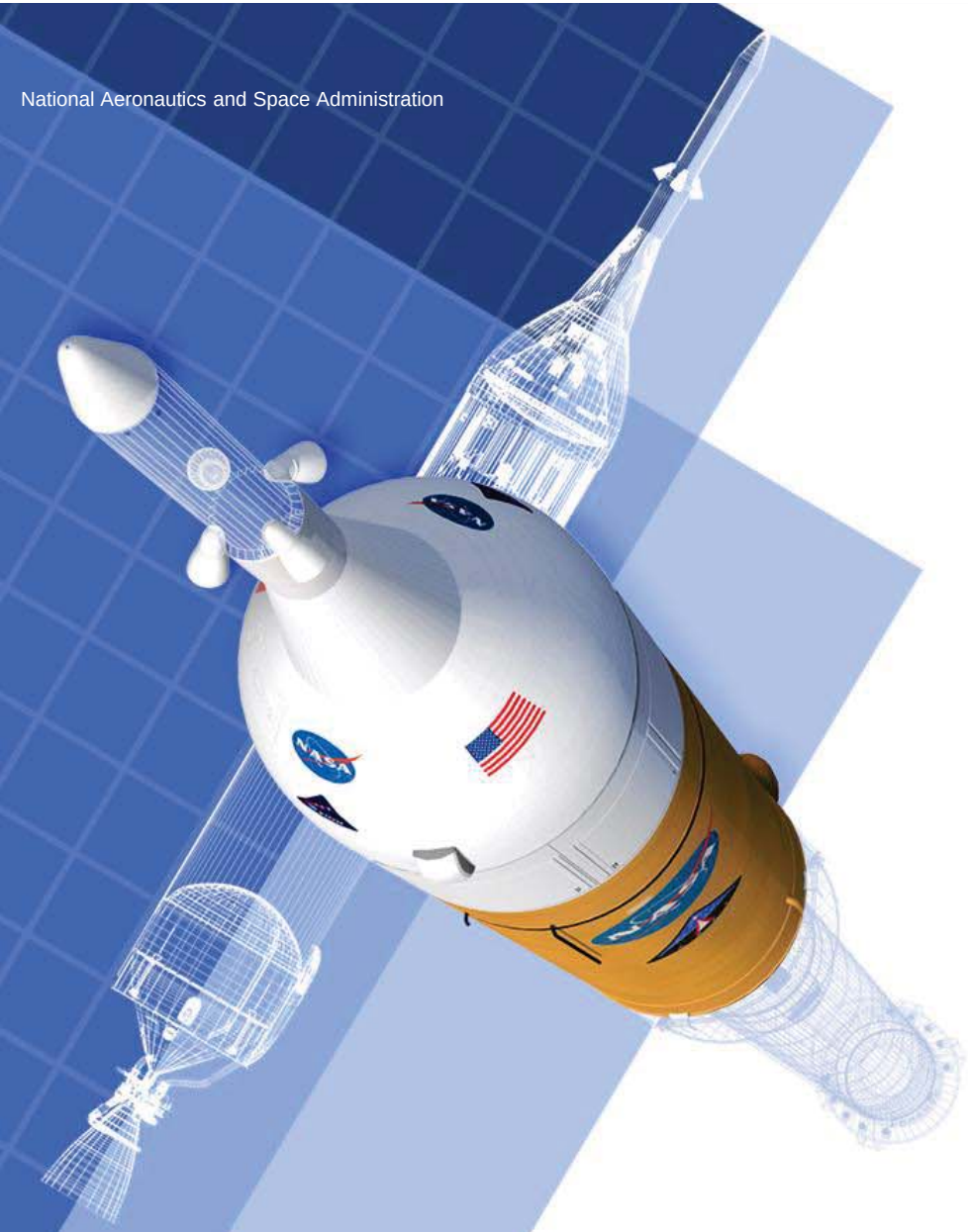
National Aeronautics and Space Administration



Ares Knowledge Capture Summary and Key Themes

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Preface

- **Within our capability**
  - NASA & industry has great people
  - We do many things right, but we do need to resolve to improve
    - Responsibility and authority
    - Core functions
    - Communication
    - Decision making
    - Planning
    - Professional discipline

- **Where we need to work with our fellow citizens & legislators**
  - Long-term policy
    - Improve how we deal with long-term issues as a nation (energy, federal budget, pollution, international relations, space exploration & planetary protection)
  - Commensurate support for large (flag ship) efforts that take longer (> 4-8 yrs)
    - Changes with political tides defeat long-term progress

Introduction

- **Knowledge Management (KM) approach**
  - In the past …
    - KM focused on gathering lessons & documenting
    - Passive … **knowledge capture**
  - New emphasis evolved during Ares toward …
    - KM focus on doing something (action items) before lessons shelved & the people that lived the lessons move on
    - Continuous improvement
    - More active … **knowledge implementation (infusion)**

