JWST PROGRAMMATIC & SCIENTIFIC CONSIDERATIONS

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Program Challenges

- **Back-loaded budget profile**
  - No funding reserve of any consequence in early and near years
- **Significant lag time between "agreement" on funding augmentation and funding showing up**
- **Contractor transparency with fiscal state of their operations**
  - Communications with prime were not very productive initially
- **On-orbit performance incentives had negative effect on contractor cost and schedule performance**
- **Technology development program caught the big-ticket items – mirror processing, sunshield material, wavefront sensing, etc. – but missed smaller things – detector yield, cooler architecture subtly, etc. – that drove schedule primarily but cost as well**

PARTNERSHIPS

INTER-CENTER AND INTERNATIONAL

“One NASA?”

- Experience and Culture
- Similar but Different
- Respect, Communications, Relationships

Experience and Culture

- **Different NASA centers have different origins, different experiences, so have different cultures**
  - Space centers vs. research centers
    - Space flight engineering and project management discipline contrasts with that for R&D. Similar cultural difference within space centers for tech dev and early-phase mission work vs. I&T phase mission work.
  - Current experience and short cycle time/frequent missions (continuous history and renewal, fresh personal experience – e.g., GSFC and JPL)
  - Legacy experience and disruption or long cycle time (past accomplishments, major disruptions, limited personal experience – e.g., JSC, KSC, MSFC)

Lessons:
- **Each center has a history that is a source of pride and outlook that is reflected in process and procedure emphasis**
- **Center history and experience is context and is a big part of why they are the way they are. Know it and appreciate it.**

Similar but Different

- **Centers have many of the same basic approaches to and processes for design, testing, reviewing. Not surprising given they all do engineering, so organically they developed similar natural and sensible approaches**

- **However, experiences affect culture and relative emphasis and shape guidelines and practices**
  - KSC and safety (deadly hazards), JSC and dissent (Challenger and Columbia), JPL and 'incompressible schedule' (planetary launch windows)

- **People 'do what they've done before' that has worked, and this can lead to 'religious wars' over design and test details, besides simple 'turf wars'**
  - Thermal cycles vs. duration vs. temperature margins (GSFC and earth orbit vs. JPL and planetary)
  - Mindset at research centers vs. space centers
  - Safety and QA authority when working on your stuff at another center

- **Language ("Those Brits have a different word for everything!"). Different terms for same things, same words for different things**

Lessons:
- **Learn to speak each other's language**
- **Find common ground in rules and practices to bridge understanding**
- **Review existing MOUs or create MOUs to document understanding**
- **Create 'embassy zones' to execute AI&T efficiently**

Respect, Communications, Relationships

- Showing a little respect gets people off the defensive and facilitates trust and communication, which of course facilitates a highly-functioning relationship
- Spend some time in person and in very small group with your counterparts at your partner center to discuss details and build a rapport

Lessons:
- "ha'wai ho'ihi, loa'a ho'ihi" – give respect, get respect
- Travel is a fact of life. Invest in 'face time' to build and cement trust

It's not rocket science, it's social science

Challenges Stemming from the Foreign Launcher "Gift" are Pertinent to the Other JWST International Partnerships

- **JWST has refined our partner relationships over many years to gain trust and to enhance collaboration and efficiency**
  - Open communication is crucial
  - Documenting expectations, with single responsible parties from each side
  - Feeling of ownership across agencies, participants
  - Team approach, regardless of disparity in contributions

- **Multiple opportunities to overcome obstacles in foreign partnerships**
  - Contractual challenges
  - ITAR issues
  - Communication pathways
  - Different ways of doing business
  - Foreign travel tactics
  - Language barriers

