Misdiagnosed: The Story of how NASA's International Space Station Planning Team Thought They Needed a Collaboration Tool to Solve Their Problems When What They Really Needed was Better Planning Tools

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Background and Purpose

The International Space Station (ISS) planning process is manually intensive and time-consuming, and efficiencies must be gained to ensure the process will scale as the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA), attach their modules to the ISS. For this reason, the planning team at Johnson Space Center (JSC) has been seeking new tools and processes that promise to streamline existing processes and strengthen their constraint management and resource modeling capabilities.

The User-Centered Technology (UCT) group at NASA Ames Research Center developed a web-based collaboration platform that JSC ISS Planners felt may assist in streamlining their planning work with other NASA Centers and IPs, ultimately reducing the rework required on ISS crew plan iterations. To ensure the deployment of the tool would be as successful as possible, the UCT team determined they would first need to better understand the ISS planning process–activities, priorities, tools, people, and pain points–to know how to best support the collaborative functions of this group. With the assistance of Sylver Consulting, a research and customer-driven innovation firm, the UCT team conducted a three-month ethnographic study of ISS planning practices and procedures.

Study results made it clear the sole addition of a collaboration tool will not solve problems in the ISS planning process. Instead, ISS Planners need to focus on expanding the current planning tools' capabilities to answer needs such as:

- Reducing the manual intensity of the ISS planning process
- Making it easier to gather and manage constraint data, and
- Simplifying the integration of plans across system platforms, among others.

This paper will provide an objective viewpoint into the current challenges of ISS planning, as of December 2006. Specifically, we discuss 11 challenges and potential solutions surrounding efficient product generation – one of the main goals of ISS Planners (there are others). Some of the challenges focus on technical limitations of the various applications the ISS planning teams use, while others refer to cultural or political issues that effect how the Planners operate. All challenges, whether technical, cultural, or political are extremely important, as they become the basis of design criteria for system development.

Research Methods

Objectives

The primary goal of the research, sponsored by JSC, was to understand how collaboration was defined and executed within ISS planning teams. Objectives included understanding:

- How groups within the same NASA Center worked together
- How groups from different NASA Centers and IPs worked together

- The tools that groups use to complete collaborative work (both formal and informal technologies)

A secondary goal of this project was to use the research findings as a catalyst for defining opportunities and design criteria for tool development and process improvement.

Data Collection

The research team used qualitative research methods, specifically Design Ethnography, to collect data. Design Ethnography combines user-centered design methods with ethnographic techniques to gain a deep understanding of people and their relationships to each other, their environments, the objects they use to accomplish their tasks, and the artifacts they produce. This methodology provided us with techniques to analyze and uncover patterns of behavior that could be translated into design criteria and guidelines for system development (Salvador and Mateas, 1997).

In total, we spent nine days in the field, conducting twenty one-on-one interviews and fifty hours of observation sessions (both on- and off-console) with ISS Planners at JSC, Marshall Space Flight Center (MSFC), and the European Space Agency (ESA) at DLR in Oberpfaffenhoffen, Germany. We spoke with people in the following ISS planning positions:

- **ISS Planning Group Leads (all three locations):** Group leads manage and coordinate the work efforts and tool development initiatives of both the long-range and real-time planners at each of their respective locations.
- **Operations Planners (Ops Planners) at JSC:** OPs Planners are long-range planners, and are tasked with establishing the initial time line for the increment. Their work begins 9 months in advance. Activities include gathering requirements for the mission, planning the activities into the mission increment and refining plans until they are execution-ready (5 days-out from execution). JSC OPs planners are also the master integrators of the various plans generated by MSFC and Russia.
- **Real-Time Planning Engineers (RPE) at JSC:** RPEs sit on-console making real-time changes to plans that are 0-5 days out. Most typically, the RPE that sits on-console in the “front-room” (Mission Control Center) concentrates on altering the plan that is currently being executed. While the RPE, serving the “back-room” of on-console alters plans 1-3 days out that are prompted by real-time changes to the current plan being executed.
- **Payload Planning Managers (PPMs) at MSFC:** PPMs are long-range planners at MSFC. They build payload activity timelines. They also gather requirements for the mission, plan the activities into the mission increment and refine plans until they are execution-ready.
- **Operation Controllers (OCs) at MSFC:** OCs are the real-time planners for MSFC. They sit on-console at MSFC monitoring payload activity and answering any questions regarding safety and technical specifications. They make real-time changes required of plans being executed.
- **Columbus Long-range Increment Planners (CLIPs) at ESA:** CLIPs are the long-range planners for ESA. Work tasks include gathering requirements for the mission, planning the activities into the mission increment and refining plans until they are execution-ready (5 days-out from execution). This role is still being defined by ESA as they are still in the process of developing plans for the execution of the Columbus module, scheduled for October 2007.
- **Columbus Operation Planners (COPs) at ESA:** COPs are the real-time planners for ESA. They will sit on-console monitoring the execution of plans and altering plans 5-days out to reflect needed change prompted by real-time changes to the plan being executed. COPs are currently training for this role, participating in a number of simulations. This role will become fully active in October for ESA’s Columbus flight.

