



Using a Free Enterprise System to Handle Complexity and Configuration Control

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AVIATION WEEK Program Leadership Roundtable
May 3, 2010, Bethesda, Maryland

The background of the slide is a composite image. On the left, the planet Saturn is shown with its characteristic rings, partially obscured by a large, semi-transparent white circle. On the right, the Cassini spacecraft is depicted in orbit, with its complex structure and antennas visible against the dark space. The overall color palette is a mix of blues, greys, and oranges.

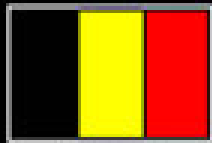
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How the Cassini Payload Reserves were Managed

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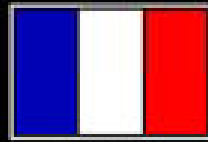
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BELGIUM



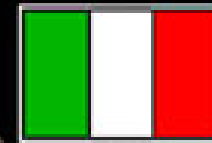
UNITED STATES



FRANCE



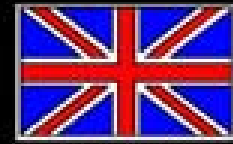
GERMANY



ITALY



DENMARK



UNITED KINGDOM



SWITZERLAND



NETHERLANDS



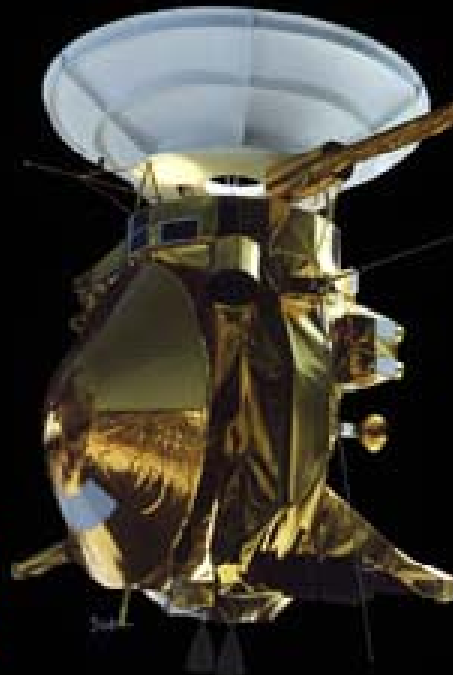
CZECH REPUBLIC



AUSTRIA



SPAIN

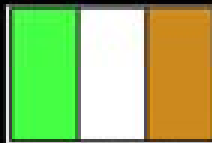


INTERNATIONAL
PARTICIPATION IN

CASSINI SATURN ORBITER AND HUYGENS TITAN PROBE



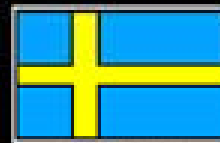
FINLAND



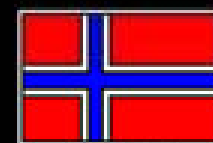
IRELAND



HUNGARY



SWEDEN



NORWAY

The Payload Challenge

Deliver all 18 instruments:

- On time
- Within cost
- At allocated mass (or less)
- At allocated power (or less)
- With allocated data rate
- Within agreed upon configuration

Also Desire

- Optimum use of payload resources
- Use the best expertise in any reallocation of payload reserves
- Minimize management overhead (consistent with above)

Cassini/Huygens Payload Situation

- 18 instruments, most using cutting-edge technologies
- Needed “expert” advice for using reserves
- In a half dozen cases all of the world’s “experts” were associated with payload instruments
- Needed a process for using their expertise and avoiding conflict of interest
- The answer for this and other problems was to set up a “free market trading” system

Prelude to Opening the Market for Trading

- Payload
 - Negotiate delivery contracts with PI's for each of the 18 instruments
 - Hold “expert” reviews to verify that the deliveries should be possible
- Distribute all payload margin (about 15%) to the PI's
 - \$ by FY
 - Mass (in kg)
 - Power (in Watts)
 - Data rate to spacecraft bus (in kbs)
- Provide a method for the PI's to trade resources
 - Define the method well !
 - Establish rules !
 - **Open the market!** (All offers and trades reported electronically.)
 - Project Manager, Project Scientist, and the Payload Manager had veto authority

The Contract

- Instruments that are delivered on time and within their resource envelopes will fly.