MAINTAINING GOOD EXTERNAL RELATIONSHIPS

WORKING WITH GAO AND HQ

Working With HQ

- **Lessons Learned**
  - Constant open communication - Almost daily verbal communication with on formal tag-up once per week
  - UFE held at HQ level (part of JWST cost cap), but early agreements between Program and Project offices on how to transfer UFE to the project minimizes overhead and allows project to look forward with expectations of receiving UFE
  - Program/Project offices always in sync in dealing with GAO (joint resolution of external issues)
  - Program office interacts with contractors and partners
    - Comes to monthlies (mostly NGAS and JPL, but occasionally STScI and JSC)
    - Coordinates visits to Hill to ensure messaging is consistent
  - Have people in program office (HQ) who have some project experience

APPROACH TO JCL AND BUDGET PLANNING

JWST JCL Process and Model

- **A Joint Cost and Schedule Confidence Level (JCL) analysis was required as part of the replanning process**
  - Target was 70% confidence level
  - Result was ~66% - 98% cost and 66% schedule
    - Was a strategic decision by the project to stop at 66%
- **Replan and JCL results were reviewed by NASA's independent external review board – the JWST Standing Review Board (SRB)**

- **Project led JCL effort but was supported by HQ Cost Analysis Division (CAD) for augmented tool support (primavera risk analysis) and schedule integration support**
  - Intensive multi- month duration
  - Initially in the process, schedule assumptions changing (based on funding assumptions coming out of HQ).