Research Analysis

The analysis phase was split into two activities – synthesizing data from the field into meaningful results, and using those results as the catalyst for a two-day “Translating Insights into Opportunity Workshop,” facilitated by Sylver Consulting. The goal was to integrate domain expertise in planning and software development with the research findings for the purpose of creating a set of design criteria the ISS Planning team could use in future tool and process development. A multi-disciplinary team of JSC planners and members of the UCT team attended the workshop.

ISS Planning Background

ISS Planning involves the complex tasks of prioritizing, negotiating, and finalizing crew activities for a given amount of time. Planning work begins when NASA’s Program Office issues a Program Document for an increment, an ISS mission timeframe (typically six months).

Various planning activities are done to create the following seven main “planning products”:

- Ground Rules and Constraints (GR&C) document
- On-orbit Operations Summary (OOS)
- Weekly Look-ahead Plan (WLP)
- Short-Term Plan (STP)
- Short-Term Planning (STP) notes
- On-orbit Short-Term Plan (OSTP)

- Planning Product Change Request (PPCR)

Planning activities at JSC are divided into long-term and short-term timeframes. Long-term planners are responsible for plans that are five-days or further out, and deal mainly with negotiating crew time and constraint management. Short-term planners sit on console and deal with all real-time and next-day planning issues.

Plans move from long-term to short-term at five-days out and are transferred from one planning system to another at one week out.

Other NASA Centers and International Partners (IPs) have their own tools to do ISS planning work partly due to development politics and budgets, but also because JSC's tools do not meet everyone's needs.

Planning Challenges

Eight systems are used to produce the seven ISS planning products mentioned above. These are: email, telephone, Microsoft Word, Microsoft Excel, User Requirements Criteria (URC), Operation Preparation and Data Collection System (OPDCS), Consolidated Planning System (CPS), and the On-orbit Short-Term Plan Viewer (OSTPV).

The graph below illustrates the variety of systems used to generate each of the planning products across Centers and IPs. Please note: The graph represents only the major planning tools and systems used by JSC, MSFC and ESA, as these were the research participants. Russia and JAXA have their own planning systems that are not represented here.

Systems used to generate planning products

		Email	Telephone	Microsoft Word	Microsoft Excel	URC	OPDCS	CPS	OSTPV
Gr&C	JSC	●	●	●					
	MSFC					●		●	
	ESA						●		
OOS	JSC				●				
	MSFC							●	
	ESA							●	
WLP	JSC				●				
	MSFC							●	
	ESA							●	
STP	JSC							●	
	MSFC							●	
	ESA							●	
STP notes	JSC			●					
	MSFC								
	ESA								
OSTP	JSC								●
	MSFC								●
	ESA								●
PPCR	JSC								●
	MSFC								●
	ESA								●

It is the number of systems and limited integration between them that cause the inefficiencies of rework and multiple reviews in the ISS planning process. The following section details the challenges experienced and the issues they cause at various points in the process.

Challenge #1: Requirements gathering for generating the Ground Requirements and Constraints (GR&C) document vary dramatically across Centers and IPs

The Program Office at NASA and each of the IPs generates a Program Document for each increment mission of the ISS. This document outlines all of the activities that should be accomplished during the course of the increment and the amount of time the Program Office expects each activity to take. Activities noted are prioritized within this document, which ultimately assists the ISS planning teams in making trade-offs between activities as the increment progresses.

Systems used to generate planning products

		Email	Telephone	Microsoft Word	Microsoft Excel	URC	OPDCS	CPS	OSTPV
Gr&C	JSC	●	●	●					
	MSFC					●		●	
	ESA						●		

Each Center and IP is responsible for scoping the activities that live within the Program Document and fall under their particular expertise or country. How each Center and IP gathers input from experts, specialists, and flight controllers to identify the ground rules and constraints associated with each activity differs considerably. Both MSFC and ESA use formal systems to collect their ground rules and constraints, while JSC's approach is more informal, relying on inputs through email and conversations.

