ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

June 2001

BUDGET ACTIVITY
2 - APPLIED RESEARCH

PE NUMBER AND TITLE
0602211A - Aviation Technology

COST (In Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	29213	30794	49265	0	0	0	0	0	0	0
47A AERON & ACFT WPNS TECH	25967	27249	45584	0	0	0	0	0	0	0
47B VEH PROP & STRUCT TECH	3246	3545	3681	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification:

PLEASE NOTE: This administration has not addressed FY2003-2007 requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.

The Aviation Technology program element (PE) conducts applied research and expands scientific knowledge in the area of rotary wing vehicle (RWV) technologies for transition to advanced development technology validations. The intent is to support authentication of new and / or upgraded Army / DoD rotorcraft systems for the Objective Force and Joint Vision 2020 to improve tactical mobility, reduce logistics footprint, focus combat power, and increase survivability for RWVs. The Army Aviation Science and Technology programs functional organization, supported by the National Aeronautics and Space Administration (NASA) at three co-located activities, is the focal point for DoD efforts in rotorcraft technology. Technical areas include unmanned aerial vehicles (UAV) rotorcraft, aeromechanics, aerodynamics, flight control, aeroacoustics, structures, propulsion, reliability and maintainability, safety and survivability, mission support equipment, aircraft system synthesis, comprehensive rotorcraft analysis, flight simulation, aircrew-aircraft integration, avionics and aircraft weapons integration. The work in this PE is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, the Department of Defense Technology Area Plans, DoD Joint Warfighting Science and Technology Master Plan, DoD Reliance Agreements (for which the Army is the lead service for the maturing of rotorcraft science and technology), and coordinated government / industry / academia RWV Technology Development Approach. This PE also supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry and academia, whose primary objective is to ensure the continued superiority of U.S. military rotorcraft systems through focused technology projects with a near term (2-3 year) return on investment, enabling rapid technology insertion into military and commercial rotorcraft. The Army and NASA provide funding for NRTC, which is matched by industry. Army, NASA, Navy, and Federal Aviation Administration (FAA) provide staffing and support of the NRTC operations. Efforts under this PE transition to projects supported by PE 0603003A (Aviation - Advanced Technology). Technology matured in this PE supports current and future rotorcraft for the Objective Force. Upgrade activities of Army systems such as the AH-64 Apache, RAH-66 Comanche, UH-60 Black Hawk, Navy SH-60 Seahawk and USMC AH-1 Cobra are included as well. Work in this PE is performed by contractors including: Boeing Company, Mesa, AZ and Philadelphia, PA; Bell Helicopter Textron Incorporated, Ft. Worth, TX; Lockheed Martin, Atlanta, GA; General Electric Aircraft Engines, Lynn, MA; Honeywell, Phoenix, AZ; Sikorsky Aircraft Corporation, Stratford, CT; Rolls-Royce/Allison, Indianapolis, IN; Kaman Aerospace Corp., Bloomfield, CT; Pratt & Whitney, Hartford, CT; Raytheon Company, Arlington, VA; and United Technologies Research Center, Hartford, CT. Additionally, work in this PE is performed by universities including Arizona State University, AZ; Georgia Institute of Technology, GA; Naval Postgraduate School, Monterey, CA; California Polytechnic University, San Luis Obispo, CA; Ohio State University, OH; Penn State University, PA; Purdue University, IN; Texas A&M, TX; University of Southern California, CA; University of Florida, FL; University of Illinois, IL; University of Maryland, MD; University of Michigan, MI; University of Utah, UT; Virginia Polytechnic Institute and State University, VA; Wichita State University, KS; Cornell

University, NY; Iowa State University, IA; Prairie View A&M College, TX; University of Dayton, OH; University of Texas Automation and Robotics Institute, TX; University of Alabama, Huntsville. The program element contains no duplication with any effort within the Military Departments. Work is led by the Aviation and Missile Command and Army Research Laboratory through the Army Materiel Command

B. Program Change Summary	FY 2000	FY 2001	FY 2002	FY 2003
Previous President's Budget (FY2001 PB)	30048	31080	31475	0
Appropriated Value	30165	31080	0	
Adjustments to Appropriated Value	0	0	0	
a. Congressional General Reductions	0	0	0	
b. SBIR / STTR	-416	0	0	
c. Omnibus or Other Above Threshold Reductions	-64	0	0	
d. Below Threshold Reprogramming	-419	0	0	
e. Rescissions	-53	-286	0	
Adjustments to Budget Years Since FY2001 PB	0	0	17790	
Current Budget Submit (FY 2002/2003 PB)	29213	30794	49265	0

Change Summary Explanation: Funding - FY 2002 funding was increased to demonstrate a long endurance, armed, unmanned rotary wing platform for the Objective Force (+17735).