SCHEDULE MANAGEMENT AND BUDGET RESERVE REPORTING

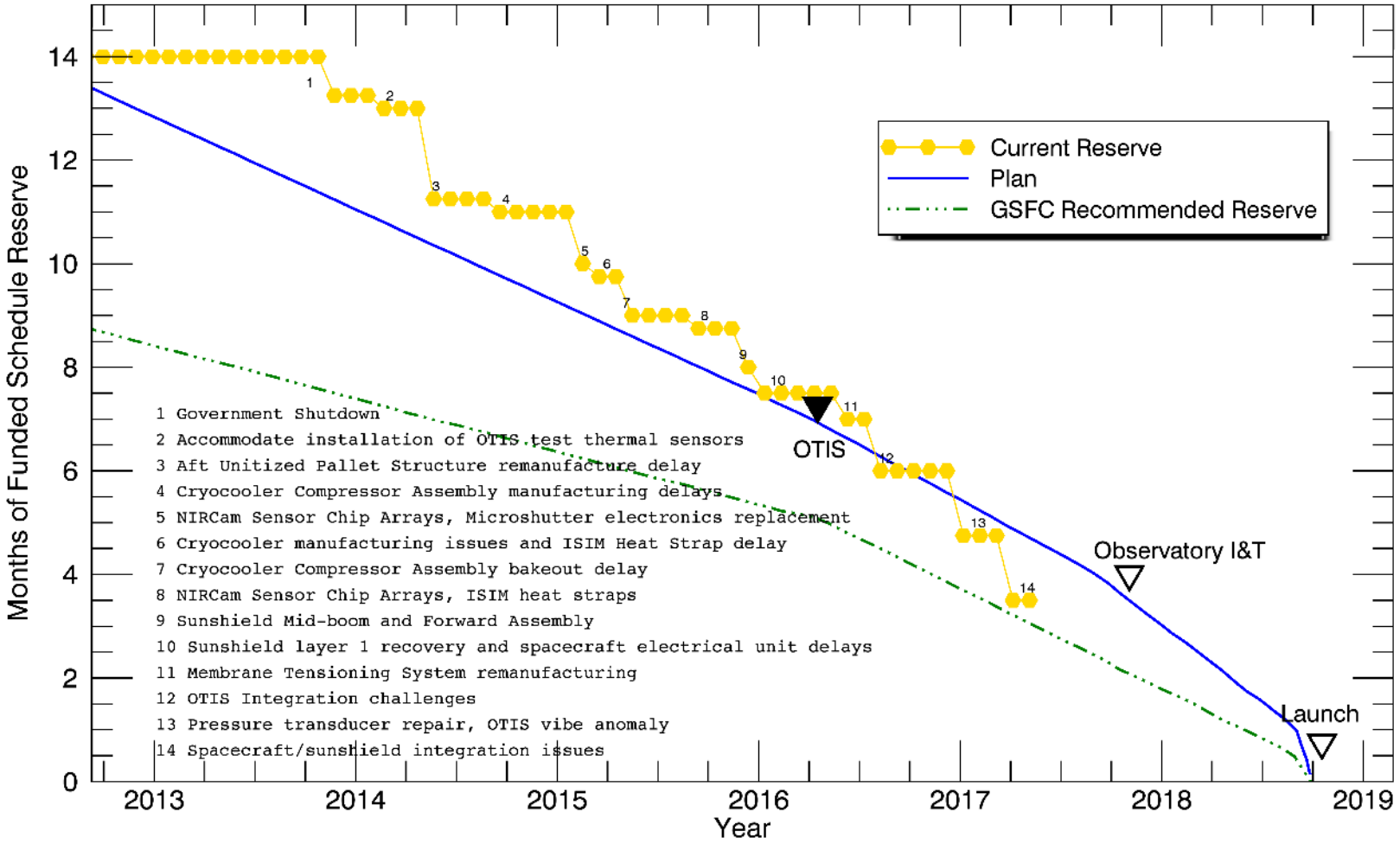
Simple reports are a must

Fiscal Year 2017 JWST HQ Milestones

Month		Milestone	FY2016 Deferral	Comment
Oct-16	1	Complete portable clean room for Telescope and Science Instruments (OTIS)		Completed 10/13/16
	2	Complete final checkout of new shaker tables at Goddard Space Flight Center	•	Completed 10/13/16
	3	Begin making electrical connections between spacecraft panels		Completed 10/7/16
	4	Complete Sunshield Mid-Boom Assembly #2 functional test	•	Completed 12/5/16
Nov-16	5	Start optical measurements of OTIS prior to vibration and acoustic tests		Completed 10/24/16
	6	Deliver Science and Operations Center release 1		Completed 9/30/16
	7	Perform Cryocooler installation into the spacecraft bus and begin functional testing		Completed 10/29/16
	8	Complete Aft Unitized Pallet Structure assembly	•	Completed 10/29/16
	9	Deliver Aft Unitized Pallet Structure to Observatory I&T	•	Completed 3/14/17
Dec-16	10	Deliver Forward Sunshield Pallet Structure to Observatory Integration and Test (I&T)	•	Completed 3/28/17
	11	Start OTIS vibration and acoustic testing program		Completed 11/19/16
	12	Complete final test of engineering model of telescope center section at Johnson Space Center (JSC)		Completed 10/31/16
	13	Deliver sunshield flight membranes to Observatory I&T		Completed 12/15/16
Jan-17	14	Complete OTIS vibration and acoustics testing		Completed 3/2/17
	15	Deliver observing proposal and planning subsystem software build that supports launch		Completed 1/12/17
	16	Complete electrical testing of the spacecraft at Northrop-Grumman		Completed 3/7/17
Feb-17	17	Complete OTIS optical measurements after vibration and acoustic tests		Completed 3/31/17
	18	Deliver wavefront and control software that supports launch (controls telescope mirror shape)		Completed 1/20/17
	19	Deliver horizontal deployable radiators to Observatory I&T		Delayed June for release testing
Mar-17	20	Deliver OTIS to the Johnson Space Center		Completed 5/7/17
	21	Deliver the pre-launch Flight Operations System software build		Completed 2/17/17
	22	Delivery of sunshield extension boom #2 membrane attachment assembly to Observatory I&T		Completed 4/13/17

Blue font(underline) denotes milestones accomplished ahead of schedule, orange font denotes milestones accomplished late. "•" denotes 2015 milestones carried forward.

JWST Critical Path Reserve History



Other Considerations

- **PI role in science scope**
  - JWST science scope derived from Decadal Survey and challenging to alter
- **Phase E cost realism**
  - HQ paying more attention to Phase E costs and early estimates
  - Probe GO program is a new beast
- **Informal Peer Review Teams**
  - JWST used these to great success – could have use more