

Evaluation of Crew Onboard Planning: Year 2

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Currently, mission planning for the International Space Station (ISS) is largely affected by ground operators in mission control. The task of creating a week-long mission plan for ISS crew takes dozens of people multiple days to complete, and is often created far in advance of its execution. As such, re-planning or adapting to changing real-time constraints or emergent issues is similarly taxing. As we design for future mission operations concepts to other planets or areas with limited connectivity to Earth, more of these ground-based tasks will need to be handled autonomously by the crew onboard.

There is a need for a highly usable (including low training time) tool that enables efficient self-scheduling and execution within a single package. The ISS Program has identified Playbook as a potential option. It already has high crew acceptance as a plan viewer from previous analogs and can now support a crew self-scheduling assessment on ISS or on another mission. The goals of this work, a collaboration between the Human Research Program and the ISS Program, are to inform the design of systems for more autonomous crew operations and provide a platform for research on crew autonomy for future deep space missions.

Our second year of the research effort have included new insights on the crew self-scheduling sessions performed by the crew through use on the HERA (Human Exploration Research Analog) and NEEMO (NASA Extreme Environment Mission Operations) analogs. Use on the NEEMO analog involved two self-scheduling strategies where the crew planned and executed two days of EVAs (Extra-Vehicular Activities). On HERA year two represented the first HERA campaign where we were able to perform research tasks. This involved selected flexible activities that the crew could schedule, mock timelines where the crew completed more complex planning exercises, usability evaluation of the crew self-scheduling features, and more insights into the limit of plan complexity that the crew could effectively self-schedule.

In parallel we have added in new features and functionality in the Playbook tool based off of our insights from crew self-scheduling in the NASA analogs. In particular this year we have added in the ability for the crew to add, edit, and remove their own activities in the Playbook tool, expanding the type of planning and replanning possible in the tool and opening up the ability for more free form plan creation. The ability to group and manipulate groups of activities from the plan task list was also added, allowing crew members to add predefined sets of activities onto their mission timeline. In addition we also added a way for crew members to roll back changes in their plan, in order to allow an undo like capability. These features expand and complement the initial self-scheduling features added in year one with the goal of making crew autonomous planning more efficient.

As part of this work we have also finished developing the first version of our Playbook Data Analysis Tool, a research tool built to interpret and analyze the unobtrusively collected data obtained during the NASA analog missions through Playbook. This data which includes user click interaction as well as plan change information, through the Playbook Data Analysis Tool, allows us to playback this information as if a video camera was mounted over the crewmember's tablet. While the primary purpose of this tool is to allow usability analysis of crew self-scheduling sessions used on the NASA analog, since the data collected is structured, the tool can automatically derive metrics that would be traditionally tedious to achieve without manual analysis of video playback. We will demonstrate and discuss the ability for future derived metrics to be added to the tool.

In addition to the current data and results gathered in year two we will also discuss the preparation and goals of our International Space Station (ISS) onboard technology demonstration with Playbook. This technology demonstration will be preformed as part of the CAST payload starting in late 2016.

Evaluation of Crew-Centric Onboard Mission Operations Planning and Execution Tool: Year 2

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Research Objectives – Aims 1-4

Aim 1: Support ISS Program evaluation of crew self-scheduling and plan execution through Playbook, providing a platform for future research on crew autonomy for deep space mission operations as well as an assessment of the potential for limited crew self-scheduling in more near-term ISS operations.

Aim 2: Provide Playbook as an operations tool to increase the realism and efficiency of the Human Exploration Research Analog (HERA) and NASA Extreme Environment Mission Operations (NEEMO) analogs.

Aim 3: Determine the appropriate level of information (e.g., constraints, plan complexity) required for crewmembers to schedule their time autonomously with limited ground support by unobtrusively (through automated software logging) gathering and analyzing Playbook use data.

