NASA PI-Team Masters Forum Responding to the Unexpected: Examples from the Mars Exploration Program

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What is the "Unexpected"

- The unexpected can be "good, bad or ugly"
- Good
 - New opportunities provided by the system capabilities or mission design
 - New opportunities propelled by discovery
 - Extended lifetimes, innovative observation modes, serendipity
 - Sometimes the greatest challenge for NASA is to fund operations of a mission which has outlived the conservatism of its Level 1 requirements ("success comes at a price")
- Bad
 - System or instrument failure
 - Unanticipated interactions in complex systems
 - Software and telecom
- Ugly
 - Loss of mission

Response to the Unexpected (1 of 2)

- Know that the "unexpected" will come and prepare beforehand
 - Build in resource margins and use them reluctantly (but use them)
 - Power, mass, data volume, mission design
 - The margins should be realistic (part of balancing system and science risk)
 - Resist the temptation to use margins to "make better" in development
 - Build a common understanding of mission "essentials" and ensure the communication paths are open and used

Pay attention to all the "little" unexpected items

- These may be the first manifestation of the "big" surprises to come
- Have a means to track and revisit all the "Incident Surprise Anomalies"-document them
- Involve systems engineering and science in the reporting, discussion and proposed resolution of these events



Response to the Unexpected (2 of 2)

- When you "solve" a problem, check to see that it's resolved
 - Inspect, re-test, verify
- Don't panic in the face of the "big" unexpected items
 - Use the expertise of your team and your partners to deal with these
 - Innovative thinking
 - Use of Margins
 - There can be happy endings, too!
- Changes may be needed
 - In mission plan or technical approach: Project decision, NASA concurrence
 - In Level 1 requirements: NASA decision
 - In approach or personnel: Depends
 - Case in point: major instrument on a strategic Mars mission

Some Examples: MGS - Aerobraking



Seasonal & Diurnal Variations

Day of Earth Year



Mars Global Surveyor: A Science Catalyst for the Mars Exploration Program









Some Examples: MER-A (Spirit's Silica Soil)



MER-A / JPL / NASA







Some Examples: MRO HiRISE images PHX



MRO HiRISE / U. Arizona / JPL / NASA