NASA/DoD UAPT PROGRAM OVERVIEW

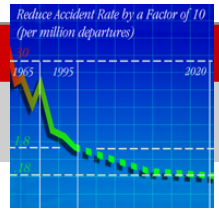
URETI on Aeropropulsion and Power Technology
Sponsored by NASA and DoD

Performed at
Georgia Institute of Technology
Ohio State University
Florida A & M

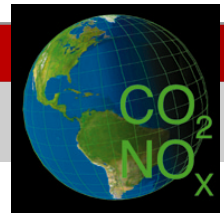
Ben T. Zinn (UAPT Director)
Dimitri N. Mavris (UAPT Co-Director)
School of Aerospace Engineering

Program Kickoff Meeting
Georgia Tech
October 25, 2002

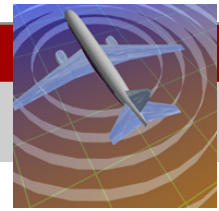
Revolutionize Aviation



Increase Safety



Reduce Emissions

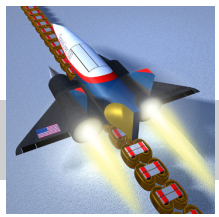


Reduce Noise

Increase Capacity

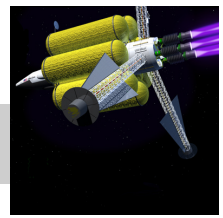
Increase Mobility

Advance Space Transportation

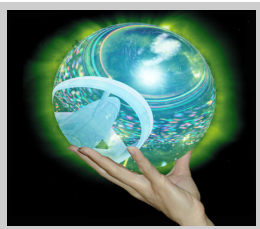


Mission Safety

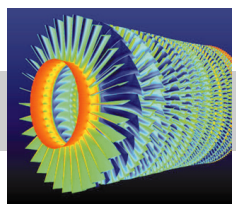
Mission Affordability



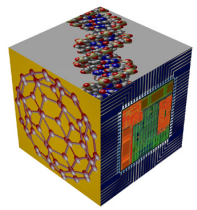
Mission Reach



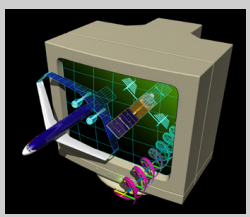
Pioneer Technology Innovation



Engineering Innovation



Technology Innovation



Commercialize Technology

Enterprise Goals & Objectives

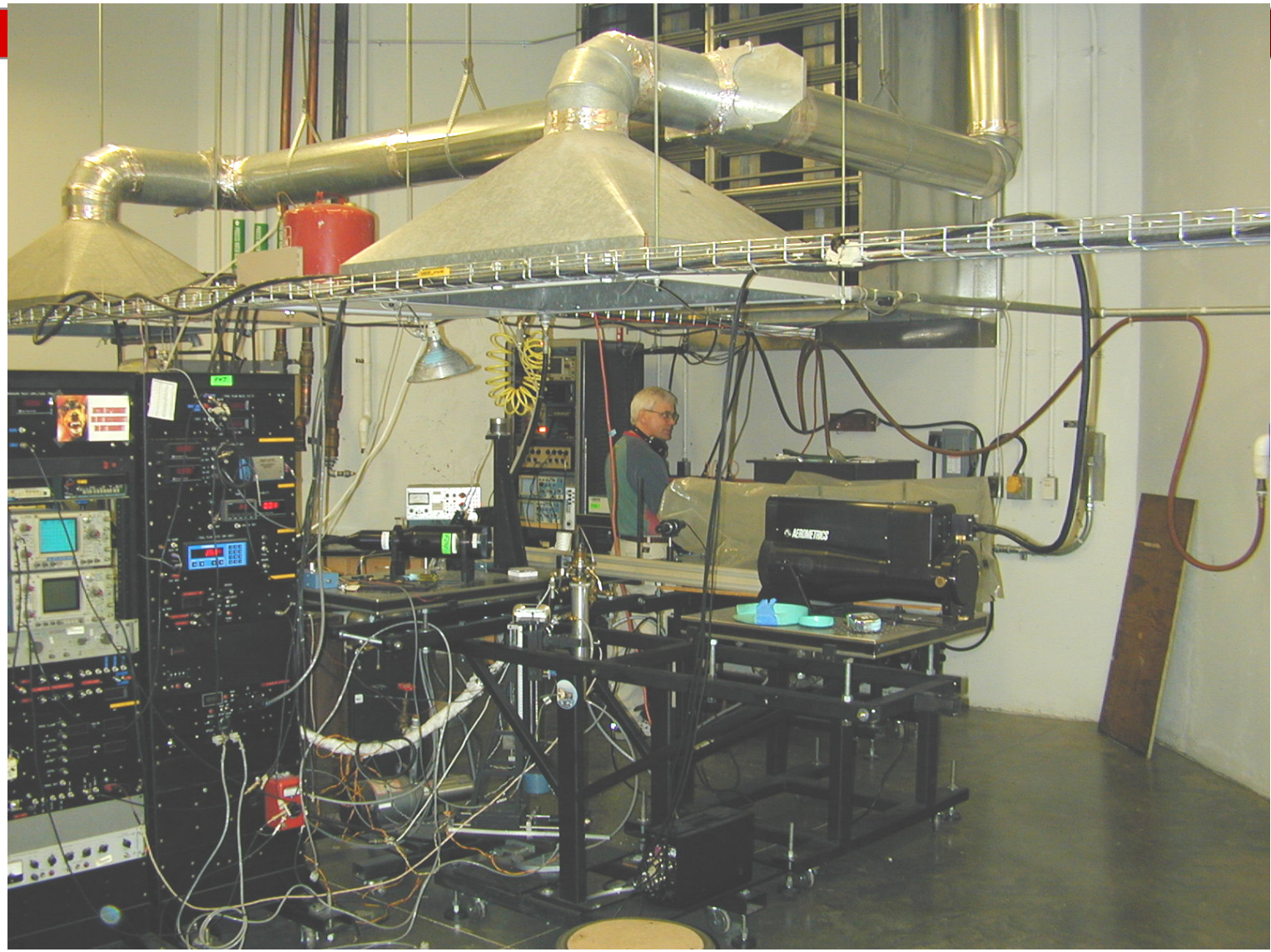
Reasons for Forming the Ga. Tech, Ohio State and Florida A&M Alliance