Aim 4: Characterize task workload (e.g. time spent planning versus execution of plans, time on self-scheduled activities) of crewmembers completing and executing self-scheduling tasks by unobtrusively (through automated software logging) gathering and analyzing initial Playbook use data.



Motivation for crew onboard planning

To design and develop a technology platform to enable assessment of critical questions about the feasibility and effectiveness of crew self-scheduling and onboard planning:

Can onboard planning be performed autonomously and safely, while not significantly impacting crew workload and operational throughput?

Can we build a technology platform to empower crew and at the same time be easy to use?

Can we demonstrate that this technology platform works on ISS with real plans and procedures?



What is Playbook?

Playbook is a next generation easy-to-use mobile web-based planning tool.

Features include collaborative self-scheduling with constraint checking and violation visualizations, full activity execution status capabilities, built in communications chat functionality (text, photo, video, or files), condition band support, task list support, procedure linking support, full support for time-delay simulations and synchronization across multiple servers.

No installation is required, simply navigate to the playbook link inside your web browser.



Deployments in Year 2



Used in both operational and research tasks.

Future Deployments in Year 3 - NEEMO 22, HI-SEAS 2017, HERA C4M1, HERA C4M2, HERA C4M3, HERA C4M4, BASALT 2

ISS - CAST Crew Autonomous Scheduling Test
In progress, runs through mid 2017



ISS Crew Autonomous Scheduling Test

Onboard demonstration of Crew Autonomy on the International Space Station.



Collaboration: ISS Program and OPS Planners in Flight Operations Directorate

Objective 1 - Crew Familiarization on ISS

Objective 2 - Execution of Mission Schedule with Playbook on ISS

Objective 3 -5 - Planning and execution of mission schedule with Playbook on ISS



Playbook Feature Overview: Self-scheduling Support

To self-schedule an activity, simply click on the self-schedule button on the timeline

Rescheduling an activity is as simple as dragging and dropping the activity on the timeline

