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
• 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
Mars Global Surveyor: A Science Catalyst for the Mars Exploration Program
Some Examples: MER-B in Eagle Crater

Martian “Blueberries”
Some Examples: MER-A (Spirit’s Silica Soil)
Some Examples: TEGA
Some Examples: MRO HiRISE images PHX