RISK MANAGEMENT EXPERIENCE ON HYPERION

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HYPERION PROJECT SUMMARY

- A very fast-paced TRW project to fabricate and deliver a hyperspectral imaging system for NASA Goddard Space Flight Center for flight on the EO-1 spacecraft
  - –220 contiguous spectral channels from 0.4 to 2.5 microns
  - –Separate VNIR (Si) and SWIR (HgCdTe) arrays
  - –Pulse tube active cryocooler used for SWIR array
- Extremely high visibility project
  - –NASA Administrator, TRW Executive Vice President
  - –Visibility provided support, so long as we “got the job done”

PROJECT MANAGEMENT CHALLENGES (1)

- Very high technology spacecraft electro-optical sensor
- Critical subcontractor about 2,000 miles away
- Some requirements changes after development initiation
- Very short program schedule
  - ~ 4:1 schedule compression

PROJECT MANAGEMENT CHALLENGES (2)

- Numerous items on program schedule critical path
- Substantial financial incentive/penalty for each day sensor delivered early/late
- Little/no margin for error possible to meet cost, performance, and schedule requirements
  - Few, if any second chances due to extremely short schedule

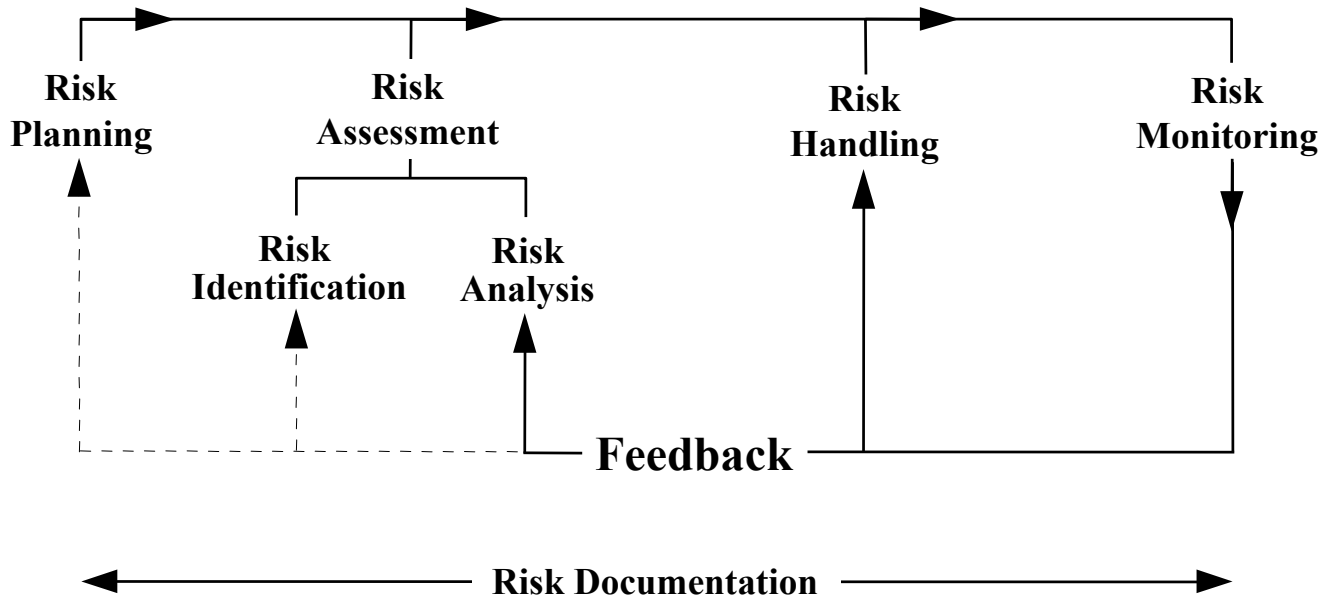
RISK MANAGEMENT BACKGROUND

- Emphasis of risk management on Hyperion is an outgrowth of:
  - NASA desire that Hyperion avoid mistakes made by previous contractor
    - Weak risk management process did not permit resolution of key issues
    - Contributed to program termination

HYPERION RISK MANAGEMENT PROCESS (1)

- Derived from process based upon DoD 1998 and applied by risk management consultant to large-scale programs
  - DSMC/DAU, “Risk Management Guide for DoD Acquisition” 1998 and 1999 (1st and 2nd editions; now 2000, 3rd edition)
  - Process is a DoD enhancement of DSMC “Risk Management Concepts and Guidance,” 1989
    - DoD 1989 process included planning, assessment (identification and analysis) and handling steps plus feedback, but not a formal monitoring step

DOD 1998 RISK MANAGEMENT PROCESS



"Risk Management Guide for DoD Acquisition" (DSMC, 1998),
http:///www.dsmc.dsm.mil/pubs/gdbks/risk_management.htm