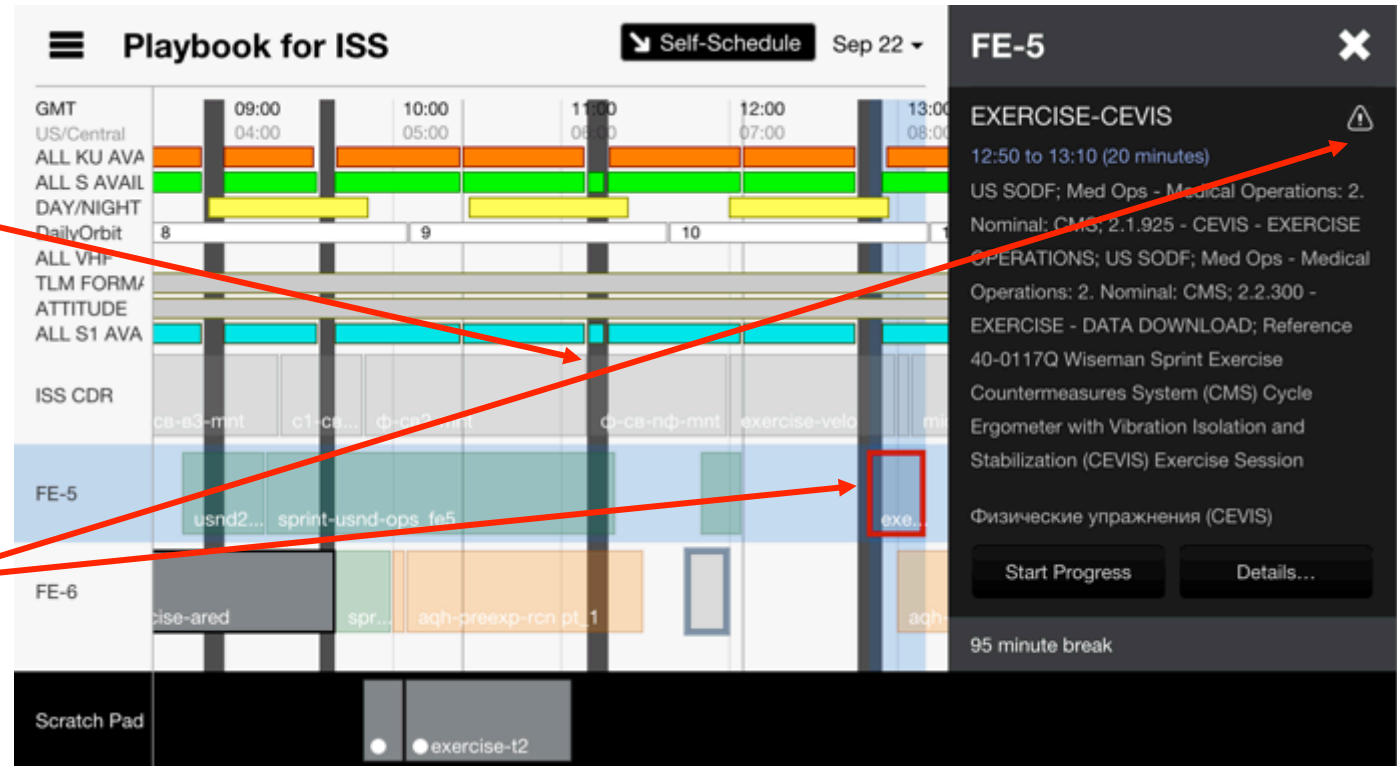
The screenshot displays the 'Playbook for ISS' interface. At the top, there is a 'Self-Schedule' button with a downward arrow, and the date 'Sep 22' is shown to its right. The main area is a Gantt-style timeline with columns for GMT (06:00, 07:00, 08:00, 09:00, 10:00) and rows for various ISS systems and crew members. A red arrow points from the text 'click on the self-schedule button' to the 'Self-Schedule' button. The timeline shows various activities as colored bars: orange for 'ALL K/L AVA', green for 'ALL S AVAIL', yellow for 'DAY/NIGHT', cyan for 'ALL S1 AVA', and grey for 'ISS CDR', 'FE-5', 'FE-6', and 'S-BD'. A 'Scratch Pad' panel is open on the right, showing a list of activities: 'MORNING PREP-WORK (15 minutes)', 'MORNING PREPARATION WORK', 'Подготовка к работе', 'EXERCISE-T2 (60 minutes)', 'US SODF; Med Ops - Medical Operations: 2. Nominal: CMS; 2.3.720 - TREADMILL 2 - CUE CARD WITH SBS; Countermeasures System (CMS) Treadmill 2 (T2) Exercise Session', 'ФУ Т2', and 'Физические упражнения (Т2) по программе п дня'. At the bottom of the Scratch Pad are 'Start Progress' and 'Details...' buttons. A 'Scratch Pad' label is also visible at the bottom left of the main interface.