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)

June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
2 - APPLIED RESEARCH	**0602211A - Aviation Technology**	**47A**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
47A	AERON & ACFT WPNS TECH	25967	27249	45584	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: The Aeronautical and Aircraft Weapons Technology project matures rotary wing vehicle (RWV) technologies for Army / DoD rotorcraft for increased strategic and tactical mobility / deployability; improved air-to-ground and air-to-air combat effectiveness; improved fire power; increased aircraft and aircrew survivability; increased reliability; reduced maintenance; and increased combat sustainability. This project supports the Objective Force and Joint Vision 2020 by providing maturing technology to improve tactical mobility, reduce the logistics footprint, focus combat power on multiple targets, enhance near-real time situational awareness, and increase survivability for rotary wing vehicles. Areas of research are focused on fluid mechanics, dynamics, weight reduction, advanced materials applications, infrared (IR) / visual electro-optical (EO) signatures, external cargo handling, combat damage repair, vulnerability reduction, ballistic tolerance and crashworthiness. These technologies will provide higher performance, improved survivability, improved sustainability, and reduced cost for propulsion and air vehicles. The propulsion component technology matured in this project provides improved specific fuel consumption, horsepower to weight ratios, and operation & support (O&S) savings for current and future rotorcraft engines. Advanced active controls, aerodynamics, handling qualities, acoustic signature attenuation and smart materials (materials that respond to specific stressors) technologies will provide rotors and flight controls with increased payload / range, maneuverability / agility and survivability. Flight simulation, avionics, weapons integration, aircrew / machine integration and pilot-vehicle interface technologies are focused on maturation of advanced crew stations and mission equipment packages that will provide improved workload distribution, reduced design / development time, and increased lethality and mission operational effectiveness. This project will begin demonstration of the Unmanned Combat Armed Rotorcraft (UCAR), a long endurance, armed, rotary wing platform. UCAR will be capable of performing suppression of enemy air defense (SEAD) and, like Comanche, putting weapons on a target using Loitering Attack Munitions-Aviation (LAM-A). This project also supports work done by NASA and work done under the auspices of the National Rotorcraft Technology Center (NRTC). NRTC addresses five critical military / civil rotorcraft technology thrusts as follows: (a) process and product improvement for affordability, quality and environmental compliance; (b) enhanced rotorcraft performance; (c) passenger and community acceptance; (d) expanded rotorcraft operations; (e) technologies to support harmonized military qualification and civil certification. NRTC projects are identified and matured by industry and evaluated and approved by government on an annual basis to ensure they are supportive of DoD rotary wing goals and objectives. Technologies matured by this project will transition to advanced development technology demonstration programs with application to current as well as future Army / DoD rotorcraft systems. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 7176 - Evaluated Variable Geometry Advanced Rotor Technology (VGART) core concepts applicability, based on initial small-scale authentication testing. Conducted parametric analysis (of potential VGART dimensions) to determine core concept technology mix potential for transition to 6.3 Variable Geometry Advanced Rotor Demonstration (VGARD) program.

  - Fabricated large-scale critical components and began bench tests for VGART core concept candidates.

  - Evaluated core concept initial wind tunnel data to guide variable geometry rotor candidate selection and prioritization for VGARD.

- 6694 - Conducted comprehensive flight test validation of Aero Design Standard (ADS)-33 requirements applied to the UH-60 with and without a sling load.

  - Integrated Rotorcraft-Aircrew Systems Concepts Airborne Laboratory (RASCAL) flight control laws in hardware in-the-loop development facility using Real-Time Interactive Prototype Technology Integration/Development Environment (RIPTIDE) modeling, control system analysis and piloted simulation environment.

  - Conducted detailed analytical study of control law concept for advanced rotor control based on 2/ revolution inputs to active pitch links for performance improvement.