MSFC uses the User Requirements Criteria (URC) system to scope and define the US Payloads that will happen within an increment. Payload Activity Requirements Coordinators (PARCs) assist the Payload Developers (PDs) in outlining the user requirements of each payload activity, while the Payload Planning Manger (PPM) interprets these inputs for the creation of their ground rules and constraints modeling within the Consolidated Planning System (CPS).

ESA uses their Operation Preparation and Data Collection System (OPDCS) to gather all the ground rules and constraints associated with all ESA-related ISS activities. The first version of this system was implemented in October 2006, in preparation for the attachment of the Columbus module to the ISS. The intended process for collecting an activity's ground rules and constraint is similar to that of MSFC. The only exception is that, development efforts will make it possible for users to input their own data directly into the OPDCS system.

JSC employs the least structure in the collection of the ground rules and constraints, collecting inputs via email telephone, the loop system, and in-person conversations. These inputs are collected and categorized in a Microsoft Word document.

Challenge #2: Requirements gathered to model activities do not carry through all planning products generated in the process

Ground rules and constraints collected are the required inputs to begin constraint-modeling activities. MSFC gathers their constraints through the User Requirements Criteria (URC) system, but it does not have the robust constraints modeling the Consolidated Planning System (CPS) has. ESA intends to collect their constraints in the same manner as MSFC; however, their plan is to build this capability into their Operations Preparation and Planning System (OPPS). The OPPS is ESA's global planning system. JSC, on the other hand, does no constraint modeling, so they rely on the Gr&C document to guide their plan development.

Constraints outline the dependencies associated with ISS activities. The constraint models embedded in the CPS file alert planners when they have re-planned an activity in a manner that challenges the constraint logic.

JSC chooses not to use the constraints modeling feature in CPS because files become to large for their system to handle in an efficient manner. JSC's under-utilization of the constraint modeling capability is problematic to the overall ISS planning process because inputs from MSFC and ESA containing constraint data must be reworked to fit JSC's preferred CPS format. This causes frequent intense manual reviews to make sure everything is included. This current process is unsustainable as IPs become centrally involved in planning work because more IPs mean more and longer manual reviews. Also, all constraint data is lost from the plan and must be relocated in a separate document.

Challenge #3: Various systems are used to generate the On-orbit Operations Summary (OOS) and the Weekly Look-ahead Plan (WLP)

The OOS and the WLP are similar in they are both a broad-brush stroke of the increment's daily activities. The WLP is a more detailed version of the OOS. It is the instance in which all Centers and IPs have the opportunity to understand if their "best guess" of the OOS is relevant once it is modeled and laid out in CPS.

Systems used to generate planning products

		Email	Telephone	Microsoft Word	Microsoft Excel	URC	OPDCS	CPS	OSTPV
OOS	JSC				●				
	MSFC							●	
	ESA							●	
WLP	JSC				●				
	MSFC							●	
	ESA							●	

JSC models both the OOS and WLP in Microsoft Excel. Currently, crew time is the most important resource that must be tracked, but CPS is not an effective tool for doing this. CPS does not provide adequate constraint management tools to make effective decisions, so planners rely on Excel, multiple conversations with experts, and multiple iterations. As a workaround, JSC created the WLP to assist in tracking crew time associated with various ISS activities.

The WLP Excel worksheet uses macros to help Planners track crew time. For example, if a certain activity requires over the allotted six hours of a specific crew member's time per day, then the "total crew time" box turns gray. This enables the planning teams to understand if they need to reiterate the plan and how much time they need to "free up."

An additional function of the WLP Excel Worksheet is the use of color-coding according to JSC customer. For instance, MSFC's payload activities are shaded one color, while Russia's activities are another. This enables JSC to account for the amount of crew resources each entity has. The information is then used in planning negotiations at weekly meetings with MSFC and the IPs.

MSFC and ESA both use CPS to model the OOS and WLP because their systems feed the constraints data directly into CPS.

Challenge #4: JSC must spend a great deal of time merging plans only to deconstruct them later

JSC is the integrator of the master plan so they receive MSFC, Russia, and ESA's inputs to the OOS and WLP via CPS files. JSC must convert the CPS files into a format that can be used by Excel in order to review the plan holistically and accurately.

