Quality Management Methods at ESA and NASA: Differences, Similarities and Lessons-Learned

Martin Born
Product Assurance & Safety (PA&S) Manager at ESA for European Data Relay System (EDRS)

October 24, 2018

Agenda

1. Processes and Systems
2. Organization and Communication
3. Culture
4. Lessons Learned

Personal Background

- **1998: Technical University in Munich, Germany:**
  MS in Mechanical Engineering
- **1997-1998: Diploma thesis at JAXA, Tokyo, Japan:**
  German science instrument on Japanese Mars Orbiter NOZOMI
- **2001-2011: NASA Kennedy Space Center (KSC), FL:**
  Non-Destructive Evaluation Engineer for Space Shuttle hardware inspections
- **2011-2014: NASA Goddard Space Flight Center (GSFC), MD:**
  Chief Safety and Mission Assurance Officer, Joint Polar Satellite System (JPSS)
- **2014-present: ESA/ESTEC, Netherlands:**
  Product Assurance & Safety Manager for European Data Relay System (EDRS)

Before we start…

A quick word on the two missions that are used for the following comparisons:

- **NASA JPSS** is a Low Earth Orbit (LEO) Earth Observation (EO) Program with up to 5 satellites, including Suomi-NPP
  - 4-5 main science instruments
  - Funded by NOAA, procurement is managed by NASA, then operated by NOAA
- **ESA EDRS** is the European Data Relay System (EDRS) with at least 2 satellites in geostationary orbit
  - Public Private Partnership (PPP): Co-funded by ESA and European industry
  - Will be commercially operated by industry
  - EDRS payload receives data from LEO EO satellites via optical/laser communication, and then transmits the data to the ground via radiofrequency
  - Additional commercial hosted payload providing broadband access to Africa

1. Processes and Systems

Mission risk classification system at NASA

- Spacecraft development projects require individual design & quality requirements to meet unique program needs
- NASA applies a risk classification system per NPR 8705.4 "Risk Classification Guidelines and Risk-Based SMA Practices for GSFC Payloads and Systems". Each mission has an assigned risk classification A, B, C, or D
- Based on this classification, NASA then applies requirements templates for design rules, quality management and project management as a generic starting point, e.g. MAR (Mission Assurance Requirements). Customization for each project is still encouraged
- Pros: Requirements are largely repeatable, cost effective tailoring process
- Cons: Applicable documents from outside sources can cause conflicts. Sub-tier vendors may work to different standards

1. Processes and Systems

ESA currently does not use a mission risk classification system

- However, implementation of a system has been initiated in mid-2018
- Opportunity to learn from the established and proven NASA system, and to collaborate during the ongoing NASA system revision
- ESA applies European Cooperation for Space Standardization (ECSS) standards: a consistent and finite set of requirements and guidelines for successful space missions. Typically no additional outside / industry requirements are used besides ECSS
- ECSS is an ideal foundation for a set of pre-tailored risk-based mission requirements templates, because all standards are coherent and conflicts (e.g. from differing outside specifications) are avoided
- ESA uses the PARD (Product Assurance Requirements Document) tailoring the standards according to the needs of the mission

1. Processes and Systems

Risk management process

NASA / JPSS	ESA / EDRS
Weekly risk board meetings	No risk board meetings; Tracking and assessment of risk register via monthly management report
Dedicated risk manager for the project	Project manager acts as risk manager
Goddard standardized 5x5 risk ranking matrix for likelihood x consequence (ref. GPR 7120.4D)	No agency-wide standardized risk ranking scheme; customized per project (ref. ECSS-M-ST-80C)
Structured focus on prevention of issues	Small teams, close collaboration, informal focus on known concerns

1. Processes and Systems

Nonconformance management process

NASA / JPSS	ESA / EDRS
Material Review Board (MRB) for issues during build phase Anomaly Review Board (ARB) / Failure Review Board (FRB) for issues during test phase	Non-Conformance Report (NCR) for all issues, regardless of project phase Assessment discussion takes place in Non-Conformance Review Board (NRB) Anomaly Review Board (ARB) for in-orbit Non-Conformances
Distinction between minor/major	Similar distinction between minor/major

