Crew Autonomous Scheduling Test (CAST)

Implementation, Observations, and Future

ASE Astronaut Reunion

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CAST: Motivation

Flight Operations believes that future human exploration efforts will require daily operations between ground and crew to evolve from the low-Earth orbit mission environment. In the future, the crew will experience communications delays and longer duration missions. With this new mission environment comes the need to explore crew autonomy to effectively and efficiently schedule and execute their day.

CAST: Goals Overview

- Objectives
  1. **To investigate if a crew self-scheduled day has an impact on mission success**
     - Hypothesis #1: If an ISS crew member is given Playbook and a limited set of planning aids they can create an individualized timeline that integrates with all other ISS operations on the day without sacrificing an objective that was listed on that day.
  2. **To investigate whether crew self-scheduling is an efficient mission planning operations concept**
     - Hypothesis #2: The difference in the total chargeable crew time statused as complete on an individualized timeline is greater than the amount of chargeable crew time statused as completed on the average timeline across the increment adjusted for holidays, sleep shifts, and available crew hours at the 90% confidence level.

  2a. To investigate if crew self-scheduling affects crew satisfaction
     - Hypothesis #3: The crew reports a higher level of satisfaction when doing their individualized timeline.

CAST Execution: Big Picture

- **An exercise in crew planning as an <u>Operations Concept</u>**
  - Five exercises (not necessarily consecutive)
    - Each day of the exercise increases the crew's control
    - Self-schedule of empty days represents an extreme self-schedule approach
  - Exercises occur on full, nominal, crew days on ISS
    - Exercise days carefully chosen to capture future mission realism, minimize current mission risks, and maximize investigation return.
    - ISS Planning team and CAST recommended opportunities are approved at the WPR
    - Total crew time is 5 hours

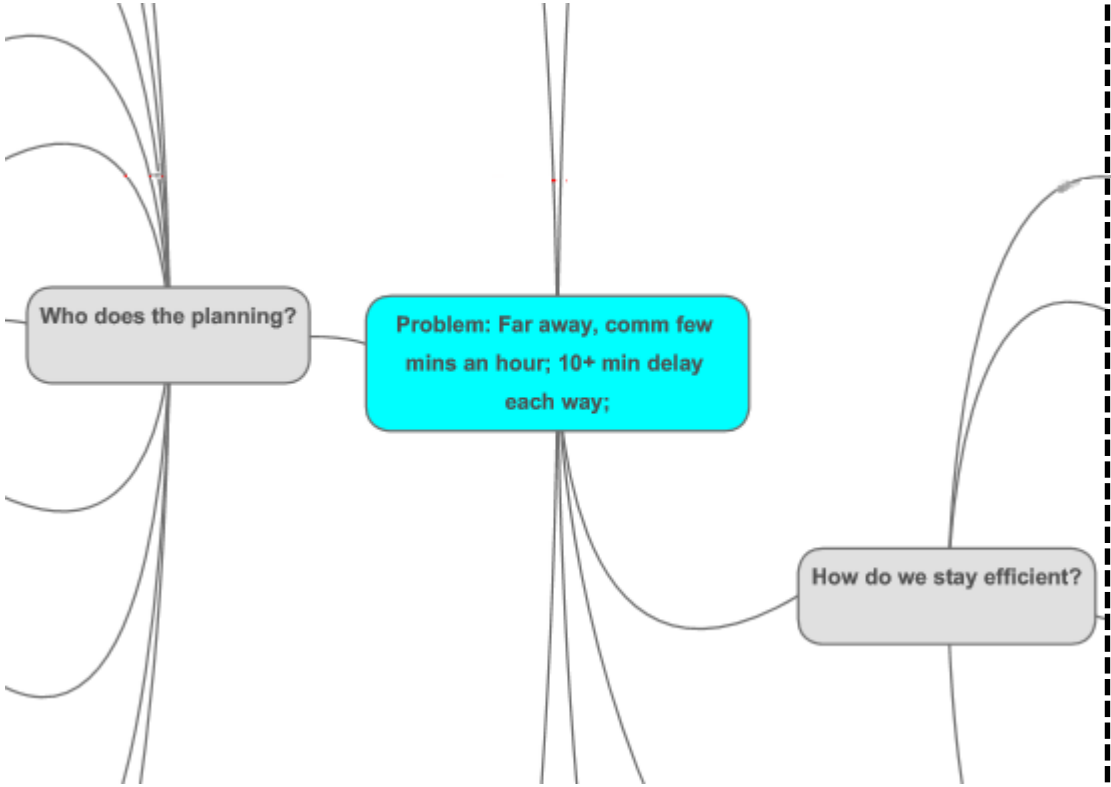
Familiarization & Training		Practice	Self-Schedule			
Exercise #1	Exercise #2	Exercise #3	Exercise #4	+2 days	Exercise #5	+2 days
Planning Familiarization (Fake day)	Execution Familiarization (Prepared Plan)	Schedule Afternoon (Limited Planning)	Self-Schedule	Execute Self-Schedule	Self-Schedule	Execute Self-Schedule