JSC uses Mr. Planner, a tool that converts CPS files into Excel files. Any changes made to the WLP worksheet during the meetings cannot be made directly into the Excel document because Mr. Planner cannot convert the Excel file back to a CPS file.

After each International Execute Planning Team (IEPT) meeting, each Center and IP makes any changes to the plan that are associated with their Center or country activities. The day before the next IEPT meeting the CPS file is due to JSC. Once again, they convert the data into a format exportable and readable by the Excel-based WLP spreadsheet.

The need for intense manual reviews increases as the plan transitions from CPS into the On-orbit Short-Term Plan Viewer (OSTPV) because constraint models that were embedded in the CPS plan are stripped off the file. This requires the Lead Real-time Planning Engineer (RPE) to inherently know the constraint models so that she/he may act quickly in a real-time, re-plan.

At the short-term plan phase of the ISS planning process, the Long-Range Planners are focused on outlining all the procedural data and special instructions associated with accomplishing the goals and objectives of each planned activity. Each of the three teams uses CPS for this work.

Challenge #5: Limited integration between CPS (the long-range planning system) and OSTPV (the real-time execution planning system) requires JSC to create Short Term Plan (STP) Notes to fill the information gaps

Systems used to generate planning products

		Email	Telephone	Microsoft Word	Microsoft Excel	URC	OPDCS	CPS	OSTPV
STP	JSC							●	
	MSFC							●	
	ESA							●	
STP notes	JSC			●					
	MSFC								
	ESA								

Once approved, the Short Term Plan (STP) is converted into the OSTPV plan one week out from the execution date. The plan data from CPS is exported into OSTPV to be used on console. However, the OSTPV version has no constraint modeling, activity dependencies, or procedural instructions as it did in CPS. JSC generates STP Notes including this information to go along with the OSTPV version.

STP Notes is a Microsoft Word document that outlines any special instructions or procedural steps associated with an ISS activity. JSC manually recreates STP Notes from the procedural data included in the CPS-formatted STP plan. Any activity deviations from the master plan are recorded in the STP Notes.

Challenge #6: Special operating instructions are disassociated from the execution plan

The STP Notes are transferred to the Real-Time Planning group. The Lead RPE manages this document during the plan's execution. STP Notes are only visible to the planning teams, and therefore, whenever changes are requested in the system, the Lead RPE must be involved to ensure that all constraints and special requests associated with this activity change are respected.

Challenge #7: Disassociated operation instructions impact the cognitive stress levels of the Lead RPE

The Lead RPE is constantly pulled in multiple directions at the same time. They are responsible for managing change requests to today's plan, tomorrow's and the next day's. And because the STP Notes are disassociated from the execution plan, the Lead RPE also performs a customer service function for the real-time operations team.

Every change to the plan requires two conversations, one to assess the impacts of a change and the other to actually request that the change be made. Integrating the special operating instructions with the execution plan would result in one less interaction per change request required of the Lead RPE, which ultimately would promise to bring more focus to the position.

Challenge #8: Dual work is occurring to keep both the OSTP and CPS plans current

Systems used to generate planning products

		Email	Telephone	Microsoft Word	Microsoft Excel	URC	OPDCS	CPS	OSTPV
OSTP	JSC								●
	MSFC								●
	ESA								●
PPCR	JSC								●
	MSFC								●
	ESA								●

Changes to the plan are requested via a Planning Product Change Request (PPCR). It takes three individuals to approve the PPCR before any changes are made.

Once the request is approved, changes must be made to both CPS and OSTPV systems, as they are not linked. At the same time, any changes made at JSC must be manually made at MSFC and the IPs.

Challenge #9: OSTPV was developed to compensate for the non-robust and non-user friendly functionality of CPS

Prior to September 2006, CPS ran on a slow UNIX-based operating system. While it was deemed inefficient and frustrating by the Long-Range planners, it was absolutely unacceptable to Real-Time Planners as it hindered the safety of mission execution, so the planners developed OSTPV.

OSTPV is widely accepted through out NASA as the planning tool for real-time operations even though it has numerous shortcomings. OSTPV does not represent constraint data from CPS and activities must be manipulated individually as relationship data is not carried over.

JSC's current vision includes expanding the capabilities of OSTPV to resource modeling so it can replace CPS and bring more cohesion to the planning process. This vision is politically charged as MSFC and Russia have structured their entire planning processes around CPS. To date, there is no decision regarding what will happen in the future to CPS or OSTPV.

