Academic Perspective on Benefits of NIRPS Solutions

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My Background

• 1 Year in Gas Turbine Industry
• Graduate CO-OP with Air Force Rocket Propulsion Laboratory
• PhD Purdue University, 1988
• 3 Years Advanced Diagnostics for Strategic Rocket Testing, AEDC
• 21 Years as Professor at UAH
  – 15 years as Director of Integrated Product Team Initiative
  – 4 years as Propulsion Research Center Director
  – 1 year as Interim Department Chair
  – 8 million in Research, 80 projects
  – 80 Advanced degrees
  – 100 classes
Overview

• **Purpose:**
  – Provide one academic’s perspective on NIRPS and what it can do to benefit universities and the STEP pipeline.

• **Outline:**
  – A) 2010 NIRPS Academic Workshop
  – B) UAH Propulsion Research FY12 Snapshot
  – C) Research Case Studies
  – D) Challenges and Opportunities
A) 2010 NIRPS Academic Workshop
2010 NIRPS Workshop - Current State of Academia

Sponsored and Hosted by The University of Alabama in Huntsville

System Architecture         Fundamental                 Multi-Physics
and Cost                     Processes                      Modeling

- OPTIMIZER
- OBJECTIVE FUNCTION
  - AERODYNAMICS
  - PROPULSION
  - MASS PROPERTIES
  - CONFLICTS
  - GUIDANCE & CONTROL
  - SIX DOF

- NEA
  - NASA's Opportunity in 2004
  - Depot-site Not on Mission
  - Critical Path
  - NEA Mission Duration 350 days

- Time-averaged streamlines
- 3-D
- 2D Slice of 3-D

- AL2O3
- Char
2010 NIRPS Workshop - Effective NASA/University Programs
(Bob Santoro)

- Continuity over the graduate student’s degree program (minimum 3 years).
- Do not tie academic research programs to current development programs.
  - Makes them compete for resources with mission critical elements.
  - Do not put their milestones in a critical path as research progress can not be scheduled.
- University research overall must be relevant to NASA near and long-term program goals
General Comments - 2010 NIRPS Workshop

• Need a compelling mission
• Insure a proper mix of DoD and NASA Research
• Insure proper industry buy in for university research work (transition research and students into industry; understand pull)
• Provide means for integrating government, industry, and academic researchers and engineers
  – NASA CUIP Program was a Model for Healthy Government/University Interactions
  – French-German collaborations on high pressure HO systems and combustion instability are sustainable and productive
• Invest in High Risk High Payoff Technology in Foundational Research Now (i.e. Combustion Instability/Crosscutting Disciplines/Life Prediction)
• Affordability/Demand is Critical to the Future (NASA Cost Models do not Include University Research)
• Focus on most difficult problems that require collaboration between multiple disciplines (but do not eliminate individual researcher contributions)
B) UAH Propulsion Research FY12 Snapshot
UAH Propulsion Research Center

PRC connects the Academic Research Community with Industry & Government to advance basic science and technology development related to propulsion and energy.

Program Technology

Education

Fundamental Research

PRC Focuses on Creating Overlap Among Competing Goals
UAHuntsville Propulsion Research Center

Mission
PRC connects the Academic Research Community with Industry & Government to advance basic science and technology development related to propulsion and energy.

PRC Strategic Vision 2015
The PRC will be a major generator of talent and innovative solutions in propulsion and energy related technologies.
MAE Faculty/Administration

UAH Department of Mechanical and Aerospace Engineering

Not Shown: 5 staff, 13 part-time instructors, Over 900 students, 143 degrees/yr. (Department)

MAE Faculty

MAE Lecturers

Emeritus Faculty
PRC Core Competencies

- **Aerospace System Design**
  Systems Requirements
  Technology/Assessment Integration
  System Modeling/Evaluation

- **Liquid Propulsion**
  Integrated Methodology
  Combustion Efficiency/Instability
  Laboratory-Scale Rocket Engine
  Advanced Diagnostics

- **Solid Propulsion**
  Propellant Formulation
  Burn Rate Determination
  Motor Testing

- **Advanced Propulsion**
  Plasma Modeling
  Fusion Propulsion
  Solar Propulsion

- **Numerical Analysis**
  Sprays
  Acoustics
  Reacting Flows
Approximately 15,000 ft² of Laboratory Space

- Air-breathing Test Cell
- Hot-Fire Rocket Test Cell
- Thermal Stability Test Lab
- Solar Thermal Lab (not shown)
- High-Pressure Solid Propellant Lab (not shown)
- Electric Propulsion Lab
- Gaseous Cold Flow Lab
- Water Tunnel Flow Lab
- Vacuum Chamber Test Lab
FY12 PRC NUMBERS