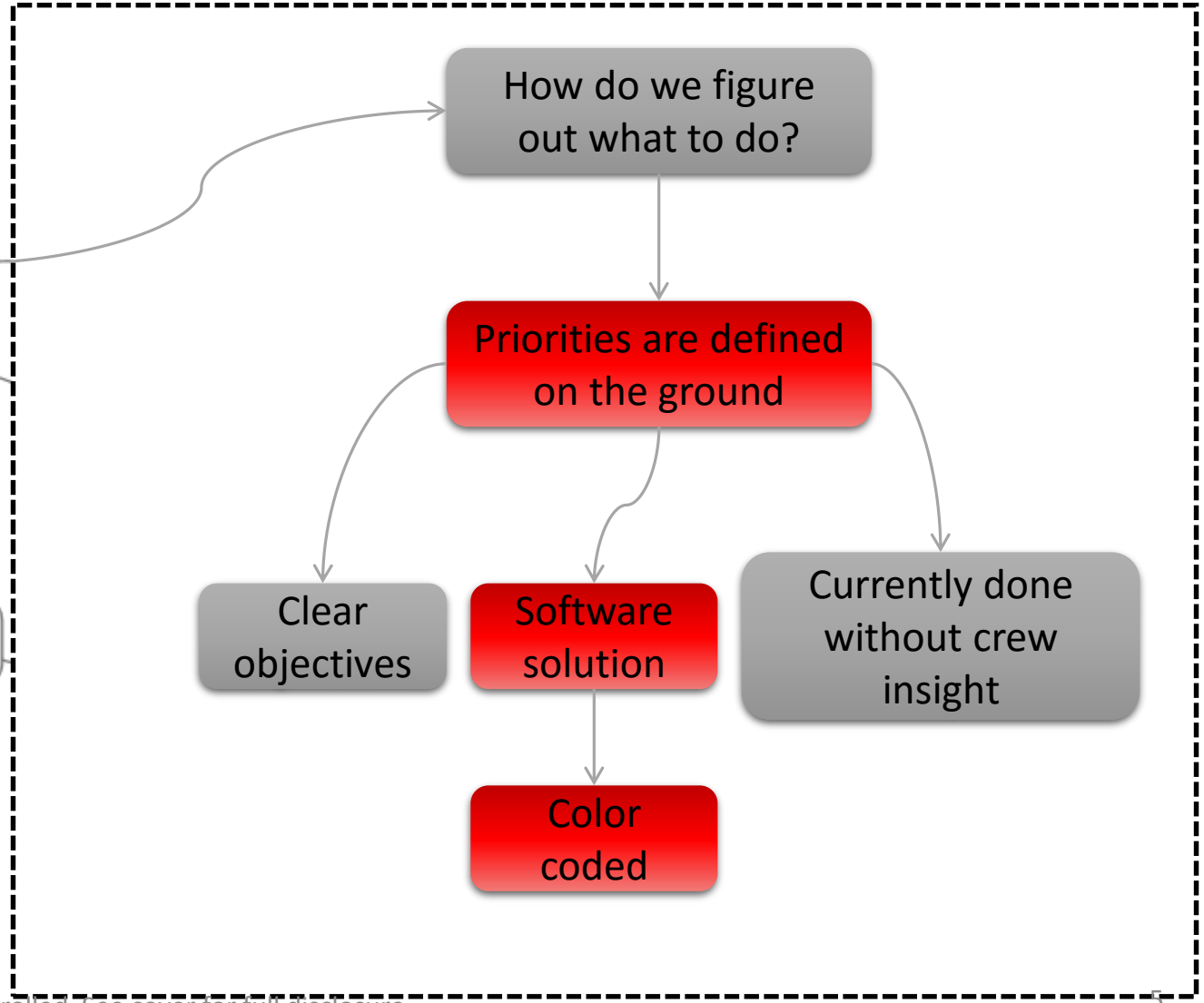
Increasing crew control

Implementation of CAST: Experimental Design

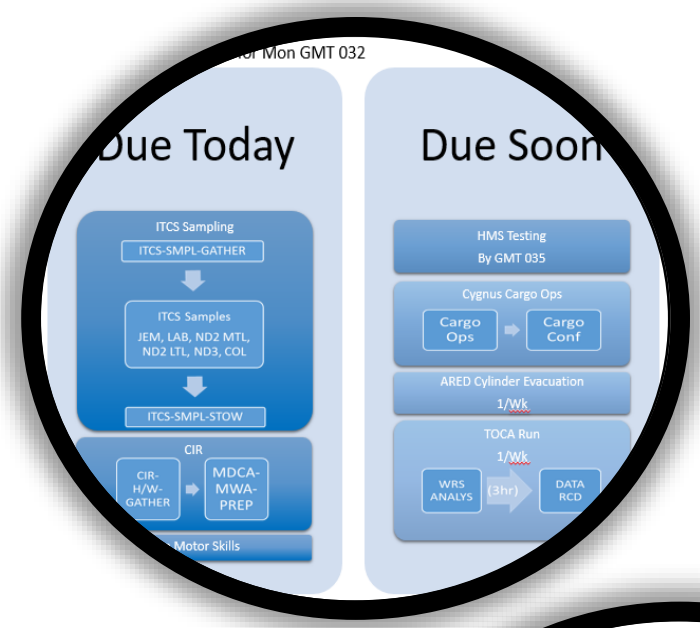
- Started with a brainstorming session using experienced planners

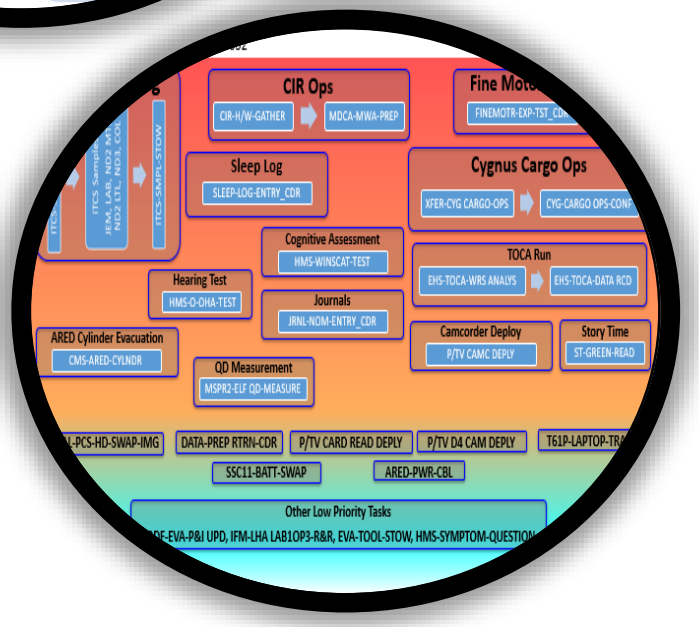
Goal was to address the motivation for CAST





Human Factors Engineering





52-0169: CAST Session #5 Priority List

[1] "Total Selected Crew Time" includes your pre-scheduled activities. Note that SPRINT-GUIDE-DON-OPR activity is hard-scheduled with FE-2 SPRINT.

