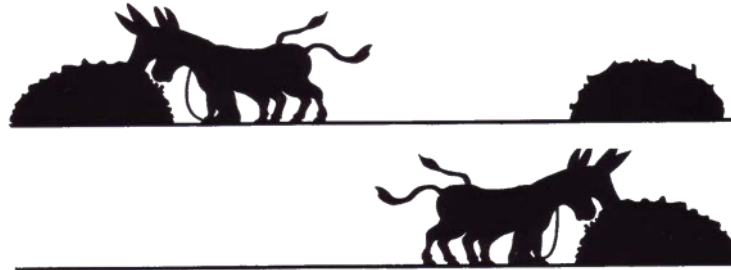
Emoticon-and-squiggle patterns courtesy of Kevin Jones/MITS-MSFC IS30



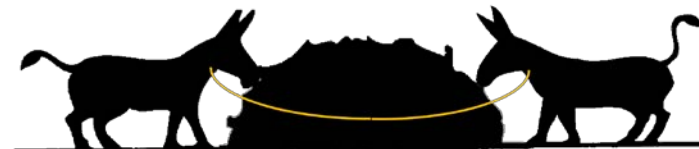
Stovepipes, Specialty User Interfaces



Realization



Aggregators



CommDash Suite

Human Factors – Fast and Slow Thinking

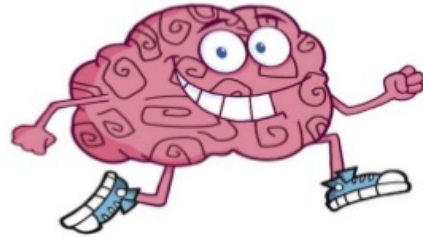
Thinking Fast

Rapid Cognition Thinking

System 1 Thinking

Naturalistic decision making/Recognition Primed Decision

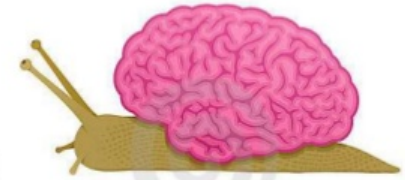
- Thinking with the subconscious
- Uses Intuition and based on 'patterns'
- Multiple decisions, multiple inputs, multiple options
- Effortless
- Dynamic
- Fast
- Processes automatically
- Emotive
- Decisive
- Can be primed or misled



Thinking Slow

System 2 thinking

- Thinking with the conscious part of our brain
- Uses logic and reasoning
- One issue at a time
- Requires effort and is tiring
- Slow and deliberate
- Follows rules and processes
- Explores possibilities and probabilities
- Less decisive
- Invites compromise and is risk averse



From <https://www.slideshare.net/actkm/williams-thinking-fast-and-slow>

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)

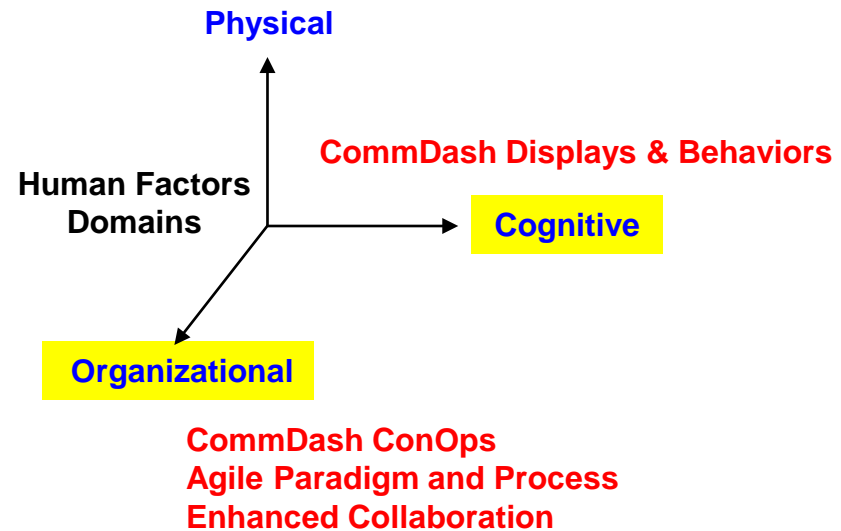
Use Sys 1's big picture & rapid response capability, with Sys 2 as a look before leap tool