  - Validated Control Designer's Unified Interface (CONDUIT) flight control design tool on successful flight tests of unmanned aerial vehicle (UAV) control laws for autonomous Vertical Takeoff UAV (VTUAV) (Schweizter 330SP) and Burro (KMAX). Completed maturation, continued verification and validation of Man-Machine Integrated Design and Analysis System (MIDAS) human operator models. Tool transitioned to industry through cooperative R&D agreements.

  - Created and analyzed conceptual designs of advanced rotorcraft in response to evolving Objective Force operational concepts. Provided advanced rotorcraft designs in support of Army Science Board studies and the Overarching Rotorcraft Commonality Assessment (ORCA) study sponsored by the Joint Staff.

  - Compiled a comprehensive reference set of mission avionics functional requirements and future operational capabilities for current rotorcraft upgrades and projected aviation systems. Drafted preferred set of open system architecture specifications and standards, the Rotorcraft Technical Architecture, based on high volume Commercial Off-the-Shelf (COTS) electronics components.

- 5994 - Completed component maturation / test / validation and transition of NRTC technology to government / industry partners in the areas of: helicopter maneuver loads, active/passive noise control technology for helicopter interiors, vacuum-based resin transfer molded tailrotor blade, planetary ring gear design technology, high speed blade core carving process, simulator evaluation of synthetic vision and decision aiding tools, crashworthy fuel tank methodology, and vibration/stress reduction in airframes.

FY 2000 Accomplishments (Continued)

- Conducted NRTC advanced technology maturation efforts in the areas of low cost and efficient composite structures, fan-in-fin unsteady aerodynamics, reduced manufacturing and operating costs, rapid prototyping tool fabrication technology, health and usage monitoring (HUM) technology, variable speed vapor cycle system and advanced applications of a 3-axis sidestick controller.

• 2732
- Completed preliminary concept screening, design, and fabrication of lightweight, high-efficiency engine infrared (IR) suppressor components that reduce suppressor weight by 20%

- Conducted detailed comparisons of predictive vs. test structural behavior based on results of full-scale crash tests and executed software code modifications where necessary; performed component test and evaluation to support load adaptive (sensing system that responds to specific stressors) crashworthy landing gear strut for 40% increased gear energy absorption; performed analysis of crashworthy fuel system components and alternative materials to support 30% system weight reduction.

• 2041
- Evaluated use of smart materials for a variety of airframe applications where passive structural tuning can provide vibration control.

- Identified technologies applicable to adaptive landing concepts, which extend the energy absorbing capabilities of current technology gear by 50%.

- Defined advanced structures technologies and fabrication concepts that can reduce the assembly labor of complex composite parts by 50% and completed the preliminary design of the test article.

• 1330
- Completed rig testing of ceramic low pressure (LP) turbine; completed combined rig testing of advanced high pressure (HP) compressor for validation of improved pressure ratio capability and reduced weight; completed fabrication and rig testing of advanced ceramic matrix composite (CMC) combustor; completed detailed design of high strength, lightweight shaft providing a reduction in the number of bearings required; completed detailed design of advanced fuel control providing improved engine/airframe performance and affordability to future turbine engines; performed design of advanced inlet particle separator providing increased separation efficiency and durability and reduced engine losses.

Total 25967

FY 2001 Planned Program

• 7036
- Conduct analytical / simulation validation of active / passive external cargo load stabilization allowing higher operational speeds and flight test evaluation of CONDUIT / RIPTIDE optimized control laws to achieve a high bandwidth in-flight simulation capability.

- Conduct initial study of analytical / simulation study of interactions of flight control and Individual Blade Control (IBC) rotorcraft control.

- Mature hardware and perform flight test evaluation using RASCAL of envelop limiting / cueing concepts.

FY 2001 Planned Program (Continued)

- Validate partial authority flight control concepts, providing attitude command/attitude hold capability with existing partial authority actuators in a joint flight test experiment in National Research Council (NRC) in-flight simulator (Ottawa, Canada).

- Evaluate MIDAS human operator models. Transition tool to industry through cooperative Research & Development agreements and/or commercialization partner. Apply operator models to follow-on empirical work in obstacle avoidance displays.

- Create and analyze conceptual designs of advanced rotorcraft in support of activities like the Army Science Board and the Integrated Concept Team (ICT) for the Future Transport Rotorcraft (FTR).