- **Research faculty/staff:** Posseses complimentary, world class, reputation in areas relevant to UAPT
  - Ga. Tech: Intelligent engine components, combustion, CFD/LES, compressors, MEMS sensors, Nanotechnology, Fuel Cells, Aerospace Systems Design and Integration
  - Ohio State: Materials and Turbomachinery
  - Florida A&M: Power Technologies
- **World Class Facilities**: e.g., Ga. Tech's combustion lab., OSU's Shock Tunnel, Florida A&M's Center for Advanced Power and National Magnet lab.
- **Management:** Needed research capabilities are "concentrated" within a relatively small number of universities – much easier to manage!
- **Locations:** All three universities are relatively close to GRC/DoD facilities and one another → encourages collaboration between participating universities and with NASA/DoD personnel

UAPT Research Team

Name	School	Dept.	Research Area
Jean-Lou Chameau	GT	Provost	Senior Research Officer
Ben T. Zinn	GT	AE/ME	Intelligent Engine Systems/Comb.
Dimitri Mavris	GT	AE	Systems Analysis & Tech. Integration
James Williams	OSU	Dean	Enabling Technologies/Materials
Cesar Luongo	FAMU	ME	Advanced Power Technology
Maurice G. Adams	CWRU	ME	Materials
Krish Ahuja	GT	GTRI	Engine Noise Control
Mark G. Allen	GT	ECE	Wireless MEMS Sensors
Mike Dunn	OSU	AE	Engine Turbo machinery
Somnath Ghosh	OSU	ME	Materials
Ari Glezer	GT	ME	Gas Dynamics/Actuators/Flow Control
Jeff Jagoda	GT	AE	Combustion/Educational Program
Meilin Liu	GT	MSE	Fuel Cells
Suresh Menon	GT	AE	Large Eddy Simulations
Michael J. Mills	OSU	MSE	Materials
Yedidia Neumeier	GT	AE	Intelligent Combustors & Compressors
J.V.R. Prasad	GT	AE	Intelligent Engine Systems/Comp.
Lakshmi Sankar	GT	AE	Compressor CFD
Jerry Seitzman	GT	AE	Intelligent Comb./Nano Fuel Additives
Jimmy Tai	GT	AE	Systems Analysis & Tech. Integration
Zhong Lin Wang	GT	MSE	Nanotechnology

Georgia Tech's New Propulsion/Combustion Laboratory - 18,000 ft^2, $7M Plus Facility