[2] RUN1 and RUN2 of ADC activities are a continuation from earlier in the week and run into next week.

[3] No activities that cause vibration should be scheduled in the LAB during both ADC-MICROSCOPE-OPS activities (i.e. ADC MICROSCOPE-OPS cannot occur during CEVIS).

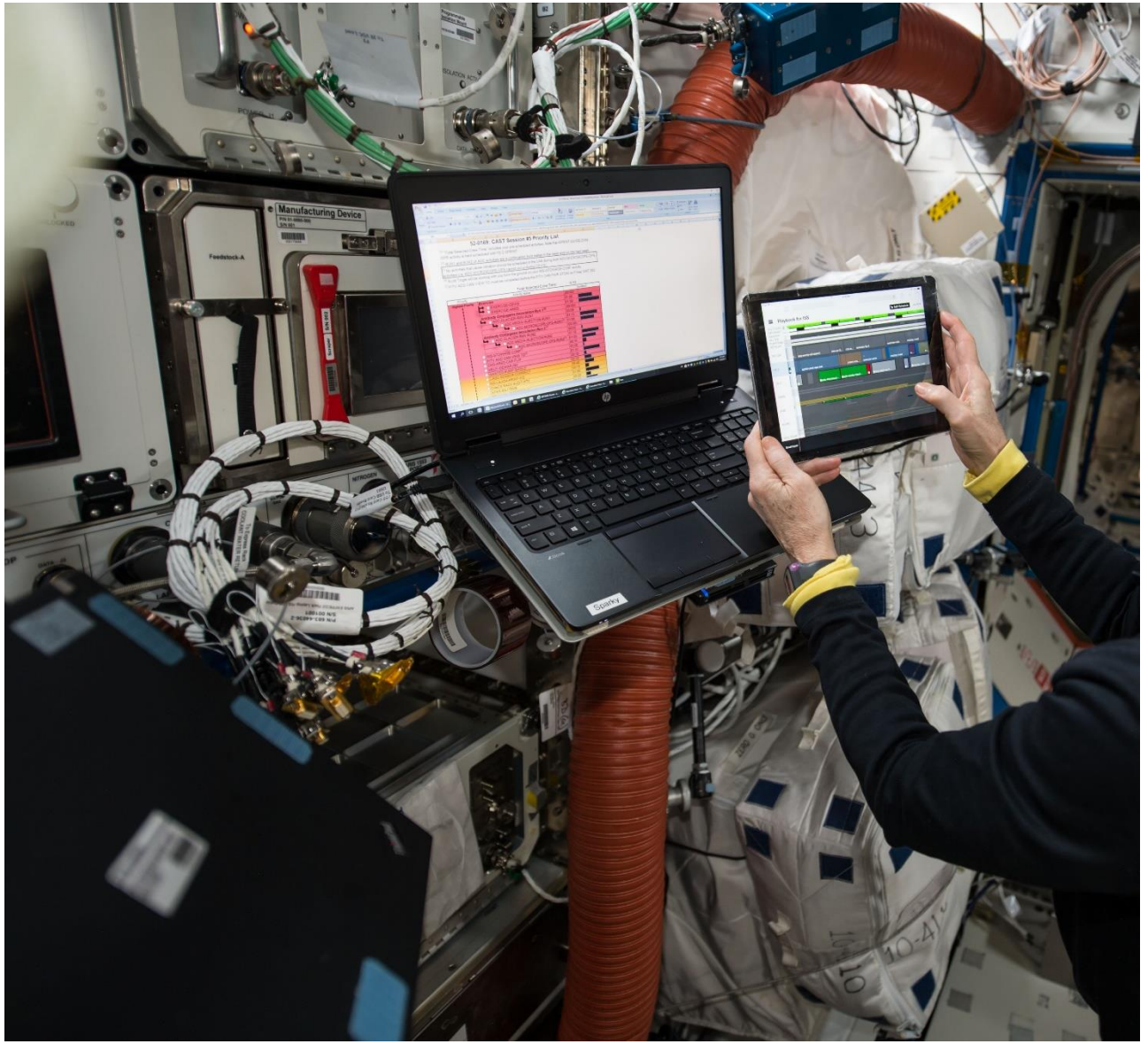
[4] Scott Tingle will be working with you from the ground on your IMS-STOWAGE-CONF activity.