HYPERION RISK MANAGEMENT PROCESS (2)

- This approach permitted rapid implementation
  - Risk management consultant started 2 1/2 months after project initiation
  - Very comprehensive Risk Management Plan (RMP) developed in less than 2 weeks
  - Key NASA personnel briefed in 3 weeks
  - Initial program-wide risk identification and analysis, development of Risk Handling Plans (RHPs), and documentation completed in less than 7 weeks
  - Updates performed monthly for next 5 months

HYPERION RISK MANAGEMENT PROCESS (3)

- Risk management process steps included risk:
  - Planning
  - Assessment (identification and analysis)
  - Handling
  - Monitoring, plus feedback
- What is the most important process step?
  - They all are!
    - But, if you do not properly perform risk planning, the entire process and its implementation will be weak or ineffective

HYPERION RISK MANAGEMENT PROCESS (4)

- Risk management consultant:
  - Developed, tailored and implemented process
  - Trained and closely worked with program staff to identify and analyze risks, and develop RHPs, and document results
  - Led monthly risk updates
- Risk Management Board (RMB) was constituted
  - Evaluated candidate identified risks
  - Approved risk analysis results and RHPs
  - Monitored progress in reducing risks to acceptable levels

HYPERION RISK MANAGEMENT PROCESS (5)

- TRW Program Manager and Deputy Program Manager participated in risk management activities
  - Provided leadership example to program staff
  - A very important contributor to the positive risk management culture established on Hyperion
- Deliverables included RMP and monthly comprehensive Risk Evaluation Reports
  - Used by TRW and NASA upper management

RISK PLANNING

- Single risk management contractual requirement
  - "Develop a comprehensive, proactive RMP"
- RMP tailored by risk management consultant from plans he developed for large-scale programs
  - Saved considerable resources (budget and time)
  - All non-essential activities removed
- Risk management training done concurrently with first program-wide risk assessment

RISK IDENTIFICATION

- Program WBS used as a framework for examining potential risk issues
  - Hardware, software and integration WBS elements examined
- Information collected via interview of key program personnel
- Candidate risk issues identified, then evaluated by RMB
- Common risk sub-issues led to creation of additional risk issues
  - For example, assembly personnel and equipment availability

RISK ANALYSIS (1)

- Technical risk analysis performed
  - Used ordinal "probability" and consequence scales
    - ***Scale levels values are only rank ordered (monotonic)!***
      - ***Ordinal is defined as rank ordered--not cardinal!***
        - "C", "B", "A," where C > B > A just as valid as 3, 2, 1
    - "Probability" scales were hardware, software, and integration-specific
    - Cost, performance, and schedule consequence scales
  - Mapping matrix converted results to (prioritized) risk
    - Low, low-medium, medium, medium-high, high

RISK ANALYSIS (2)

- Technical risk analysis performed, continued
  - Mathematical operations were not performed on "probability" of occurrence and consequence of occurrence scores
    - ***"Probability" values are almost never probabilities***
      - ***You can not invent a probability out of "thin air"!***
    - ***Scale coefficients are almost never accurately known***
      - ***Coefficients are only rank ordered, not cardinal!***
    - Can, and often does, lead to erroneous results
      - In one simple case, an average deviation of 188%!
      - Another case; most "Top 5" risks missed or mis-ordered

RISK ANALYSIS (3)

- Dubious practice of performing math on ordinal scale results was pioneered, but withdrawn, by DoD
  - Systems engineering
    - Included in 1986 Defense Systems Management College "Systems Engineering Management Guide," 2nd Edition
    - Withdrawn in 1990 D.S.M.C. "Systems Engineering Management Guide," Third Edition
    - Rebuked in 1999 D.S.M.C. "Systems Engineering Fundamentals" (first follow-on to D.S.M.C. 1990 S.E.M.G.)
  - Citing an obsolete version when information is later withdrawn or rebuked is unwise, improper, and potentially dangerous

RISK ANALYSIS (4)

- Dubious practice of performing math on ordinal scale results was pioneered, but withdrawn, by DoD (cont.)
  - Risk management
    - Included in Air Force Materiel Command (A.F.S.C.) Pamphlet 63-101 “Acquisition Risk Management,” 1993
    - Withdrawn in A.F.M.C. Pamphlet 63-101 “Acquisition Risk Management,” 1997
    - Rebuke prepared and approved for follow-on version
      - Document dormant (update may not occur)

RISK ANALYSIS (5)

- Dubious practice of performing math on ordinal scale results was pioneered, but withdrawn, by DoD (cont.)
  - Risk management
    - Never included in D.S.M.C. 1989 “Risk Management Concepts and Guidance”
    - Rebuked in D.S.M.C. 1998, 1999, 2000 “Risk Management Guide for DoD Acquisition” (First, Second and Third Editions)

RISK ANALYSIS (6)

- Dubious practice of performing math on ordinal scale results was pioneered, but withdrawn, by DoD (cont.)
  - Commercial publications
    - Included in Harold Kerzner, "Project Management: A Systems Approach to Planning, Scheduling, and Controlling," Sixth Edition, 1998
    - Withdrawn, rebuked, and left as an exercise to the student to discuss the numerous, inherent flaws in Seventh Edition (September 2000)
  - It is irrelevant how many documents cite or organizations use flawed information--if it is erroneous, do not use it!