Ares KM Process Summary

- **The Ares project implemented a new KM approach, making Lessons Learned (LL) actionable**

- **3 methods for Knowledge Capture by Ares KM Team:**
  - **Workshops** – group activities (many using ThinkTank s/w tool)
  - **KID form** – web based individual input
  - **Harvesting** – gathering data from previous group activities or LL reports

- **"Distilling"**
  - Raw **Knowledge Objects (KOs)** were sorted, combined, and dispositioned via a Distilling Team – forum consisting of engineering, S&MA, and project representatives, chaired by Chief Engineer
  - Distilling develops & assigns actions to discipline areas (lead) for implementation and forms **Knowledge Items (KIs)** former term, "Lessons Learned"
  - The Distilling Team met 2/week from 11/10 - 3/11
    - Task completed by CE and Ares KM Team

Ares KM Process Results

- **463 Knowledge Items (KIs) in 29 discipline areas**
  - Difference is KIs document potential / suggested actions needed for resolution
  - Distilled from 1958 independent inputs or Knowledge Objects (KOs)
  - Over half are in 8 areas: Program Planning, Knowledge Management, Risk Management, Procurement, Data Management, Analysis, Requirements, and Systems Engineering / Engineering Planning

- **Ares Knowledge Management Report (APO-1104)**
  - Rev. A released October 14, 2011
  - Discusses Knowledge Items and Key Themes

Ares KM Process Results

- **Improvement to the Knowledge Mgmt (KM) Process**
  - Being undertaken within CE Office
  - Develop a simplified continuous KC and implementation process
    - Kaizen event held February 22-24, 2011 for the Ares Project & MSFC Chief Engr.
    - Next evolutionary step for existing Lessons Learned Information System (LLIS)
  - Disposition of Ares KI's still needs to be addressed by functional areas

“Key Themes” from Ares

- **Many Knowledge Items (lessons) trace back to the following 10 “Key Themes”:**

1. Leadership and Discipline
2. Plan Ahead
3. Communication
4. Establish Strong CM and DM Functions
5. Design and Analysis Integration
6. Experience
7. End Product
8. Budget and Schedule
9. Training
10. Cautions When Using Heritage Hardware

“Key Themes” from Ares

1. Leadership and Discipline

- Background:
  - Board approval (decision) process for Constellation and Ares perceived as confusing at times.
  - Responsibility and authority were perceived as unclear at times.

- Summary / Recommendations:
  - Make clear description of path / process for decisions and where/how voices are heard
  - Make clear, concise, and well-communicated definitions of responsibility and authority
  - Assign commensurate authority (resources) with responsibility .
  - Decision-maker / authority must be a “benevolent dictator’.
    - Must hear all
    - To be efficient, does NOT have to do all

"Key Themes" from Ares

2. Plan Ahead

- Background:
  - Projects/elements preceded the program … very fast pace for First Stage, Upper Stage Engine, and Ground Systems and Constellation Program took more time to "spool up"
  - Set stage for requirements creep

- Summary / Recommendations:
  - Avoid "ready, fire, aim" and layout the players and process
  - Suggest walk-through of how the program should proceed to the end product(s) and processes (with awareness of constraints)
  - Recommend heavy emphasis on plans
    - Program/Project Plans, Master Schedule
    - SEMP
    - Development Plan
    - Key processes need to be up and running
      - CM & DM
      - Drawing, model standards
      - Engineering release (official data)

"Key Themes" from Ares

3. Communication

- Background:
  - As the volume of formal decisions picked up, the associated communication appeared not to keep pace
  - Also appeared to be some hesitancy on putting out decisions until all discussion was closed
  - There were instances of lacking all the stakeholders on a decision

- Summary / Recommendations:
  - Define what a good decision package consists of and what the basic path is for formal decisions
  - Get all the voices to the table – improve screening can help
  - Continue to promote informal communication to gather - go wide
  - Increase the emphasis to get to a "decisional package" – get to the point
  - All leaders and decisional sponsors know and emphasize the agreed-to decision path – find a traffic cop

"Key Themes" from Ares

4. Establish Strong CM and DM Functions

- Background:
  - The far-reaching effects of CM and DM was underestimated
    - Configuration control and audit capability
    - Data access and control
    - Down to simple formats – quantity can make this much bigger problem

- Summary / Recommendations:
  - Determine critical needs of program and engineering
    - What is a must versus nice-to-have? e.g. Must have capability to know and audit the product structure. What is baseline?
    - Efficiency and rigor – do need rigorous path with all the bells & whistles and an agreed-to work around ("redline") path if needed
  - Establish strong centralized functions for CM and DM
  - They must work within the program, across projects, across other centers, and with all primes

"Key Themes" from Ares

5. Design and Analysis Integration

- Background:
  - Big challenge for large systems, especially in early analysis and development
  - Was often unclear what configuration was being analyzed, or should be analyzed, and what product was needed

- Summary / Recommendations:
  - Build from what we learned on DAC (Design Analysis Cycles) and analysis task tracking
  - Clearly define who is in charge of the system level analysis – roles of integrated system-level versus the component projects or elements
  - Clearly describe how design and integration will work together
    - What (configuration) must be analyzed?
    - By whom? Who is playing?
    - With what output and fidelity at this point in time?
    - By when and for what purpose (feed other analysis, feed milestone)?