***CommDash* provides respectful triggers**

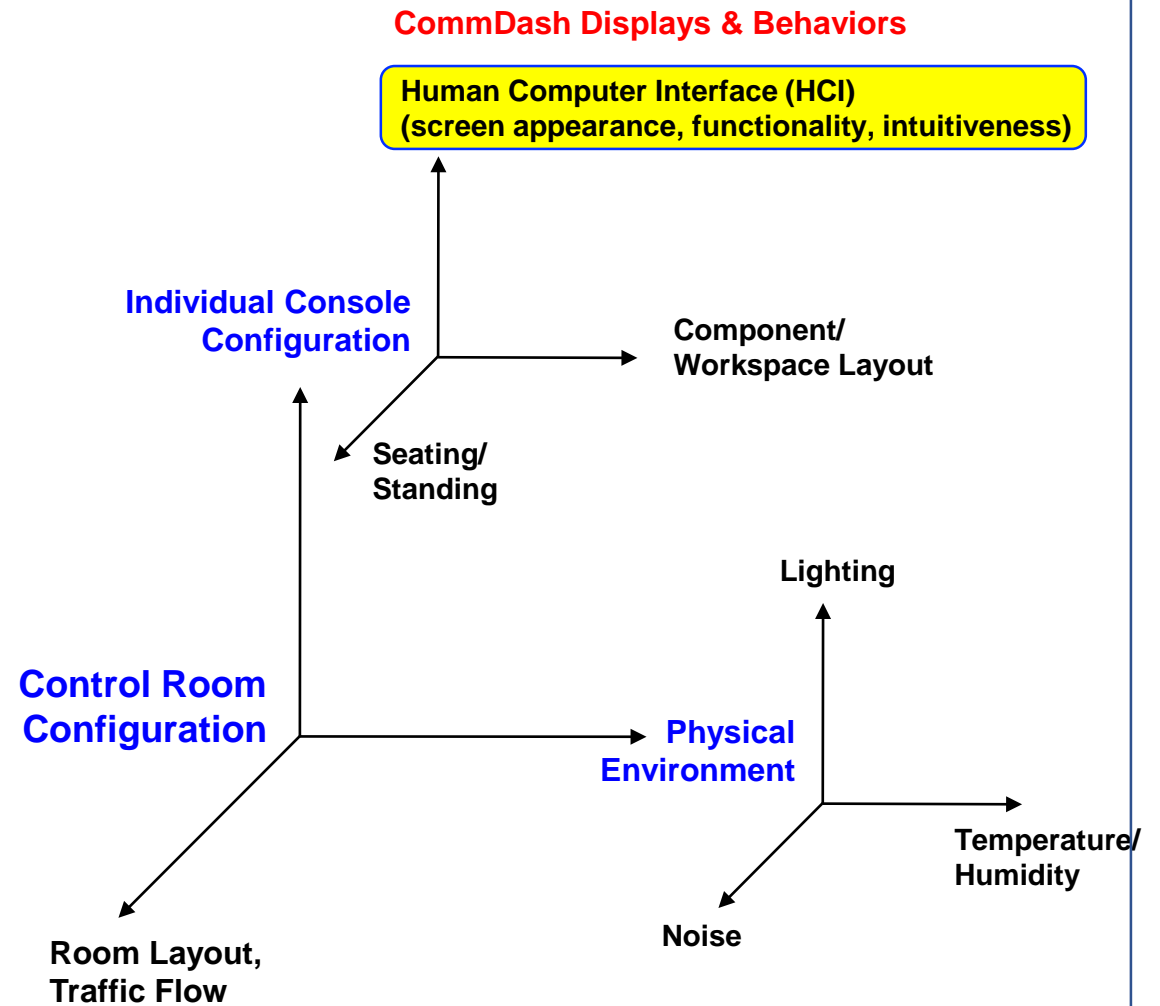
Where else to apply?... Next-gen display design, perhaps?

Human Factors Engineering Context

Primary Human Factors Domains



Control Room Ergonomics

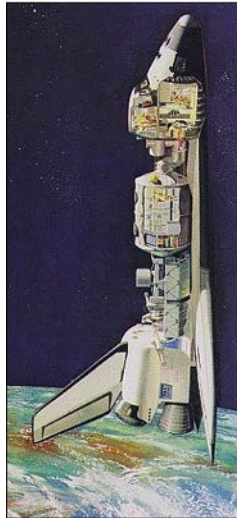
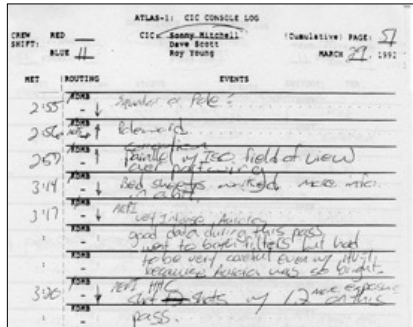
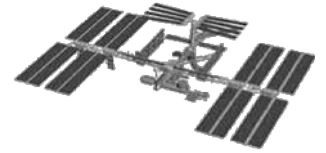


