Rocket and Missile Propulsion: Shared Challenges, Shared Solutions

Society of Cost Estimating and Analysis (SCEA)

Greater Alabama Chapter

April Luncheon

Tuesday, April 17, 2012

William P. Ondocsin, P.E.
National Institute for Rocket Propulsion Systems
NASA Marshall Space Flight Center
It Really is Rocket Science
Rockets and Missiles: Critical to our Country
Propulsion in the headlines

Jim Maser, president of Pratt & Whitney Rocketdyne, said United Technologies' announcement was not a surprise. "We've been prepared for today's news," he said. "I've been involved in the process. I don't see the sale making a major impact on our business strategy. I'm optimistic about our future." – Los Angeles Times

Drexel Hamilton analyst Rick Whittington gave a mixed review to the sales. He said "good riddance" to Rocketdyne, which represents the "end of an era" in space travel. – Associated Press

"Without a national space policy, growth will be limited," Chief Financial Officer Greg Hayes told analysts. – Associated Press
State of the Rocket Propulsion Base

• More than 40 industrial base studies and assessments, focused on the challenges facing the propulsion community, have been performed over the past decade.

• Common problematic themes:
  – Budget constraints require acquisition programs to rely on heritage hardware, leading to a lack of development programs to sustain workforce and suppliers
  – Absence of an integrated science and technology plan for launch technologies
  – Difficulty in obtaining access to government facilities

• 2011 GAO report highlights the need for better information and government-wide coordination to support DOD EELV acquisition strategy decisions

• 2012 NRC report on NASA Space Technology Roadmaps and Priorities names “Improved Access to Space” a top technical challenge to all 3 2011 NASA Strategic Plan goals

The Challenges are Known
U.S. Rocket Engine Development History


No Competitive Liquid Rocket Engine Developments in 3 Decades

8/23/2012
# U.S. Propulsion Program Stability

## Aerojet Launch Vehicle Propulsion Programs Over the Last 20 Years

<table>
<thead>
<tr>
<th>Engine Program</th>
<th>Application</th>
<th>Customer</th>
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<tr>
<td>Transtar</td>
<td>Upper Stage</td>
<td>A/F</td>
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<tr>
<td>Uprated OME</td>
<td>Shuttle</td>
<td>NASA</td>
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<td>XLR-132</td>
<td>High Performance Upper Stage</td>
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<td>XLR-134</td>
<td>Cryogenic Upper Stage</td>
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<td>ARRE</td>
<td>Advanced Peroxide Upper Stage</td>
<td>A/F</td>
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<tr>
<td>HOPE-X</td>
<td>Japanese Upper Stage</td>
<td>Japan</td>
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<tr>
<td>Atlas V Solid</td>
<td>Advanced Solid Rocket Booster</td>
<td>L/M</td>
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### Program Maturity
- Preliminary Design
- Component Development
- Demonstration Testing
- Protocal
- Qualification
- Full Scale Development
- Flight
- Production

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We Need A Plan and Commitment to “Stick to It” and Finish What We Start

A Shared Stake in the Industrial Base

• “Maintaining our industrial base and a viable highly skilled workforce is essential to DOD.”
  Brig. Gen. Ole Knudson, PEO Missiles & Space, Army Aviation & Missile Command, Hail to AMC, (12/12/11)

• “Anything that NASA does is important to us in terms of the industrial base. And anything that we do is important to NASA as well.”
  Gregory Schulte, Deputy Assistant Secretary of Defense for Space Policy, The National Journal (7/20/11)

• “As constrained DoD budgets become more strained by higher priority programs, investments in missile research & development and procurement may be more challenged.” Annual Industrial Capabilities Report To Congress, May 2010, DoD report

• “The need to move with clear velocity is imperative if we are to sustain our endangered U.S. space industrial base, to protect our national security, and to retain our positions as the world leader in humans spaceflight and space exploration.”
  Jim Maser, Chairman of Corporate Membership Committee AIAA and President, Pratt & Whitney Rocketdyne. Testimony to Congress (3/30/11)
Collaboration: A National Pursuit

- “Departments and agencies shall improve their partnerships through cooperation, collaboration, information sharing, and/or alignment of common pursuits. Departments and agencies shall make their capabilities and expertise available to each other to strengthen our ability to achieve national goals, identify desired outcomes, leverage U.S. capabilities, and develop implementation and response strategies.”
  National Space Policy  June 28, 2010

- “We seek to foster a U.S. space industrial base that is robust, competitive, flexible, healthy, and delivers reliable space capabilities on time and on budget. DoD and the IC [Intelligence Community], in concert with the civil space sector, will better manage investments across portfolios to ensure the industrial base can sustain those critical technologies and skills that produce the systems we require.”
  National Security Space Strategy (Unclassified Summary) January 2011
Recognizing Sustainment/Industrial Base Issues
SLS: Impacts on the Propulsion Base

• Boosters
  – 5-segment Solid Rocket Booster in-scope modification to existing Ares contract with ATK for initial flights through 2021
  – Advanced Boosters
    • Engineering demonstration and risk reduction via NASA Research Announcement (NRA): Full and Open Competition (FOC) in FY12, with award by FY13 (Industry Day on Dec 15, 2011)
    • DDT&E: FOC, with Request for Proposals (RFP) target in FY15

• Stages
  – Core/Upper Stage: Justification for Other Than Full and Open Competition (JOFOC) to Boeing, modifying current Ares Upper Stage contract
  – Avionics (Instrument Unit): In-scope modification to existing Ares contract with Boeing; consolidated with Stages contract to Boeing

• Engines
  – Core Stage Engine: RS-25 JOFOC to existing Space Shuttle contract with Pratt & Whitney Rocketdyne (PWR)
  – Upper Stage Engine: J-2X in-scope modification to existing Ares contract with PWR

• Spacecraft and Payload Adapter and Fairing
  – Initial design: Payload Adapter and Fairing design/development in-house through Preliminary Design Review (PDR)
  – FOC to begin in FY13

• Advanced Development
  – Broad Agency Announcement (BAA)/NASA Research Announcement (NRA): FOC in FY12
  – Future Core Stage Engine: Separate contract activity in FY12
An Easy Solution?
NIRPS: Capability Sustainment Beyond the Gate

Scope:
- National
- Multi-organizational
- Multi-sector

Purpose:
NIRPS will help preserve and align government and private rocket propulsion capabilities to meet present and future US commercial, civil, and defense needs, while providing insight and recommendations to National decisional authorities.