Comparison of "Traditional" vs. Market Approaches

- Margin vesting
- Who changes an instrument's resource profile?
- Visibility of resource usage
- Margin optimization
- Who will fly?
- Trading complexity
- Overhead
- Team building
- Lessons learned

Margin Vesting

Payload Manager

- **Margin or reserve is vested in the Payload Manager (“payload reserve account”)**

Resources Exchange

- **Each PI is vested with the reserve for his instrument**
- **Gives the PI control over his/her fate**

Who Changes Resource Profiles?

Payload Manager

- **Payload Manager**
- Manager does not have detailed knowledge of the situation and necessary expertise
- Every margin allocation by the Payload Manager is a win-lose transaction. The PI who is granted additional reserve wins and everyone else loses due to there now being less reserve.
- “Early bird gets the worm.” Those who declare an early bankruptcy have the advantage. Those who struggle to get by with what they have are at a disadvantage. If they later need help, the reserves may be full allocated.
- “NASA Board said my instrument more important!” Take what I need from someone else.

Resources Exchange

- **Instrument PI's via the commodities exchange**
- Decision made by PI's and teams. They are best qualified to evaluate complexity, risk, and need for their instrument and investigation.

Visibility of Resource Usage

Payload Manager

- **Payload Manager is often expected to maintain a predefined reserve profile.**
- Payload Manager under pressure to increase his reserve if it is too low for the present stage of development. Often the only option is to cancel an instrument.
- Pl's are wise to hide anything not used in order to prevent seizure . This behavior undermines an accurate assessment of the reserve available.

Resources Exchange

- **No advantage to secrecy**
- **No required reserve levels**
- **Knowledge of reserve is continuously available**
- Openness has advantages. (e.g., an accurate knowledge of instrument development status)
- Others can make helpful suggestions (e.g., trades).
- Gifts can be given by a rich instrument in order to avoid a specific adverse impact later.
- Promotes shared developments such as data reduction software through the recognition of common problems

Margin Optimization

Payload Manager

- **Depends upon the skill (some say luck) of the manager.**
- Needs advice from external experts
- PI's try to hide anything not used in case they need it later.

Resources Exchange

- **System tends to drive outcome in direction of optimum usage.**
- Strong motivation to trade excess mass and power. These commodities will have no value at launch.
- Strong motivation to loan unneeded current year \$\$ (e.g., earn interest)

Who will Fly?

Payload Manager

- **Management decides**
- When management feels that it must raise more reserve it removes instruments. Big lose-lose for everyone as the science advisory group is usually called upon to recommend which instrument goes.

Resources Exchange

- **Flight guaranteed if instrument delivered on schedule and within budget (i.e., the PI meets his contract)**
- This is a big morale booster because many teams know well in advance that they will fly.

Trading Complexity

Payload Manager

- **Single transactions**
- Payload Manager moves resources to and from his “payload reserve account”
- Transactions are against current holding in the “payload reserve account”

Resources Exchange

- **3 or 4 party transactions possible**
- Parties do not need to trade with each other. In 3 or 4 party trades you can give to and receive from different parties.
- We had a "broker" and software to help arrange multiparty exchanges

Overhead

Payload Manager

- Payload manager must prepare for each decision
- Unhappy parties may appeal to Project Scientist or Project Manager
- All parties prepare for each level of management “shoot out”.

Resources Exchange

- Decisions are made at the lowest possible level
- Trades are final. No appeal after a trade has been made.
- PI's are not compelled to trade and will only trade if they believe that they will benefit from the transaction.

Team Building

Payload Manager

- Interactions have winners and losers.
- People hate each other. ☹️

Resources Exchange

- Transactions are win-win.
- Everyone happy. 😊
- Strong team building program requires win-win activities.

Lessons Learned

- Traded commodities and rules must be well defined. Uncertainty “kills” the system.
- Team building –through win-win interactions– paid off later when PI’s and their teams had to cooperate in using the spacecraft.
- Resource trading worked very well. All 18 instruments flew to Saturn.

[Additional reading: Wessen RR, and D. Porter, A management approach for allocating instrument development resources, Space Policy 31 (3): 191-201 Aug 1997]2