The Home Stretch



Console Logs

“Brief Narrative of Significant Operational Events”



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

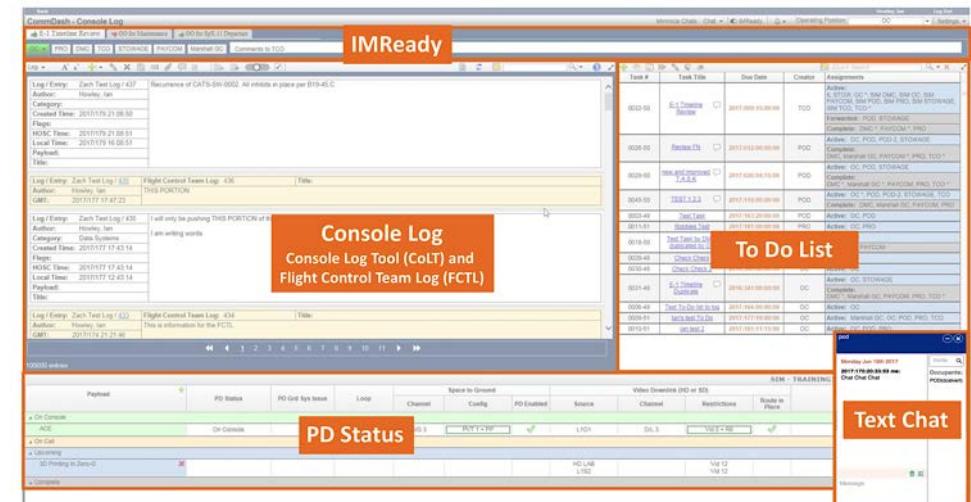
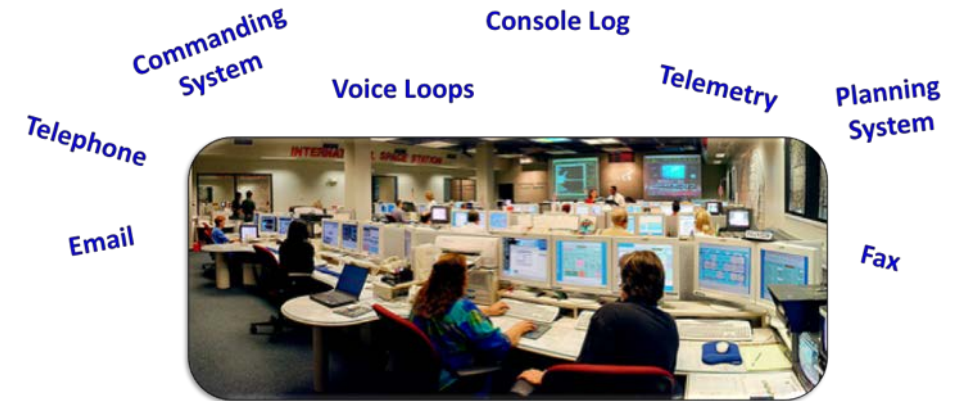
So many systems, so much generated/duplicated text

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

Communications Dashboard

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)

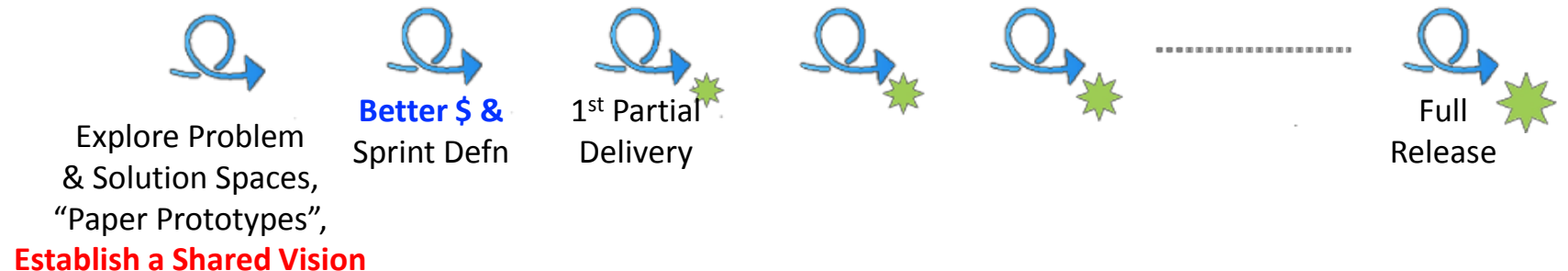
Cost estimate as 1st step in ASD project may induce
a) premature adoption of design approach, or
b) cost variance later.