Challenge #10: System ownership impacts tool development and system sustainability

The simplistic answer for fixing the problem of having multiple systems that produce multiple products is to have fewer and smarter systems. However, system ownership is an issue to NASA and the IPs. An outside contractor owns CPS, while the Planners owns OSTPV. Requests for changes to the CPS system take eight months to a year and a half to be implemented, and many times, do not meet the planers' needs. Changes to OSTPV can be implemented at any time because it is owned by the Planners.

For this reason, it is unlikely OSTPV will be replaced. Due to the integration of CPS into the core of MSFC and Russia's planning processes, CPS may also never be fully replaced. The guide post in future development needs to be about finding the simplest interface between the two systems.

Challenge #11: Every plan executed gets reviewed excessively before execution

Every plan is reviewed a minimum of eleven times before execution. The function of each of the reviews is to identify errors and omissions in the mission's plan. However, the lack of integration between systems requires the plans to be manually manipulated to compensate for information that does not appropriately get converted from one system into another. The constant manual manipulation of the increment plans increases the opportunity for error. Therefore, plans must be continually critiqued from the same viewpoint to ensure that manual, human error did not alter previously agreed upon aspects of the plans.

Below is a graph that explains in detail the various types of reviews that are conducted on an increment day's plan and the function or purpose of that review.

Types of plan reviews and their function

Quantity	Type of planning review	Function of the planning review
2	TIM: Technical Interchange Meeting	• To discuss how to accomplish the priorities of the increment.
3	WLP review: Weekly Look-ahead review	• To review if the "best guess" plan established in the OOS works within the modeled constraints of a day's activities.
3	STP review: Short-Term Plan review	• To verify that no activity constraints have been omitted. • To verify that all procedural steps noted are correct, sequenced appropriately and that there have been no omissions
3	Flight controller reviews (5, 3 and 1 day out from the date of execution)	• To verify that no activity constraints have been omitted. • To verify that all procedural steps noted are correct, sequenced appropriately and that there have been no omissions
1	JIT: Just In Time Review (applicable only for MSFC payloads)	• To verify that no activity constraints have been omitted. • To verify that all procedural steps noted are correct, sequenced appropriately and that there have been no omissions

The highlighted reviews are iteratively reviewed for the same purpose. Lack of integration between CPS (where the STP plan is generated), and OSTPV (where the execution plan is created) cause the need for these stringent reviews. Different people are involved and accountable for the outcomes of the STP reviews than the flight controller reviews.

Understanding 11 Challenges + Development Guidelines = Potential Solutions

There are multiple ways to help the planners overcome their challenges. We could throw technology at the problems, but that causes procedural and budgetary issues. We could tackle them from a policy angle, but again, that does not address the technology limitations illustrated in the challenges.

Instead, we used the research as a catalyst for solution development by holding a two-day "Translating Insights into Opportunity" co-development workshop with the UCT team, ISS planners, and the Ames Planning and Scheduling team. The focus of the session was to brainstorm potential solutions to the 11 challenges from the research using the following development guidelines, stating that all solutions must:

- Reduce the manual intensity of the ISS planning process (i.e. manual reviews, dual work)
- Make it easier to gather and manage constraint data
- Simplify the integration of plans across system platforms
- Make real-time plans easier to edit

The following section outlines a sub-set of the solutions the team produced. Associated with each solution are lists of design criteria. Please note: not all design criteria shared are technically oriented. This is intentional, as the Design Ethnography methodology used for this research focused on first understanding human behavior and then asking the question of how technology could address the challenges discovered.

Design criteria for each solution is categorized into the following sub-categories:

- "Must Have" design criteria: refers to conditions that must be integrated into or considered in the development of the systems or tools to ensure its acceptance and use
- "Nice to Have" design criteria: attributes that should be considered, but are not essential to be addressed in the first version of the system's development
- "Must NOT Have" design criteria: Cautions developers to conditions that must be avoided to ensure adoption of the tool.

Provide a Consistent Data Set for Multiple Planning Tools

Currently, ISS Planners are challenged by limited integration between tools that support planning activities. Politics, both within NASA and across International borders, hinder the development of one single planning system to support the entire ISS planning activity. Therefore, this concept attempts to support the creation of a technology that enables the seamless interchange of data.