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

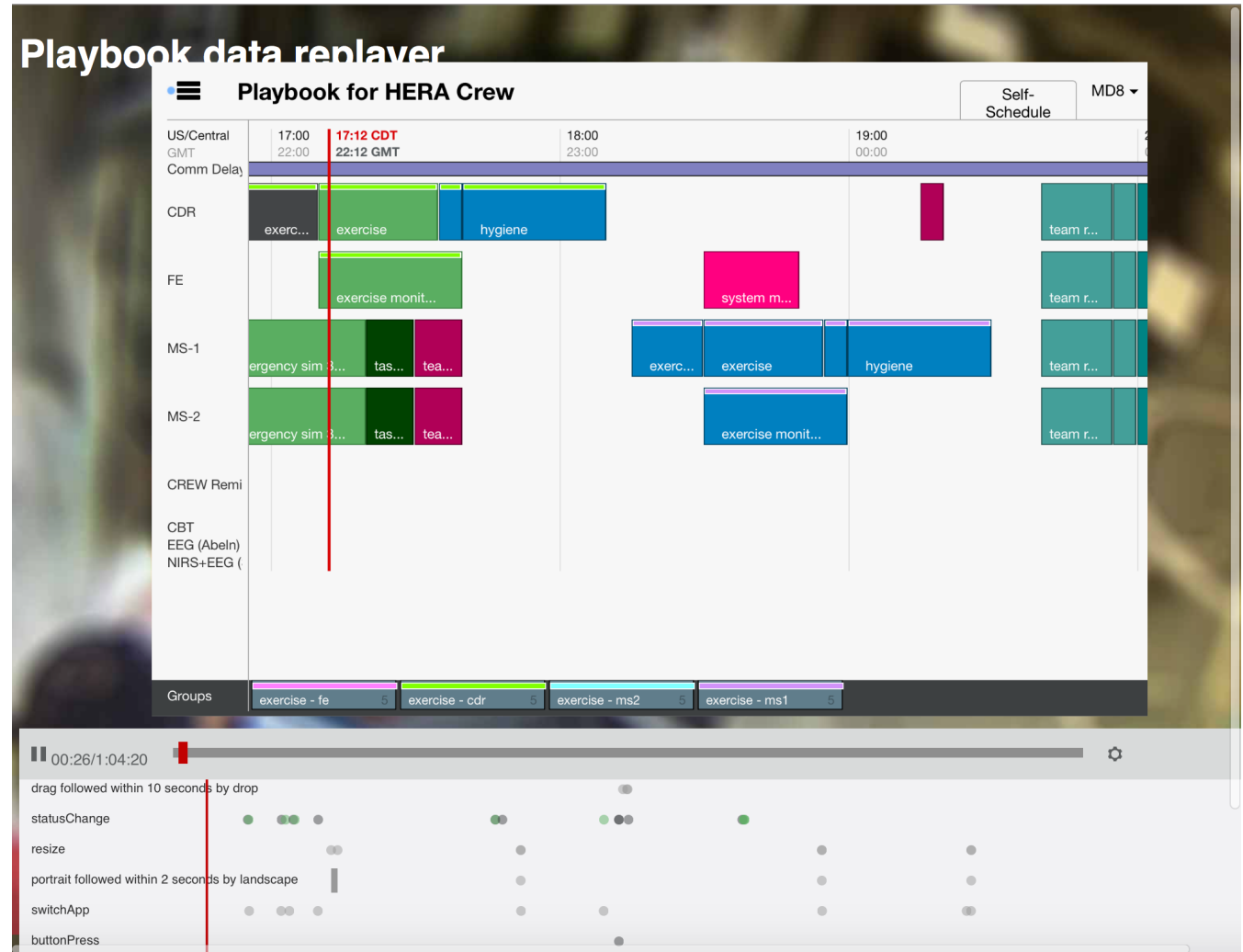


Playbook Feature Overview: Data Analysis Tool

Video tape like playback of a user's session

Structured data allows for retrieval of metrics without manual analysis.

Heatmap shows events of interest in the recording.



HERA Exercise Planning in Year 2



Collaborative and individual planning sessions with different levels of plan difficulty.

Goal: To push the tool to find usability issues to build better features for crew self-scheduling and autonomy.

Outcome: Still analyzing results. No major usability issues found. Evidence for redesigning activity group manipulation feature.



NEEMO 21 EVA Planning in Year 2

Two planning strategies: Strategic and Tactical

Strategic: Crew activity creation for the EVA framework



Tactical: Crew planning with preconfigured activity blocks

Outcome: Successfully planned the EVA in the time allotted for both strategies. Still analyzing results but did not notice a difference in planning times between these strategies. Planning time seems to be mostly devoted to discussion rather than inputting the plan into the tool.



Playbook Live Demo



Questions?



Thanks!

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