Sprint One

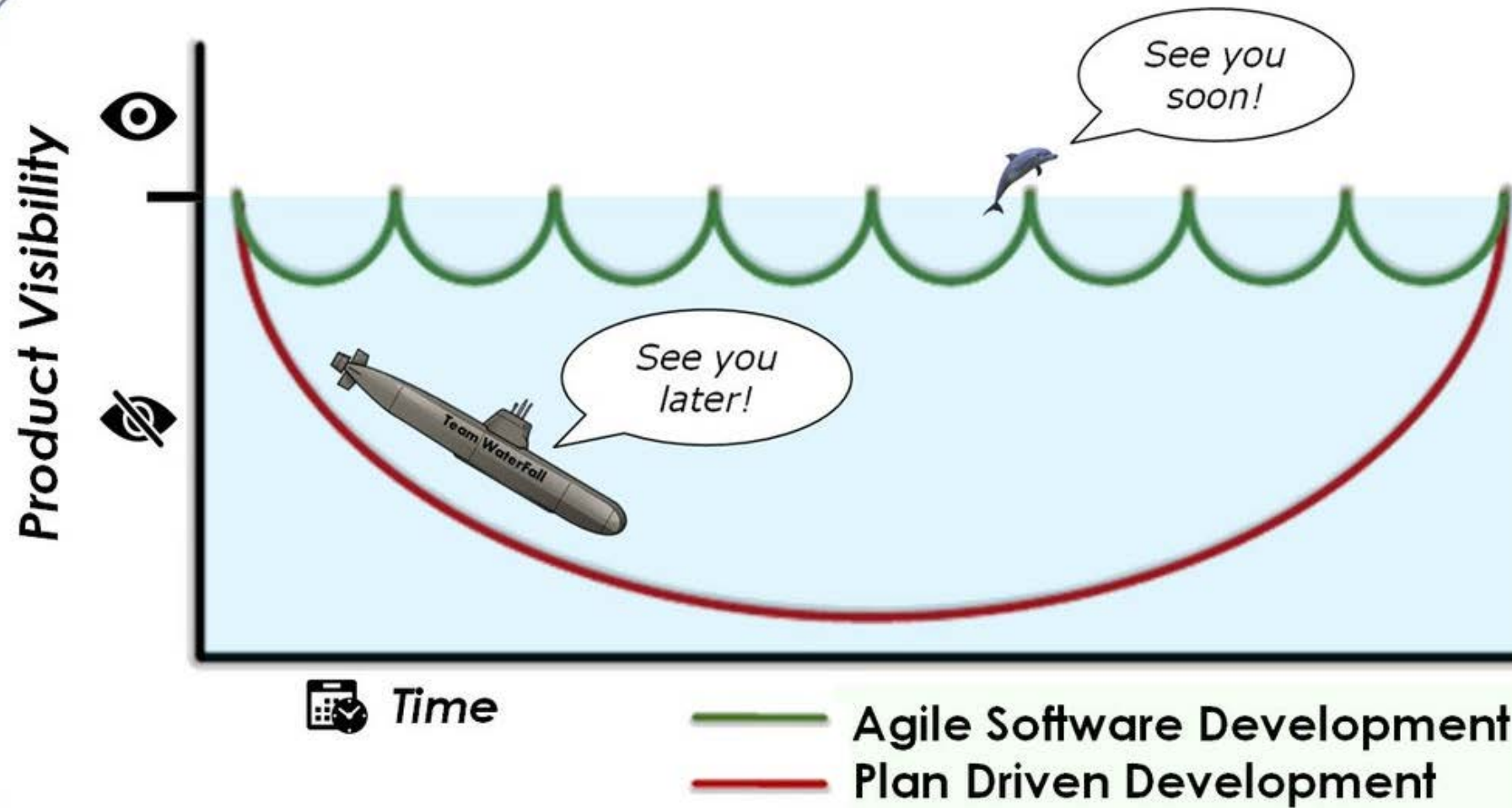


Sprint Zero

Suggest adding Pre-Project Sprint Zero



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!

T hanks for Joining U s