"Key Themes" from Ares

6. Experience

- Background:
  - People came from many diverse backgrounds, but relatively few have development background
  - Many from operational systems (e.g. Shuttle, ISS)
  - Others came from industries unrelated to space systems

- Summary / Recommendations:
  - Lack of experience is not a problem in itself, but you have to account for coming up the learning curve
  - Put the most experienced people in critical positions
    - Get the last guy/gal that bumped their head on it – they want to fix it
    - Emphasize and reward teaching/mentoring the next leader(s)
  - Programs/centers - look for opportunities to foster small tasks and R&D to grow new leaders , especially: design, test, manufacturing (fabrication), assembly
    - Component or sub-system level
    - Technology maturation

"Key Themes" from Ares

7. End Product

- Background:
  - The "process" can become the central effort , which can lead to always refining the process … links to experience
  - Symptoms :
    - Bureaucracy … not sure why, but "we have got to do all of these things" or "it's always been done that way"
    - Adding to the process … never quite ready or robust enough … never enough requirements, plans, etc.
    - Not sure of when … everyone needs done now… not every requirement, process, plan, or function needs to be done up front

- Summary / Recommendations:
  - Continue to emphasize getting down to core processes needed to get the job done
  - Re-align focus on next step and end product
    - Re-emphasize what the process needs to do (minimally) – what is good enough?
    - And re-emphasize that good enough and better do to the end product

"Key Themes" from Ares

8. Budget and Schedule

- Background:
  - Budgets will continue to be lean and schedules will be tight
  - There was perception that budget and schedule got de-linked from the work itself
  - Scope changes and annual funding decreases drove numerous activities (what-if scenarios, re-planning) that added work load and appeared to detract form knowing exactly where were with regard to tasks versus budget and schedule

- Summary / Recommendations:
  - Establish clear budget and schedule tools and processes that can work from NASA HQ, through and between centers, and with our primes
  - Help form above …
    - Work with our elected officials to try and establish longer term funding profiles for the big flag ship type efforts

"Key Themes" from Ares

9. Training

- Background:
  - Appeared to be lack of information early enough in the program
    - Specific job skills
    - Data access
    - Security
  - Ties back to experience and planning

- Summary / Recommendations:
  - Emphasize early planning and defining what is needed by when and negotiate with discipline (functional) providers
    - Take time to describe what is needed, e.g. "road show" or "Project X 101"
  - Functional disciplines
    - Define critical skills needed and identify most experienced personnel
    - Develop training needs for those most crucial areas
  - Utilize and improve IT-based training

“Key Themes” from Ares

10. Cautions When Using Heritage Hardware

- Background:
  - We tended to choose “heritage” hardware and then assume more advantage for cost and schedule than may have been practical
  - Integrating heritage hardware into a new architecture arguably consumed a lot of the advertised benefits in cost & schedule

- Summary / Recommendations:
  - Be cautious of “heritage” solutions couple with great expectations of dramatic cost and schedule improvements
  - Emphasize practical assessment of heritage applications
  - Design margins on both older (heritage) hardware and newer systems are driven by performance , reliability, and now cost … leave very little room to accommodate changes in architecture or the issues/baggage packaged within an older design

Wrap Up … "Things we can do"

- **Continue evolution from passive LL to continuous Knowledge Capture and Implementation (chaired by CE)**
- **Work with functional leads to disposition KIs reported in APO-1104**

  If a functional area is not covered (or if Ares recommendations may be argued), let's fall back to fundamentals:

  - Know our key functions and the tools / processes - work on our areas of expertise (disciplines)
    - Identify key / critical / core functions
    - Know all pertinent guidance & requirement
    - Define & develop our best practices
  - Sharpen the tools - act on what we learn, when we learn it
    - Continuous process/produce improvement (CPPI) … day-to-day, grassroots
    - Pause & Learn (PALs) … at task waypoints
    - Knowledge capture / management (KC/KM) or Lessons Learned … at major events
- **Utilize R&D and smaller task as we spool up**
  - Acknowledge the learning curve - people learn by doing
  - Train new leaders