Annual Report

Fiscal Year 2006

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Submitted by PPSA Leadership Team

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INTRODUCTION/OVERVIEW

Vision

The primary goal of the Department of Defense (DOD), Department of Energy (DOE), Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), and Propulsion and Power Systems Alliance (PPSA) is to:

"Improve propulsion and power systems technology program coordination and collaboration among government agencies, e.g., DOD, DOE, FAA and NASA – leading to a greater national alliance/reliance among the program participants and, therefore, stakeholders resulting in more effective leveraging of existing federal investments in aerospace propulsion and power research and technology."

As the vision statement indicates, PPSA is a Federal government agency centered activity. However, PPSA does openly encourage industry and university participation on a case-by-case basis where the non-government partner's contribution would be critical to the success of a specific collaborative effort.

Collaboration Model

The collaboration model being utilized by PPSA is shown in figure 1.

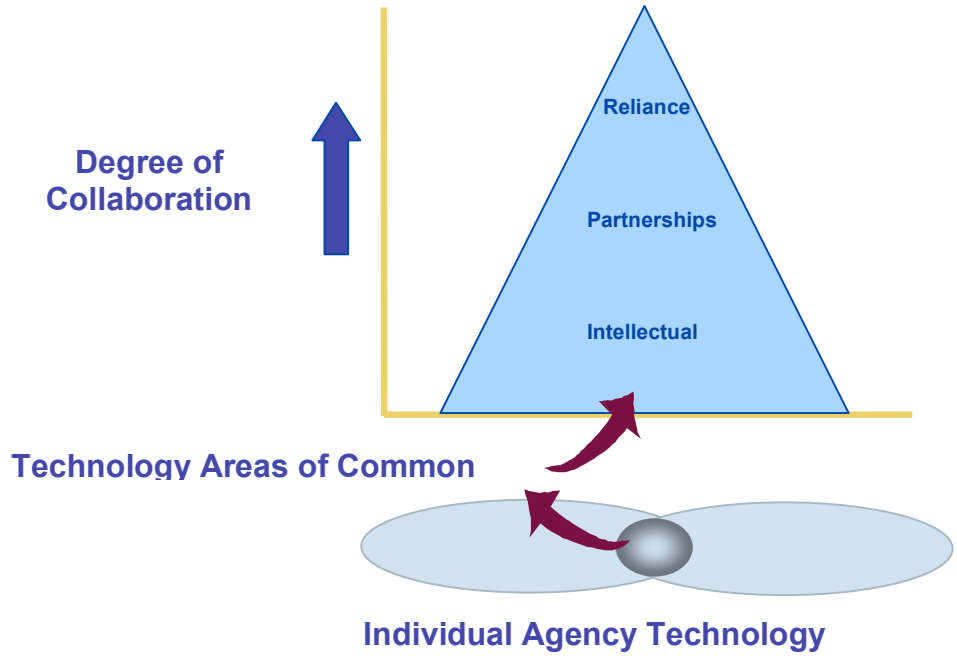

Figure 1. PPSA Collaboration Model

Intellectual collaboration is the basis upon which PPSA is formed and managed. PPSA provides opportunities for government researchers in common areas of interest to regularly meet and exchange information on current research efforts. These interchanges form the basis to explore and plan more formal collaborations designated, as partnerships where common objectives are defined, available resources from each partner are committed, and roles and responsibilities are defined along with appropriate intellectual property agreements.

Partnerships are a shared risk, shared reward effort. Opportunities will occasionally be determined where one agency could chose not to pursue a required technology area as it is being developed by another agency (or agencies). These relationships are defined to be dependencies. Obviously, the higher up one goes in the collaboration triangle the greater degree of trust which must exist.

Organizational Structure of PPSA

The current organizational structure of PPSA is shown in figure 2.

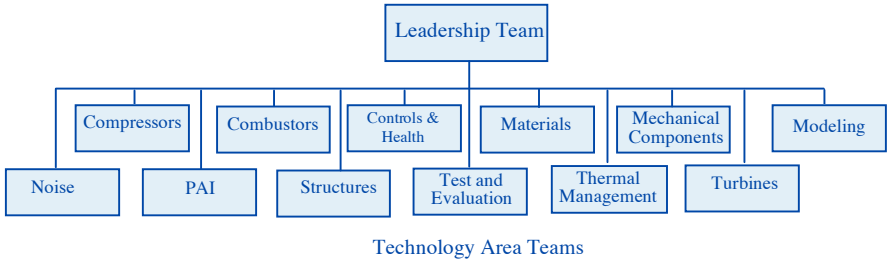

Figure 2. Current PPSA Structure

The Leadership Team (LT) is comprised of senior managers from the member government agencies. The roles and responsibilities of the LT include providing the necessary senior leadership and direction to ensure that PPSA achieves its vision. The LT is led by a chairperson selected from the current LT membership. The chairperson normally serves a two-year term.