One of Ga. Tech's Laboratories for Active Control of Combustion Instabilities

OSU's Large Shock Tunnel Facility

Some FAMU Facilities

FAMU's National High Magnetic Field Laboratory

CAPS-Center for Advanced Power Systems

NASA/DoD UAPT Vision

- To develop ***revolutionary technologies and design methods, in a systems-oriented integration environment***

- To ***enable NASA and industry to close technology gaps*** that prevent deployment of high performance, intelligent, safe and environmentally compatible systems

- To implement ***integrated and multidisciplinary education programs*** that will prepare future graduates and NASA/industry engineers to develop the revolutionary engine systems that will be needed ***to ensure pre-eminence of the U.S. aerospace industry***

NASA/DoD UAPT General Technical Approach

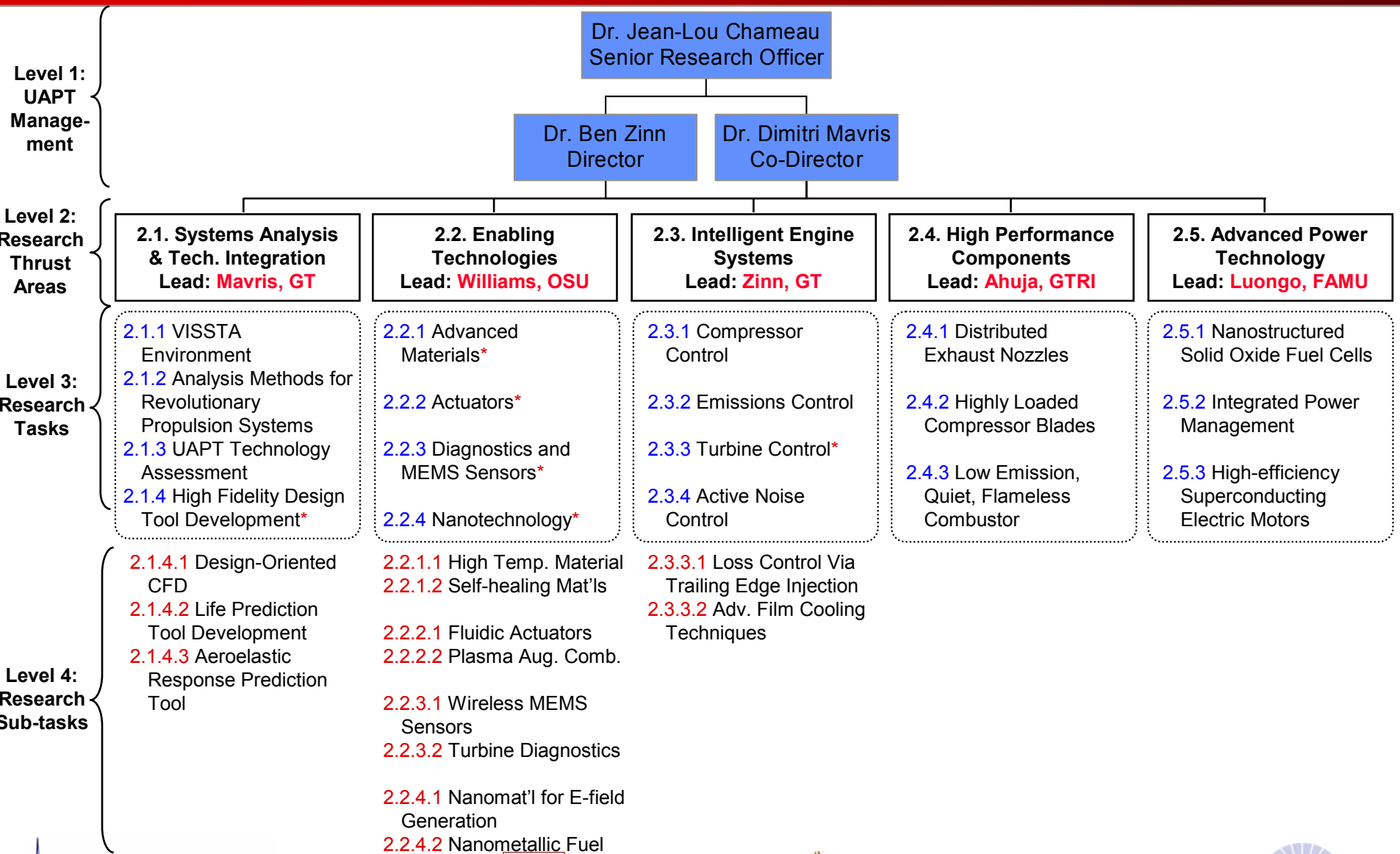
- **Investigate a wide range of innovative propulsion and power technologies that will enable NASA/DoD/industry to produce systems that –**
  - Meet highly restrictive environmental (emission and noise) regulations
  - Burn less fuel and reduce global warming
  - Improve safety beyond current levels
  - Possess lower acquisition and operating costs