1. Processes and Systems

Supply chain / industry partner site audits

NASA	ESA
Goddard's Safety and Mission Assurance (SMA) performs onsite supplier quality management assessments of major primes approx. every 3 years Onsite assessments of lower tier suppliers as warranted by concerns and risks	No regular audits of primes or lower tier suppliers, except in the frame of projects (as needed)
Supplier research & analysis to provide insight as warranted	Certification schemes for: - external test centers - EEE parts suppliers - printed circuit boards (PCB) suppliers - surface mount technology (SMT) suppliers

1. Processes and Systems

Milestone review process

NASA / JPSS	ESA / EDRS
Step 1: Dedicated presentations are prepared by NASA flight project and industry teams Step 2: NASA flight project and industry teams present their status, areas of interest and concerns in front of independent review team Independent reviewers challenge the project teams in real-time during the presentations, and issue Request for Action (RFA) if answer is not satisfactory Step 3: Final outcome and action item closure is captured in final report to the independent reviewers	Step 1: Actual project documentation from industry is submitted online to ESA for review Step 2: Review Item Discrepancies (RIDs) are issued online from ESA to industry Step 3: Industry assesses RIDs and responds back to ESA online Step 4: Final negotiation / action item creation during in-person collocation Step 5: Depending on review class, ESA review leads may present final outcome to independent review board

2. Organization and Communication

Nomenclature differences

NASA	ESA
Business travel	Mission
Document revision	Document issue / revision
Memo	Admin
Spacecraft bus	Platform
Observatory	Satellite / Spacecraft
Wall calendar	Agenda
Bare printed circuit boards (PCB) vs. populated circuit card assembly (CCA)	Only PCB, for either type
Mill, thou (1/1000 of an inch) Micron (one micrometer)…	Metric system

2. Organization and Communication

Government residents at industry sites

NASA / JPSS	ESA / EDRS
NASA representatives permanently stationed at industry sites	No permanent ESA reps at industry sites
Full time or part-time	ESA experts travel to industry site as needed
Contractor, DCMA, civil servants	24/7 on-site coverage of sensitive activities, e.g. satellite test campaign
Engineering and Quality roles	
Work hand-in hand with industry on daily basis. Attend meetings, perform inspections	
Report back to NASA flight project	
Up to 5 reps total per industry site	

2. Organization and Communication

Contract types

NASA / JPSS	ESA / EDRS
Mix of • cost-plus (CP) contracts • firm-fixed-price (FFP) contracts Generally depending on risk and technological readiness level (TRL)	FFP contracts Occasional need for contract changes, adjustments and negotiations (Possible to use CP until PDR, then FFP)

Reminder that the ESA EDRS Program is a Public Private Partnership, with funding being provided by both ESA and industry.
NASA is studying a similar system, also for a data relay satellites, also with optical/laser payloads, also to be co-funded and operated by industry:

Space News, 22 Aug 2018: "NASA to study use of commercial partnerships for space communications services"

2. Organization and Communication

Status meetings with industry partners

NASA / JPSS	ESA / EDRS
Every month, the NASA team visits all four industry partner sites	ESA and industry meet every other month for 1-2 days at industry location
One week of travel and meetings	Half week of travel and meetings
Status discussions across all project areas	Status discussions across all project areas
Approx. once per quarter, all teams get together at one site to discuss common topics at overall system level	

2. Organization and Communication

Internal reporting and information exchange

NASA / JPSS	ESA / EDRS
Many weekly meetings (in-person & WebEx): Senior Management Project Team Instrument Technical Teams Instrument SMA Teams Spacecraft Team Spacecraft SMA Team Global SMA Team (20 people) Instrument Risk Board Global Risk Board Configuration Control Board (CCB)	Fewer weekly meetings: Project Team Spacecraft Technical Team Management & Systems Engineering Bi-weekly Global SMA Team (4-5 people) Monthly CCB
Weekly reports (which are actually read by the Goddard Center Director)	N/A
Monthly presentation to Goddard Management	Monthly report to ESA Management
Monthly presentation to SMA Directorate (20 min)	Monthly report to SMA Directorate (1 page)