The PPSA currently has twelve Technology Area Teams (TATs), which are comprised of technologists and project managers from the member organizations. The TATs are critical to the success of PPSA as they identify, plan, and execute specific collaborative efforts. Currently, PPSA TATs are:

Combustors
Compressors
Controls & Health Management
Materials
Mechanical Components
Modeling and Simulation
Noise
Propulsion/Airframe Integration
Structures
Test and Evaluation
Thermal Management
Turbines

As the listing of TATs indicates, the current emphasis in PPSA is on technologies that are required for future turbine based propulsion systems across the speed range (subsonic through hypersonic) as well as for future ground power systems which incorporate turbine systems.

The number of TATs can change from time to time as new areas are identified that seem opportune for collaborative opportunities or areas are de-emphasized and no longer appropriate for collaboration.

Business Practices

The current business practices of the PPSA are as follows:

Annual Meeting: Each year the PPSA LT plans and executes a multiple day meeting that provides an opportunity for the individual TATs to meet and conduct business as well as meet with other TATs where cross functional collaboration opportunities can be explored. Each TAT is also asked to report out to the LT emphasizing the topics of status, opportunities, and issues for that particular TAT. At these meetings, the LT invites external organizations, which might have collaboration opportunities, to present appropriate overviews in a plenary session. In addition, the LT invites speakers to present featured presentations on various aspects of the collaboration process. This annual meeting also provides an opportunity for the LT to have closed sessions to devote to overall PPSA business.

Monthly telecons: Each month the LT has a one to two hour telecon to discuss appropriate PPSA business as well as hear an update from selected TATs. A schedule for these telecons is developed by the Executive Secretary such that each of the TATs has one session with the LT each quarter. It is felt that these brief but regular interactions have improved communication between the LT and TATs and improved the collaborative activities being conducted by PPSA.

LT mid year meeting: Each February, the LT conducts a one half day closed session to conduct appropriate business. Typically this meeting is planned to occur the day before the DOD VAATE Steering Committee meeting in Washington, DC.

Web site: PPSA has an operational publicly available web site: **https://ppsa.grc.nasa.gov**.
The website is used to communicate the PPSA story to external individuals and organizations as well as provide opportunities for organizations to recommend collaboration opportunities to PPSA.

Annual report: Each year the PPSA writes an overview report on status and accomplishments of PPSA. This is a publicly available report but is primarily intended for key stakeholders.

Metrics: The impact of PPSA (in terms of adding value to the technology development and insertion processes) should be measured and assessed using appropriate metrics. The metrics being employed are of two types - activity and accomplishment. As the title suggests, *activity metrics* are those which count PPSA sponsored and supported activities which should foster opportunities for collaboration. *Accomplishment metrics* measure the critical efforts that contribute to the prime outcomes or products of the various activities sponsored by PPSA. Currently, the PPSA metrics are:

Activity Metrics
- Technology exchange meetings held
- Technology exchange telecons conducted
- Invited technology exchange presentations
- Intra government working groups established

Accomplishment Metrics
- Formal collaboration agreements established
- Partnership efforts initiated to jointly develop/demonstrate selected technologies
- Reliance agreements established
- Partnership efforts successfully completed
- Partnership agreements terminated

OVERVIEW OF RECENT ACCOMPLISHMENTS

PPSA did not publish an annual report in Fiscal Year 2004 or 2005. This report will cover the period of FY2004-2006.

Leadership Team

1. Developed a collaborative relationship with the Interagency Advance Power Group (IAPG) to ensure that needed collaborations are developed related to turbine engine based power systems and to avoid duplication of effort.
2. Supported development and signing of formal agreement between NASA and FAA regarding NASA participation in and support for FAA/NASA/Transport Canada Center of Excellence on Noise and Emissions.
3. Reviewed and updated all PPSA business practices to improve organization's efficiency and activities so as to lead to improved future products.
4. Developed an operational web site to serve as an education/outreach tool for PPSA and a knowledge management tool for the members of PPSA.
5. Compiled a comprehensive list of Small Business Innovative Research (SBIR) contracts currently being funded by the member agencies, which will be used by the TATs to explore possible collaborative opportunities.
6. Supported development of the Navy/Air Force/NASA collaborative effort on Revolutionary Approach to Time Critical Long range Strike (RATTLRS), a high-speed flight demonstration of a turbine based propulsion system.
7. Planned and conducted a PPSA annual meeting which includes speakers from government funded, university based research activities that are relevant to the PPSA charter and could provide opportunities for collaboration.