- **Apply the expertise and capabilities of the UAPT resources to –**
  - Establish, enhance, and exploit advances in critical technologies
  - Use an integrated approach to develop revolutionary engine components and systems

NASA/DoD UAPT Educational Vision

- **An integrated, multidisciplinary, education programs to prepare future graduates, NASA engineers, and industry engineers to handle the challenges associated with the development of revolutionary propulsion systems via –**
  - Introduce future engineers to advanced air-breathing propulsion systems and related disciplines at the **undergraduate** and **graduate** levels
  - Provide **continuing education** for government and industry engineers
  - **Improve existing propulsion and power educational programs** by involving **government and industry personnel** in teaching activities through **classroom, seminar, and research participation**, as well as providing opportunities for **students to intern** at NASA GRC, DoD laboratories and engine companies.

NASA/DoD UAPT Research Tasks Organization



NASA/DoD UAPT Propulsion Technology Taxonomy

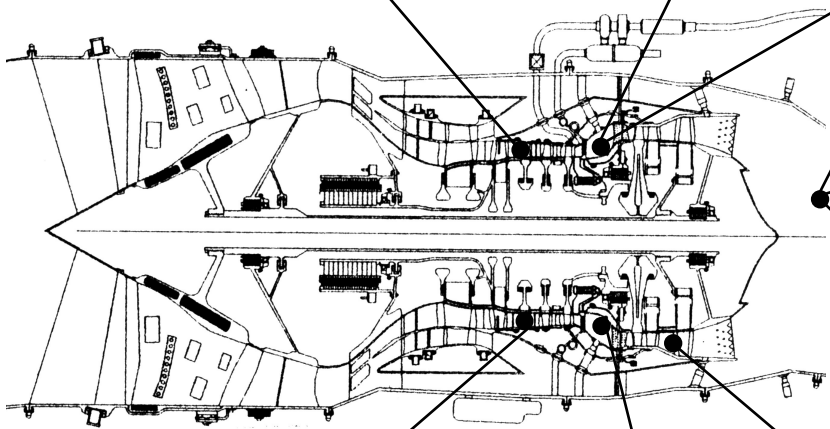
2.1.1 VISSTA Environment
2.1.2 Analysis Methods for Revolutionary Propulsion Systems
2.1.3 UAPT Technology System Assessment
2.1.4 High Fidelity Design Tool Development

2.4.2 Highly Loaded Compressor Blades

2.3.2 Emissions Control

2.2.2 Actuators

2.2.1 Advanced Materials
2.2.4 Nanotechnology
2.2.3 Diagnostics and MEMS Sensors



2.3.4 Active Noise Control

2.4.1 Distributed Exhaust Nozzles

2.5.1 Nanostructured Solid Oxide Fuel Cells
2.5.2 Integrated Power Management
2.5.3 High-efficiency Superconducting Electric Motors

2.3.3 Turbine Control

2.3.1 Compressor Control

2.4.3 Low Emission, Quiet, Flameless Combustor

NASA/DoD UAPT Multidisciplinary Research Strategy

Advancing Science, Engineering, & Technology

Active Compressor Control	Fuel Cells
Active Emissions Control	Nano Fuel Additives
Active Turbine Pressure Loss Control	Thermal Barrier Coatings
Advanced Turbine Film Cooling	Co-Continuous Composites
Active Noise Control	High Temperature Materials
Distributed Exhaust Nozzles to Reduce Noise	Combustion Driven Actuators
Compressor CFD	Plasma Augmented Combustion
Flameless Combustion	Passive, Wireless MEMS Sensors
Wireless MEMS Sensors	Refractory Inter-Metallic Composites
Nano Sensors	Self Healing Turbine Blade Tip Materials
	Turbulence and Hot Streaks Diagnostics