RISK ANALYSIS (7)

- Monte Carlo simulation used for schedule risk
  - Used to estimate the probability of meeting key project milestones (penalty/award fee versus delivery date)
  - Before starting, carefully evaluate software packages
    - Some packages are clearly inadequate
    - How would you evaluate (actual Hyperion data):
      - Low (0th percentile) = 2, Median (50th percentile) = 2, High (100th percentile) = 3?
      - Hint: the data are not representative of a beta-PERT, normal, triangle, or uniform distribution

RISK ANALYSIS (8)

- Monte Carlo simulation used for schedule risk (cont.)
  - Sloppy selection of probability distributions is often an indicator of poor risk management "across the board"
    - "Variation due to the selection of the probability distribution is less than that from uncertainty of the inputs"
    - This is not a valid reason for carelessly selecting and using the "wrong" distribution
      - At a minimum, perform a sensitivity analysis

RISK HANDLING

- Risk Handling Plans developed for all risk issues with low-medium or higher level
- All risk handling options examined for each risk issue
  - Assumption, avoidance, control (mitigation) and transfer
  - Do not default to the control option--common mistake on many projects--can lead to sub-optimal risk handling
- Backup option(s) developed where practical along with decision date for implementation
- RHPs updated during monthly risk evaluation updates

RISK MONITORING

- Extremely short schedule and availability of hardware and software from previous programs precluded extensive, formal risk monitoring. However,
  - Earned value data collected and analyzed
  - Weekly program-wide schedule updates provided opportunity for examining schedule issues
  - Daily engineering management meetings provided opportunity for examining programmatic, schedule and technical issues

SOME LESSONS LEARNED (1)

- Sound risk management can be effectively implemented on short duration programs
  - Process should be comprehensive, but tailored to program and eliminate non-essential activities
  - Expert tailoring and application is essential
    - You can not just copy a risk management process and expect it to work! (Unfortunately, this is routinely done!)
- Risk updates should be performed quickly when program changes occur (e.g., added requirements)
  - Provides management with proactive, versus reactive, options

SOME LESSONS LEARNED (2)

- Savings from a single averted risk problem paid for the entire risk management program many times over
  - Backup option developed for an optical component. Primary option failed, backup option succeeded
  - 120:1 Return On Investment (ROI) for this example
    - Most cases will not have this high an ROI
    - In some cases a ROI < 1.0 may be both acceptable and necessary if it keeps the project from being terminated!

SOME LESSONS LEARNED (3)

- Key management involvement is necessary for proper risk management implementation
  - Provides viable leadership example to project engineers rather than lip service
- Successful Hyperion risk management implementation
  - Aided TRW and NASA project managers
  - Contributed to project success
  - Prevented project termination more than once (as reported by NASA project management)

SOME LESSONS LEARNED (4)

- It is essential to perform formal risk planning prior to the initial risk assessment
  - Identify likely risk categories, ground rules, etc.
- Risk identification should be fairly comprehensive to minimize the number of risk issues going undetected
- Risk analysis results should be carefully interpreted
  - Numerical values almost always have unknown uncertainty
  - Low-medium and higher risk levels were indicators of issues requiring additional management attention more so than an absolute level of risk

SOME LESSONS LEARNED (5)

- Essential to consider all risk handling options
  - Do not just focus on the control (mitigation) option
- Development of brief, written RHPs often helped identify:
  - "Missing" implementation steps
  - The need for a backup risk handling strategy

SOME LESSONS LEARNED (6)

- Culture shift led to risk management acceptance
  - Led by project manager, deputy project manager, and risk management consultant
    - Behavioral and technical skills both essential for success
  - Project team accepted risk management consultant
    - Trust earned via behavioral skills, and technical and risk management competence, not by “title” or position
  - Reinforced by on-going risk management successes
  - Risk management became part of the daily decision making process at both management and worker level

SOME LESSONS LEARNED (7)

- Positive environment to perform risk management is as crucial, if not more so, as the entire process!
  - A positive environment is much more important than any single risk management process step
  - Without having a positive environment, the “best” risk management process will yield highly ineffective results, if not contribute to project failure
  - A positive environment for performing risk management is not discussed in PMI material