Combustors TAT

1. Supported NETL led efforts to develop collaborative program on combustion simulation.
2. Completed diagnostics oriented tests of trapped vortex combustor tests at NETL (NETL/Air Force) that led to NETL decision to upgrade diagnostic capability in test facility.
3. Completed particulate matter testing on T-700 (NASA/DOD)
4. Completed initial information sharing on fuel injection, spray properties for fuel reforming (NASA/NETL).

Compressors TAT

1. Completed T700 Stall Avoidance test with Fuel Flow Control (Georgia Tech/NASA/Army).
2. Completed T700 Stall Margin Enhancement test with Air Flow Injection (Flow Control) (Army/NASA).
3. Completed initial development of damping technologies to reduce High Cycle Fatigue (HCF) impact on turbine engines (Army/Air Force/SBIR contractor).
4. Completed investigation of Navy/NASA casing flow control/recirculation for fan stability enhancement of UCAV engine (Navy/Army).
5. Supported SBIR Phase II effort on flow control (NASA/Air Force/SBIR contractor).
6. Initiated effort to model inlet/fan distortion transfer (Navy/Air Force/industry).
7. Investigated performance-limiting flow processes in highly loaded, high Mach number (HLHM) compressors (NASA/Air Force/academia).

8. Initiated development of collaboration roadmap for high stage loading technology development (Air Force/NASA/Army).
9. Initiated development of damping technologies to reduce high cycle fatigue (Army/Air Force/SBIR contractor).

Controls and Health Management TAT

1. Supported Engine Health Management Industry Review (EHMIR) and collaborative planning effort, and other information exchange in the field of model based performance diagnostics. (Army/NASA/Navy/Air Force)
2. Supported NASA planning and proposal reviews for IVHM and IRAC programs. (NASA/NAVY/USAF)
3. Consulted and supported planning for Propulsion Safety and Affordable Readiness (PSAR) initiative, addressing both controls and prognostic health management. First PSAR Conference drew broad participation. (USAF/NAVY/Army/Industry)
4. Continued informal intra-governmental collaboration (including informal dependence) on model predictive control application to advanced propulsion control. (USAF/Navy/industry)
5. Completed collaborative data gathering during NAVSEA LM2500 stall/surge testing. (NAVY/USAF/industry /universities)
6. Coordinated participation and presentations at technical society conferences (ASME/IGTI Turbo Expo, IEEE Aerospace Conference, Joint Propulsion Conference). (NASA/Navy/Air Force/industry)
7. Coordinated development of variable displacement vane pump technology continues. (Air Force/Navy)
8. Coordinated development of model based "power meter" and engine health management for H-60/T700 application initiated. (Army/Navy)
9. Continued broad collaboration in RATTLRS flight demonstration program including inter-service/agency teamwork in managing design & development of advanced integrated propulsion flow path, power and flight controls. (Navy/Air Force/NASA)
10. Continued informal coordination of SBIR planning, solicitations and program evaluations, including joint proposal reviews. (Navy/Air Force/NASA]
11. Completed initial joint explorations of future directions for autonomous propulsion management and advanced control architectures/capabilities. (Navy/USAF/NASA)
12. Continued information sharing and cooperation in planning control and diagnostic sensor developments for test instrumentation (including Propulsion Instrumentation Working Group), ground support equipment, airborne diagnostics and control. (NASA/Air Force/Navy/Army)

Materials TAT

1. Initiated research on NbSi and Ni turbine blade alloys, coatings (Air Force/NASA).
2. Initiated jointly funded research on advanced turbine disk alloy and dual microstructure heat treatments (Air Force/NASA).
3. Conducted extensive Integrated High Performance Rocket technologies (IHPRPT) interactions focused on CMC and copper rocket engine materials (Air Force/NASA).
4. Transferred NASA developed ceramic fiber treatment to industry via Space Act Agreements and Air Force funding.