LEADS: GIT, OSU, FAMU

System Level Engineering, Analysis, & Technology Integration

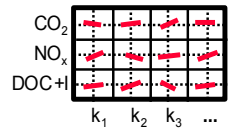
VISSTA

LEAD: GIT-ASDL

Numerical Propulsion System Simulation (NPSS)

Aircraft Synthesis & Sizing: FLight OPtimization System (FLOPS)
Aircraft Life Cycle Cost (ALCCA)

Technology Impact Forecast Environment



Design Tool Development

- Uncertainty Analysis
- Reliability Based Design
- Design-Oriented CFD
- Life Prediction
- Probabilistic Analysis for Predicting Failure

NASA Goals

Goal 1: Revolutionize Aviation
Reduce Accident Rate 10X
Reduce Emissions 80%
Reduce Noise 4X
Triple System Capacity
Decrease Door to Door Time 2/3

Goal 2: Advanced Space Transp.
Mission Safety
Mission Affordability
Mission Reach

Goal 3: Pioneer Tech Innov.
Engineering Innovation
Technology Innovation

Goal 4: Commercialized Tech.

Fulfill NASA Goals & Objectives

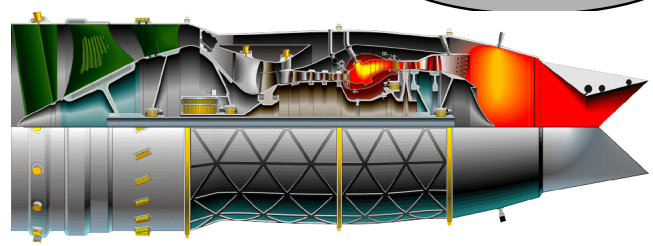
Aircraft Level Integration

LEAD: GIT-ASDL

Revolutionary and Innovative Aeropropulsion Concepts

Hybrid, Electric, TBCC, Distributed Power, Novel Power Architecture

LEADS: GIT, OSU, FAMU



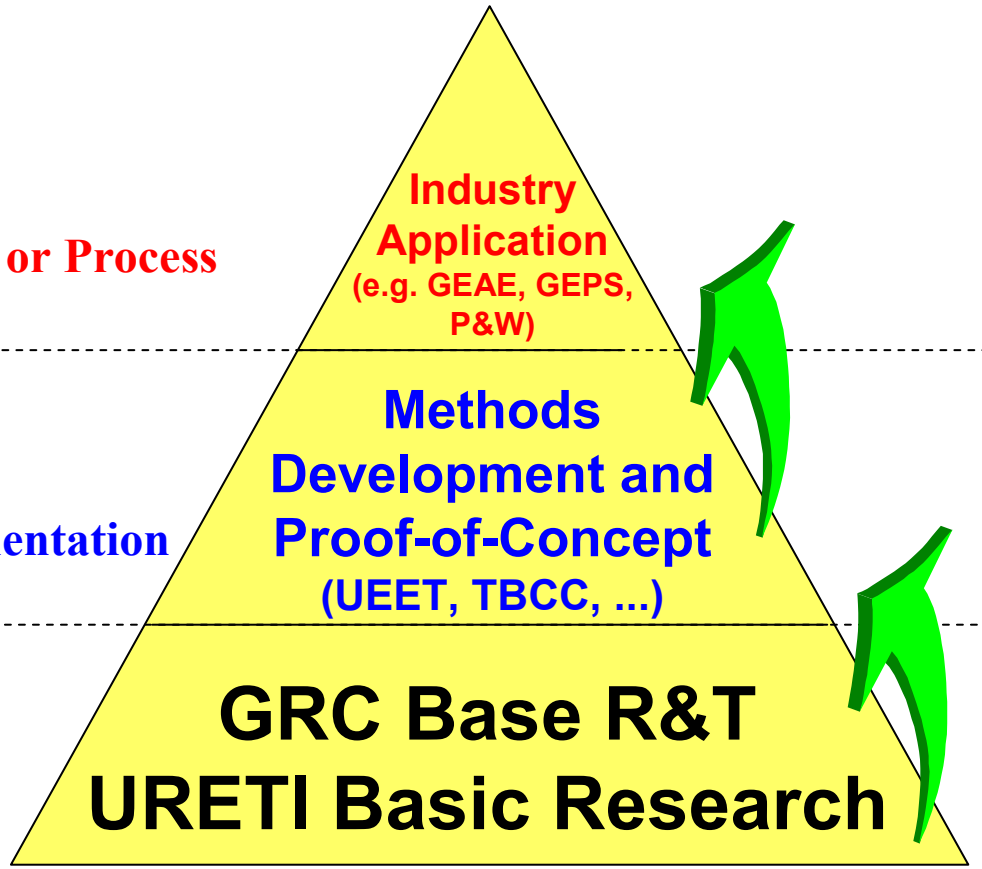
Georgia Institute of Technology | The Ohio State University | FAMU Florida A&M University | CWRU