2. Organization and Communication

Mandatory training courses

NASA	ESA
Lots of repetitive / periodic training requirements Often the same courses have to be taken many times: Anti-harassment, conflict of interest, ethics, fire extinguisher usage, chemicals labeling, working at heights, confined spaces, pressure systems, IT security… KSC: 3 days of annual repetitive "block training", plus numerous mandatory online or hands-on courses per year Goddard: Individual Development Plan (IDP). Career development courses online via SATERN system	No mandatory repetitive annual training courses One-time safety briefing at start of duty Focus on career development and educational trainings. Agreed at annual assessments depending on the tasks of the employee. Usually up to 3 training courses per year Additional safety briefings depending on the task (lab, test-facility, control center…)

3. Culture

International culture / language mix

NASA	ESA
Developments mainly within one country (USA)	Developments distributed over 22 member states
Occasional international collaborations	Contract distribution across member states according to their financial contributions to ESA
Civil servants must be US-citizens	ESA staff member populations according to financial contributions of member states
Single language across the agency	2 main / official languages (English & French) English is dominant language, but often used by non-native speakers (risk of miscommunication)
Diversity implemented via regulations and quotas	"Lived" diversity via inherent international mix, but also regulated through quotas

3. Culture

Meeting culture

NASA	ESA
General tone: Professional and courteous	General tone: Direct, outspoken
Meeting minutes only captured occasionally (as-needed)	Meeting minutes almost always captured
Always start on time	Some industry partners tend to join 10-15 minutes late
Goddard: Guideline to keep Fridays meeting-free as much as possible	No meeting-free days, but also significantly fewer meetings in general

3. Culture

Work-life balance

NASA	ESA
~15 days of annual leave average (+/- 5), depending on seniority	32,5 days of annual leave plus 8 days of home leave (every second year)
Manual time tracking	Automated time tracking, hours in excess of 40 per week can be used as leave (within limits)
Gym on site at GSFC	Gym plus numerous other sports options
Goddard Employee Welfare Association: over 40 social clubs	47 social and sports clubs at ESTEC campus
	Access for family members
	Frequent social & professional gathering, often in coffee restaurant
	Fewer meetings, more time to accomplish tasks, resulting in sense of satisfaction (and fewer weekends in the office)

4. Lessons Learned

Knowledge management

- **Both agencies, and most industry partners, are working on implementing lessons learned systems**
  - No easy solution
  - ESA ECSS standards: Requirements, guidelines and best practices (applicable to most ESA projects)
  - Similar approach via NASA's pre-tailored requirements templates
  - "Second closure" concept:
    - Capture key finding & preventive action from an anomaly in a dedicated system, which is intended for external collaboration & information sharing
    - Lessons learned summary, anonymous, clear language, no acronyms, searchable
    - Challenges: legal implications, funding for root cause investigation

4. Lessons Learned

Stress level

- **Happy employees are healthy, engaged and productive**
  - ESA's international perspective creates a unique team spirit of tolerance, appreciation and collaboration, regardless of origin
  - Work-life-balance matters!
  - Stress from milestone reviews, excessive reporting and non-stop meetings can be mitigated by considering and implementing other processes

4. Lessons Learned

Either way works

- **Both agencies approach the quality management processes differently, but both found working solutions**
  - Small teams, with smaller budgets can be effective through close personal collaboration
  - Less reporting obligations and fewer standing meetings create space for productive tasks, personal involvement and direct exchange
  - Risk management requires competence and accountability, coupled with suitable tracking systems. Formality is secondary
  - NASA's mission risk classification system has obvious programmatic advantages and ESA is starting to implement a similar system
  - Having permanent on-site reps is certainly beneficial, but alternatives are possible with smaller budgets and well-trusted, established suppliers

Thank you for your time and attention.

Martin Born
Product Assurance & Safety Manager
European Data Relay System (EDRS), TIA-PRQ
Telecommunications Satellite Programmes Department
Directorate of Telecommunications and Integrated Applications

ESA - European Space Agency
ESTEC
Keplerlaan 1, 2200 AG Noordwijk, The Netherlands
martin.born@esa.int | www.esa.int
Office: CF327 | Tel: +31 (0)71 565 6351