[5] P/TV ADD CAM VIEW TD must be completed before the P/TV CAM PWR STOW on Friday GMT 202.

Total Selected Crew Time: 0:15

Priority	Activity Name	Duration
Highest Priority	***Exercise***	(00:00)
	☐ EXERCISE-CEVIS	01:00
	☐ EXERCISE-ARED	01:30
	Antibody Conjugates Inoculation Run 1 [2]	(00:00)
	☐ ADC-GLACIER-RMV-RUN1	00:05
	☐ ADC-MEDIA-INJECTION-RUN1	01:15
	☐ ADC-MICROSCOPE-OPS-RUN1 [3]	01:00
	Antibody Conjugates Inoculation Run 2 [2]	(00:00)
	☐ ADC-GLACIER-RMV-RUN2	00:05
	☐ ADC-MEDIA-INJECTION-RUN2	01:15
	☐ ADC-MICROSCOPE-OPS-RUN2 [3]	01:00
	☐ IMS-STOWAGE-CONF [4]	00:15
	☐ P/TV ADD CAM VIEW TD [5]	00:05
	☐ CMS-ARED-CAR-FLIP	01:10
	☐ MELFI-DEWAR-INV	00:10
	☐ WANTED-BUMP-SHIELD	00:30
	☐ J-RSU SENSOR-CORRECT	00:40
	☐ MD-LAUGH-PRINT-VID	00:15
	☐ CHeCS RACK-AUDIT-PT2	01:00
	☐ XFER-RS-ITEMS	00:20
	☐ BEAM-IMV-INSPCT&CLN	00:50
	☐ CHRCL FIL-BAG-VERIFY	00:20

Self-Scheduling in Action



CAST: Measures (Survey)

- Goal was to submit a job satisfaction type survey to the crew, that could help measure satisfaction against three objectives;
  - Mission success: Mission objectives and priorities met
  - Efficiency: Impact on productivity (crew Time) and Frequency of ground correction
  - Crew Satisfaction: Level of satisfaction with self-scheduling and timeline control
- Used a Likert Scale
  - This is a scale commonly used in research for questionnaires, and is used to scale responses that specify the level of agreement or disagreement of a series of statements.