Mechanical Components TAT

1. Re-invigorated TAT established with full representation from all DOD departments and NASA.
2. Transferred Navy technology on grease lubricated gears to NASA helped in resolving Shuttle actuators issue. (Navy/NASA)

3. Initiated coatings research for foil bearing collaboration for small engines. (NASA)
4. Exchanged existing gear superfinish technology to avoid duplication of efforts. (NASA/Army/Navy)

Modeling and Simulation TAT

1. Signed Space Act Agreement to develop virtual engine test cell. (NASA/Air Force/ AVETeC)
2. Developed NPSS Engine military engine turbofan library. (NASA/ Air Force/ U of Cincinnati/ U of Toledo/ AVETeC)
3. Completed variable cycle engine simulation collaboration. (Air Force/ NASA/ Georgia Tech)
4. Completed Integrated Collaboration Environment Project. (Air Force/NASA/Georgia Tech)
   a. Process development (CBP)
   b. Mission Performance Model
5. Initiated development of Environmental Design System. (FAA, NASA, Georgia Tech, Massachusetts Institute of Technology).

Noise TAT

1. Agreed to use existing, established noise working groups (e.g. NASA/FAA Technical Working Group), to form basis of PPSA TAT activities through addition of representatives from the Navy and Air Force.
2. Completed static engine test of high bypass ratio engine and technology development for more aggressive noise reduction goals. (NASA/FAA)
3. Evaluated Air Force inquiry regarding possible acoustic measurements for planned NASA/FAA/General Electric engine test.
4. Signed broad agreement to collaborate on noise and emissions research. (NASA/DOD)
5. Conducted successful field campaign to assess the ability of simulators to capture "sonic booms" –to define metrics to define supersonic aircraft noise acceptability criteria. (NASA/FAA/Penn State)
6. Continued to develop the structure and membership of the Joint Planning and Development Office Environment Integrated Product Team. (NASA/FAA).

Propulsion and Airframe Integration TAT

1. Coordinated with the Noise Reduction TAT for conduct of GE engine test.
2. Developed collaborative approach for nozzle noise and exhaust plume prediction modeling effort. (Air Force/Navy/NASA)
3. Initiated collaborative efforts on inlet flow control. (Air Force/NASA)
4. Initiated development of broad based collaborative relationship on topic of propulsion-airframe integration. (NASA/Air Force)

Structures TAT

1. Continued successful collaboration on turbomachinery forced response through the GUIde III consortium (NASA/AFRL/AFORSR/USN/Industry/Universities). PPSA provided opportunity for new ideas for GUIde IV consortium (NASA/DOD) planning.
2. Established two collaborations on developing and testing composite fan containment case (NASA/ A&P Technology).
3. Continued successful collaboration in three turbo-electric propulsion system studies (NASA/Georgia Tech URETI). PPSA connected NASA turbo-electric work with URETI.

4. Damper design/analysis tools (B-DAMPER), developed through collaboration, were successfully transitioned to U.S. industry (NASA/AFRL/Ohio State University/ US engine companies). PPSA provided unique opportunity for transition.
5. Disk crack detection technology test received validation. PPSA provided connection to Navy spin pit facility. (NASA/Navy)

Test and Evaluation TAT

Formed technical area team and developed initial vision for group.

Thermal Management TAT

1. Formulated Thermal Management TAT and defined scope of future activities.
2. Initiated collaborative effort to integrate thermal management modeling with the propulsion system. (NASA/Air Force)

Turbines TAT

1. Initiated collaboration on turbine design tools. (NASA/Air Force)
2. Continued collaboration on NASA single spool rig design and AFRL turbine research facility. (NASA/Air Force/Ohio State University)
3. Continued collaboration on film-cooled turbine experiment/modeling and simulation. (NASA/Air Force/Honeywell/Ohio State University)
4. Developed advanced thin-film heat flux sensors. (Air Force/NASA/Texas A&M)

CONCLUDING REMARKS

Turbine engine based propulsion and power systems play a critical role in our country's health both economically and militarily. Nevertheless, future Federal government investments in technologies relevant to turbine engine systems are forecast to, at best, remain level for the foreseeable future. If required technologies are to be developed and transitioned to the US user community in a timely fashion, collaboration between government agencies and with external organizations must become an even more important part of the technology development process. PPSA has an opportunity to play a leadership role in identifying, forming, and executing collaborative activities that will contribute to a strengthened technology portfolio.

The most recent accomplishments of the organization as described in this report suggest progress is being made towards the PPSA vision.

PPSA welcomes any/all feedback on this report. Responses should be sent to the current chairperson of the Leadership Team Robert J. Shaw (robert.j.shaw@nasa.gov). PPSA also encourages interested persons to utilize our website (https://ppsa.grc.nasa.gov) for additional information on our organization.