FINANCIALS
• $2.3 Million Expenditures
• 25 Active Res. Accounts
• Top 5 Projects
  – 80% of Funds, Average $370K
  – AMRDEC, MDA, Craft Tec, NSF, State of Alabama
• Bottom 20 Projects
  – 20% of Funds, Average $23K
  – SBIRS, Company, DoE, etc.
• $210K State Support

Other
• Recognized as 3rd Most Awesome Laboratory in Nation by Popular Science
• Supported 12 Full Time Graduate Students
• Assisted 40 Graduate Students
• Published 12 Articles
• Participated in 7 Professional Societies
• Hosted NASA USLI Team
EXAMPLE CENTER FUNDING PROFILE FY10

PRC Sponsored Research Expenditures

TOTAL EXPENDITURES

$1,500,000
$1,400,000
$1,300,000
$1,200,000
$1,100,000
$1,000,000
$900,000
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$0

Sponsored Research Expenditures YTD
$1.0 Million Annual Projection
FY2010 Authorized Budget
$1.29 Million Annual Projection

UAHuntsville
The University of Alabama in Huntsville
C) Research Case Studies

Show Relationship Among Agencies
Advantages/Disadvantages
1980’s – Air Force/University
Solid Propellant Development

- Fundamental Research
- University Based
- Multi-Year
- Annual Contractor Meetings
- Research Coordinated with Air Force Rocket Propulsion Laboratory
- 8 years
1990’s – Company Research IRAD
Hybrid Propulsion

- Fundamental Research
- University Based
- Multi-Year
- Student Focused
- Annual Meetings
- Research Coordinated with In House Technology Projects and MSFC Tech. Projects
1990’s – ONR MURI
Novel Energetic Materials
Office of Naval Research, Multi-University Research Initiative

- Fundamental Research
- University-Assembled and Lead Teams
- Multi-Year
- Student Focused
- Annual Meetings
- Research Coordinated Among Universities
- 3 years
1990’s System Concept Study- STEM

- Advanced System Concepts
- Multi-Disciplinary Sr. Design Projects – Classroom Focused
- International University
- STEM Outreach
- External Reviews
- Annual Funding – 20 Years

2000’s Example Class - Adv. Solid Rocket Propulsion
Developed by Robert Geisler and Dr. Robert Frederick, Jr.
ITAR Cleared, UAH Graduate Course, UAH Professional Development Course, and AIAA Short Course

14 Industry Speakers
Multi-Year (Recorded)
2000’s – UAH NASA REAP
Combustion Instability and Thrust Chamber Cooling

- Applied Research
- Host University Manage Subcontracts
- University Based
- Multi-Year
- Student Focused
- Research Associated with In House Technology Issues
- 3 years
2000’s – NASA CUIP
Constellation University Institutes Project

- University Based
- Applied Research
- Multi-Disciplinary
- Host University
- Manage Subcontracts
- Multi-Year Efforts
- Agency Technical Mentors
- Student Focused
- Annual Evaluations
- Over 7 years
2000 - Nationally Recognized Student Launch Initiative
National First-Place Design-Fab.-Build – R. Frederick, UAH Faculty Advisor

• Basic Funds From Space Grant
• PRC Provides Laboratory/Safety
• VP Res. Augments Funding
• National Student Competition
• Annual Bids
2010’s – MDA MSTAR
Missile Defense Agency, Science and Technology Advanced Research (MSTAR) 
”Innovative Propulsion Technology Support”

- Applied Research
- University-Assembled/Lead Team
- 1-3 year Contract
- Weekly Meetings, Monthly Reports, Quarterly TIM’s, Annual Reports
- Faculty PI’s
- Graduate Students
- Security Clearances, ITAR
- Multi-Party Non-Disclosure Agreements with Propulsion Companies and Small Businesses
D) Challenges and Opportunities
Program Orientation
Multi-Disciplinary

- Aerodynamics
- Structures
- Propulsion
- Production
- Seeker
- Guidance and Control
- Warhead – Fuze
Example – UAH Integrated Methodology

System Engineering

Cold-Flow Spray Facility

Low-Pressure Combustion Stability

High-Pressure Combustion Performance

Modeling and Verification

New Component Technology

Digital Database
Multi-Year Funding
Programmatic Challenges

Why the Neanderthals Became Extinct

I don't know. It seemed easier when we just went hunting.

Yes, but Og assures me that this will improve our efficiency and keep us ahead of those Cro-Magnons in the valley.
UAH Propulsion Research Center

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PRC Focuses on Creating Overlap Among Competing Goals
Summary Thoughts – NIRPS University Strategies

• Relevance to Agency Needs
• Commitment to Basic Research
• Multi-Year University Programs
  – Carefully Contracted Umbrella Admin.
  – Technical Mentorship
  – Technical Review and Deliverables
  – Special Care on ITAR, Proprietary, Safety, and other Sensitive Information
  – Leverage the Professor’s Assets
• CUIP is Model Program to Consider