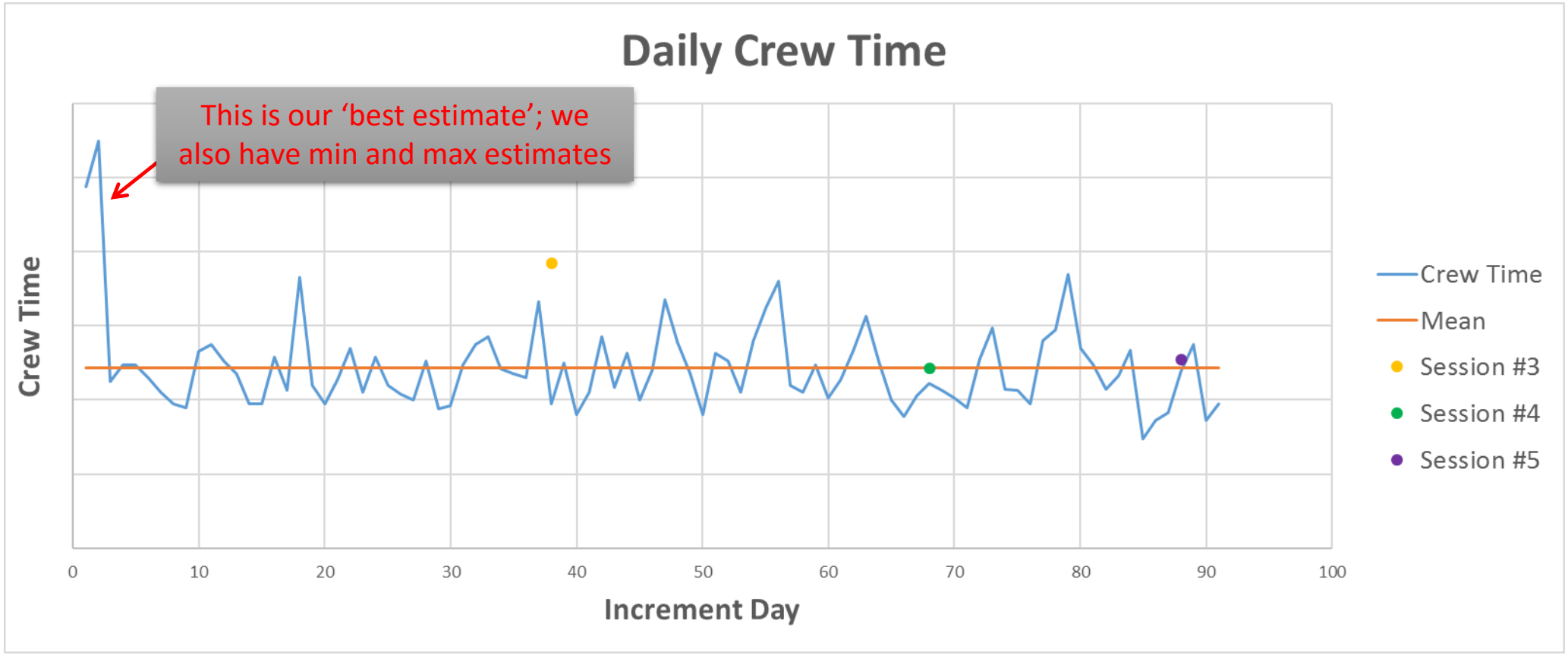
○ Strongly Disagree	○ Disagree	○ Neither Agree or Disagree	○ Agree	○ Strongly Agree

  - The questionnaire contained 11 statements that the crew would rate how they agree with.
    - Statements divided up to target all three objectives
    - Statements reviewed to be balanced between positive, neutral, and negative
- Free Response
  - Four free response questions were asked to give the ability to provide additional insight from the crew

CAST: Measures (Crew Time)

(**INCOMPLETE DATA SET**) Preliminary data not to be shared

- Hypothesis #2: Crew self-scheduling will result in an increase in the amount of crew time accomplished on a given day.



CAST: Future of Self-Scheduling

- **Crews like timeline control but they don't like making schedules**
  - The capabilities of the tool will need to scale with complexities of the constraints so that the crew effort remains constant
- **Crews paint a picture where planning is a joint exercise between them and the ground**
  - Ground proposes a plan including the items that are judged to be complex
- **Building constraints is a big job**
  - The ground effort scales almost geometrically
  - Crews likely need a bit more insight into methods for resolving violations
  - The current tool box is insufficient to cover all cases
- **Crew self-scheduling by itself is probably not a route to increased productivity**
  - Operational evidence indicates that schedule flexibility is most important – self-scheduling is a tool to enhance already existing flexibility
  - Crew feedback confirms that schedule flexibility is a primary factor in overall productivity

What is Next for CAST?

- **Design experiment that finds the balance between the two extreme planning environments (ground control vs. crew control)**
- **Investigate experiment objectives that take into account multiple crew self-scheduling**

What do you think the future of self-scheduling should be?

Playbook Feature Overview: Constraint Visualization and Violation Detection

Playbook visualizations temporal, resource and activity constraints as go/no-go zones

If an activity is moved into a no-go zone, Playbook outlines the activity in red and shows it in violation