Historical Perspectives of NASA Missions

NASA Goddard Space Flight Center, Code 400
Cindy Fryer, Chief Resource Analysis Office (RAO), Code 405
Paul Guill, Lead Mathematical Modeling
Dori Cates
Devon Greene

COST, Inc.
Donald H. Strope

August 13, 2014
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Mission Classification

- **Earth Science**
  - Land surface, atmosphere, oceans & climate

- **Space Science**
  - Heliophysics, astrophysics & lunar excluding the Small Explorer Program (SMEX)
Ground Rules & Assumptions

- Database excludes Hubble Space Telescope (HST)
- Database excludes planetary missions (lunar missions are included)
  - Slides 26 & 27 include all NASA SMD missions
- Costs are for Phase C/D except where designated as life cycle cost
  - Excludes: formulation, Phase C/D for ground systems/mission operations, prime contractor fee, Phase E and launch vehicle
- Costs normalized to out-of-house rate and are in constant year millions
- Satellite refers to the instrument payload (WBS 5), spacecraft bus (WBS 6) and systems I&T (WBS 10)
- Bus costs include the cost of the spacecraft bus and systems I&T
- Meteorological and operational missions in a series are included in cost and mass, but schedule represents only the first build
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Satellite Cost Time Series
Mission Schedule Time Series
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Percentage Distribution of Satellite Mass

Earth

- 1980's: 24%
- 1990's: 27%
- 2000's: 29%
- After 2010: 29%

- 1980's: 76%
- 1990's: 73%
- 2000's: 71%
- After 2010: 71%

Space

- 1980's: 39%
- 1990's: 36%
- 2000's: 39%
- After 2010: 18%

- 1980's: 61%
- 1990's: 64%
- 2000's: 61%
- After 2010: 82%

SMEX

- 1980's: 27%
- 1990's: 34%
- 2000's: 40%
- After 2010: 48%

- 1980's: 73%
- 1990's: 66%
- 2000's: 60%
- After 2010: 52%
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Average Satellite Cost
Cost per Kilogram & Mass Comparison

**Cost per Kilogram**

### Satellite
- Earth: $0.32
- Space: $0.32
- SMEX: $0.39

### Bus
- Earth: $0.23
- Space: $0.32
- SMEX: $0.4

### Instrument Payload
- Earth: $0.58
- Space: $0.37
- SMEX: $0.4

**Average Mass**

### Satellite
- Earth: 1429 kg
- Space: 1910 kg
- SMEX: 264 kg

### Bus
- Earth: 1074 kg
- Space: 1063 kg
- SMEX: 167 kg

### Instrument Payload
- Earth: 354 kg
- Space: 847 kg
- SMEX: 97 kg
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Average Mission Schedule by Decade
Start of Phase A to Launch

![Bar chart showing average mission schedule by decade.](chart.png)
Life Cycle Average Monthly Satellite Burn Rate
Start of Phase A to Launch

![Chart showing burn rate by decade and mission class](chart.png)
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Failures represent failures of the spacecraft bus or instrument payload.
Hardware Failures: Planetary & Non-Planetary
NASA SMD Missions

![Bar charts showing hardware failures comparison between Planetary and Non-Planetary missions across decades.]
Hardware Percentage Failure Rate
Planetary & Non-Planetary Missions

1990's

27%

27%

31

8

3

2

6%

Mission Type

Planetary

Non-Planetary

Mission Type

Successful

Non-Planetary Failures

Planetary Failures

2000's

8%

38

12

0%

Mission Type

Planetary

Non-Planetary

Mission Type

Successful

Planetary Failures

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Conclusion

- Last 30+ years have been relatively stable in terms of cost & schedule
- SMEX program began prior to “Faster, Better, Cheaper” initiative, which was coined by Administrator Goldin
- SMEX missions stand out as being “Faster” and “Cheaper” thus making them “Better”
  - No judgement has been made on the value of science return
- SMEX program continues to be successful with low reliability missions (Class C and D) and few failures
- “Faster, Better, Cheaper” appears to be successful with lower reliability missions