Tri-faceted approach:
- **Stewardship**: Formulate and recommend National Policy options and strategies that promote a healthy industrial base.
- **Technology**: Identify technology needs and recommend technology insertions.
- **Solutions facilitator**: Maintain relationships and awareness across the Government and industry to align available capacity with emerging demand.

A Jointly Created and Sponsored Institute Providing Coherent Policy Recommendations to National Decision Authorities
All Sectors of the Propulsion Community are Engaged in NIRPS Formulation Efforts
Grand Challenges

Lack of integrated space strategies across Government Agencies and Departments

Frequent program starts & cancellations

Shuttle retirement

Uncertainty in future needs

Industrial base decline

Overcapacity of production capability

Rising supplier costs

Difficulty in access to government facilities

Large solid rocket motor industrial base decline

Lack of multi-Agency vision

Lack of defined space missions

Lack of predictable long-term funding

Aging work force

Lack of sustained technology development

Fewer engineers have technology development experience

Overall decline in aerospace engineer demand

Reduce development & sustainment costs

Collaborate across Agencies

Implement an integrated science & technology plan

Invigorate the STEM pipeline

Foster access to facilities & expertise

Support industrial base competitiveness & resilience

Loss of competitiveness in the global market

Systems infrastructure, supply chain, & skill base challenges

8/23/2012
## Attacking the Issues

<table>
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<tr>
<th>Grand Challenge</th>
<th>Stewardship</th>
<th>Technology</th>
<th>Solutions Facilitator</th>
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<td>Support the competitiveness and resilience of the industrial base</td>
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<td>Invigorate the STEM pipeline</td>
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<td>Develop and implement an integrated science &amp; technology plan for propulsion systems</td>
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<td>Reduce development and sustainment costs for missile and rocket systems</td>
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<td>Collaborate across agencies for missile and rocket propulsion system development</td>
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<tr>
<td>Foster access to facilities and expertise across Government, industry, and academia</td>
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NIRPS will address open needs and coordinate across the domains

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Needs Assessment

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## Accomplishments Since September 2011

### NIRPS Establishment
- Developed “Propulsion Forum & Needs Assmt” matrix to distinguish NIRPS role relative to other forums
- Established NIRPS Strategy Teams with broad membership
- Established NIRPS Planning Team bi-weekly with broad participation
- Established initial NIRPS Web Site
- Developed preliminary concepts for interim governance model

### Partnership Collaboration
- NIRPS Government Meeting Kickoff (Oct)
- Briefed the NIRPS concept with multiple senior officials and general officers within DoD
- Supported AFRL with Fleet Viability Assessment for MMIII (cancelled)
- Supported negotiations with USAF on AUSEP collaboration
- Visits to AF, SMDC, MDA, OSD, etc.

### Propulsion Studies
- Completed assessment for 23 public studies
- Conducting review of 21 restricted access studies
- Completed prelim assessment of SBU industrial base studies
- Drafting paper on historical studies of industrial base
- Supporting Dept. of Commerce Industrial Base Survey
- Supported DoD on Liquid Rocket Engine Industry-base Assessment

### Goals & Strategy
- Identified key concerns of the propulsion community
- Developed Grand Challenges & allocated Primary/Secondary responsibilities to NIRPS Strategy Teams
- Developed draft Strategies to meet Grand Challenges
- Begun further development of Strategies into Objectives – prioritization & metrics in work

### Planning Activities
- Started preparations for support of Defense Authorization 1095
- Stewardship team developing FOMs to assess the health of the Prop Industry Base
- Technology team assessing Agency’s Propulsion Technology Roadmaps in relation to other Agency needs
- Solutions Facilitator team developing strategy for easier access to USG facilities & expertise
- Initiated work on Propulsion EcoSystem

### Forums Supported
- Von Braun Symposium (Oct) – outlined ‘Grand Challenges’
- Space Trans. Policy Workshop at GWU (Nov)
- JANNAF Plenary Session (Dec) – outlined ‘Plan of Attack’
- National Defense Industrial Association (NDIA) (Feb)
- Space Trans. Assoc. Breakfast (Oct)
Many uses – One commodity
Additional NIRPS Value-Added Insight

National Rocket Propulsion Strategy

SLS Advanced Booster Procurement

SLS Advanced Development NRA to NIRPS Grand Challenges

INITIAL CAPABILITY, 2017–21
EVOLED CAPABILITY, Post-2021
Near-term Partnership Opportunities

**Delta IV**
- (Med)
- (Med+ 4m)
- (Med+ 5m)
- (Heavy)

**Atlas V**
- (400 Series)
- (500 Series)

**Space Launch System (SLS)**
- MPCV (with crew)
- Cryogenic Propulsion Stage (CPS)
- Advanced Liquid Booster

**AUSEP Near Term Need**
- 4 m DCSS
- 5 m DCSS

**Domestic Hydrocarbon (RP) Engine Long Term Need**
Rocketry and Reality
Rockets: closer to our lives than we realize