Transition Pyramid for NASA/DoD UAPT Research

- Full System Prototype
- Applied to Actual System or Process

- Application Formulation
- Verification
- Proof-of-Concept Implementation

- Basic Principles
- Analytical Formulation
- Initial Testing



TRL 7-9

TRL 4-6

TRL 1-3

November 18, 2002 URETI GRC Meeting Goals

- Present the UAPT research and educational programs to NASA/DoD personnel
- Develop a frame work for future collaboration between the UAPT and NASA/DoD research programs
- Obtain feedback from NASA/DoD personnel about UAPT's research and educational activities
- Discuss meetings/communications between NASA/DoD and UAPT personnel
- ???

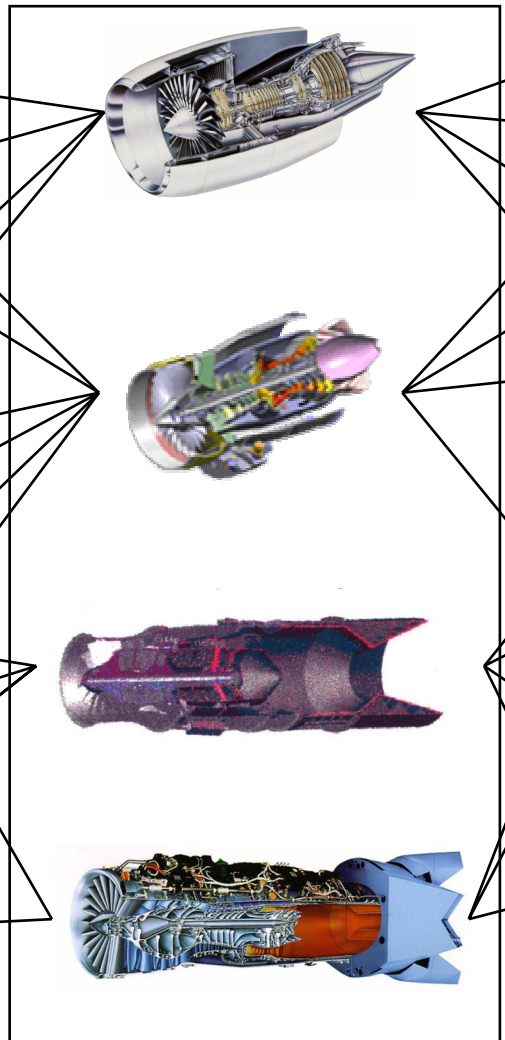
UAPT Management

- Manager of each thrust area manages his/her projects
- Regular interactions between UAPT directors, thrust area managers and individual project leaders
- Bi-annual review meetings of UAPT program (one as part of the NASA/DoD review meeting)
- Annual program review meeting with NASA/DoD and UAPT Advisory Board
- Quarterly reports from each research activity
- Special meetings, tele- and video conferences between collaborating teams in a given area on as needed basis
- Monthly research meetings on the Ga. Tech campus (modeled after our MURI on Intelligent Turbine Engines)

Virtual System Integration & Evaluation

Vehicle Concepts

Propulsion Concepts



Virtual Integrated Stochastic System and Technology Assessment Environment

Technology Identification, Evaluation, and Selection Methods

Technology Concepts

- Active Compressor Control
- Active Emissions Control
- Active Turbine Pressure Loss Control
- Advanced Turbine Film Cooling
- Active Noise Control
- Distributed Exhaust Nozzles to Reduce Noise
- Compressor CFD
- Flameless Combustion
- Wireless MEMS Sensors
- Self Healing Turbine Blade Tip Materials
- Fuel Cells
- High Temperature Materials
- Thermal Barrier Coatings
- Refractory Inter-Metallic Composites
- Co-Continuous Composites
- Combustion Driven Actuators
- Plasma Augmented Combustion
- Passive, Wireless MEMS Sensors
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- Nano Fuel Additives
- Turbulence and Hot Streaks Diagnostics