One way to do this is to build a central database for storing and accessing common planning data (i.e. activity templates, ISS power resource schedules). This allows multiple groups to access common data to use in their own systems, lessening the need for integration tools or a common planning system. Any changes made to the data in the database would then be changed in each system.

"Must Have" design criteria

- All tools using the consistent data set must be inter-operable
- Configuration management must be included in the database to ensure that simultaneous edits cannot be made to the same activity
- The development group of the central database needs to be in the same mail code as the users to ensure that the technology continues to mirror its users' requests, both in its initial implementation and evolving states

"Nice to Have" design criteria

- All users simultaneously modifying the same plan should be able to see each other's modifications to their individual plans and the current working plan
- All planning tools would operate on the same platform and desktop, possibly under one login

"Must NOT Have" design criteria

- Tools accessing the central database must not get overloaded and break
- Tools accessing the central database must work efficiently, not being bogged down by data or loosing data

Incorporate Globalization (localization and internationalization) Standards Into OSTPV

All members of the ISS planning and mission operations teams must use and reference the OSTPV planning system for real-time operations. At the moment this system is only programmed in English which is the official language of the ISS. However, decision-making processes of the IPs are often delayed as they are continually translating interfaces and documents into their native languages to make the most informed decisions, and this takes time. Resource and system limitations have not allowed JSC to fully explore the possibilities for globalizing OSTPV as it would involve translating user interfaces from one language to another. This is a difficult problem to tackle as the OSTPV system infrastructure was not originally designed with this intent in mind.

"Must Have" design criteria

- A development team in charge of globalizing OSTPV must understand multiple foreign languages and cultures and have a technical background
- Knowledgeable resources must be readily available to make message updates as system interfaces are changed. For instance, once internationalized, any change to one message/field within OSTPV will make system-wide changes to all messages/fields. Someone needs to be available to check the validity and understandability of messages across the system
- The JSC planning team must retain ownership of the OSTPV system

"Must NOT Have" design criteria

- The globalization of OSTPV must not slow down the overall ISS planning process and the systems used within it
- The globalization of OSTPV must not hinder cross-partner communication and collaboration

Build Versioning Management Capabilities Into the Planning Process

Currently the ISS planning systems, CPS and OSTPV, have no versioning capabilities. This means every plan they create, and every activity embedded into that plan, must originate from scratch. In the past, the JSC ISS planning team created a separate database of standard planning activities in hopes of streamlining the plan generation process. However, with the scarcity of time for regular database maintenance, it became difficult to tell where activities originated and which ones were derivatives of others. For this reason, it often takes longer to find the version of the activity the planner wants than it does to generate the activity from scratch each time.

A versioning management capability built into the ISS planning process would positively assist the plan generation activity, as it would trace the life cycle of an ISS activity. A planner would be able to trust that an activity within the database was the most up to date, which would decrease the decision-making process of which activity to use. Additionally, a versioning management capability would make each of the experts providing input into the plan accountable for their work as it would track when each of the activities was changed and by whom. This would enable the planners to have fewer, more productive reviews.

"Must Have" design criteria

- Changes between activities must be explicit and readily available
- All changes made to an activity must coalesce back to the master activity
- All activities within the database must be searchable by more than text alone; thereby enabling a planner to immediately reference all related activities simultaneously
- Versioning management must be compatible, and ideally integrated, with at least one of the existing planning platforms–CPS and/or OSTPV
- The data entry for establishing activities must be flexible to accommodate crunched deadlines. For example, it would be highly undesirable if there were twenty separate data fields and all were required for advancement in the system

"Nice to Have" design criteria

- Versioning management should support real-time scenario planning to assist with rapid re-plans
- Versioning management should also automate some of the creation steps associated with PPCRs in real-time operations as the plan evolves
- The JSC planning team must retain ownership of the OSTPV system

"Must NOT Have" design criteria

- The introduction of versioning management must not slow down the overall planning process (machine or planner-wise)
- The accountability aspects of the versioning management must not allow "finger pointing" or laying blame on the experts and specialists using it. The focus, instead, needs to be on improving the overall integrity of planning activities

Where Things Stand Today at JSC

Solutions presented in this paper are initial proposals for the ISS planning team to address the challenges that they experience with respect to efficient product generation. JSC is beginning to work with tool developers from other Centers and IPs to create a more cohesive process. They are also working on multiple software projects to create better constraint planning and management tools, system optimization, and merging functionality of the CPS and OSTPV systems. Next steps for JSC involve sourcing the best technology to address the design criteria that resulted from the user research.

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