- Authenticate a COTS based, open systems mission processor hosting Apache Longbow operational flight program (OFP) applications in an Apache-like laboratory environment. Use COTS operating system and open graphics language as the host software environment. Integrate the mission processor with the network components (data buses, network interfaces, switches) and authenticate performance with Comanche OFP applications in a Comanche-like laboratory setting.

• 7023 - Complete bench and wind tunnel testing of critical components for variable geometry rotor core concept technologies.

- Formulate, select, and recommend rotor system technology configuration for the 6.3 VGARD program.

- Complete core concept applicability based on small scale validation testing.

- Conduct active on-blade control loads modeling tools upgrade for transition to 6.3 VGARD concept mix and pre-design requirements.

• 6150 - Conduct component maturation / test / validation and transition of NRTC technology to government / industry partners in the areas of: rotorcraft performance improvement and exterior noise reduction, improved prediction methods for complex rotorcraft applications, tiltrotor shipboard handling qualities improvements, carefree maneuvering technology, damage tolerance, crashworthiness and advanced structures, advanced low-cost composite manufacturing, advanced high speed machining of complex rotorcraft components, rotorcraft transmission casting technologies, and titanium high-speed machining.

- Perform NRTC advanced technology maturation efforts in low noise, improved bevel gear design concepts, advanced transmission technology, variable speed vapor cycle system, health and usage monitoring (HUM) smart transducer data bus maturation, antenna technology, composite durability and damage tolerance, non-deterministic fatigue life methodology, and integrated helicopter design technology.

FY 2001 Planned Program (Continued)

- 2710 - Authenticate full-scale, light weight, high-efficiency engine IR suppressor; perform low-energy dynamic impact testing of load adaptive crashworthy landing gear strut; perform coupon impact testing of alternative crashworthy fuel system components / designs for system weight reduction; perform conceptual analyses of advanced ballistic protection techniques for Army rotorcraft to achieve 15% net reduction in installed armor weight; affirm 50% assembly labor reduction for complex composite rotorcraft assemblies; apply smart materials to adaptive airframe structures to reduce vibration; mature more accurate structural load predictions to reduce airframe weight and development time; evaluate durable composite rotorcraft structural concepts to reduce weight and operational costs.

  - Screen low glint canopy coating material specifications.

- 2450 - Design and authenticate smart material actuator and global control schemes that can alter the structural response of an airframe in-flight in response to changing mission conditions.

  - Utilize modeling and simulation to predict the performance and screen candidate adaptive landing gear concepts; conduct design support tests on most promising concept.

  - Identify smart material/actuator technology that can be integrated into adaptive helicopter airframe structure for active control of loads/vibration; screen innovative technologies applicable to high reliability control signal and power requirements of evolving advanced rotor concepts.

- 1480 - Fabricate high strength, lightweight shaft providing a reduction in the number of bearings required; fabricate advanced fuel control providing improved engine/airframe performance and affordability; design advanced inlet particle separator providing increased separation efficiency and durability and reduced engine losses; design advanced power turbine providing increased cycle efficiency and reduced stage count.

- 400 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 27249

FY 2002 Planned Program

- 9087 - Install test monitoring equipment on aircraft and perform flight test planning for passive external load stabilization.

  - Affirm significant improvement in agility and all-weather operations using rotor state feedback in RASCAL.

  - Conduct wind tunnel test of integrated flight/rotor control using on-blade flaps.

  - Perform simulation/flight test validation of autonomous guidance control laws using unmanned rotorcraft and piloted simulation quantifying benefit of "high situation awareness" rotorcraft cockpit displays emphasizing obstacle/traffic avoidance.

FY 2002 Planned Program (Continued)

- Flight validate tactile cueing (real-time feedback of aircraft limits to pilot's sidestick controller)/active sidestick benefit for rotorcraft maneuver limiting.

- Produce rotorcraft primary flight display symbology aeronautical design guide, incorporating findings from other services/government labs.

- 6610 - Conduct component maturation / test / validation and transition of NRTC technology to government / industry partners in the areas of: rotorcraft interior noise reduction, rotorcraft interactional aerodynamics, rotorcraft performance improvement, carefree maneuvering technology, enhanced handling qualities for night operations, limited authority flight control technology, damage tolerance, crashworthiness and advanced structures, advanced low-cost composite manufacturing, structural joining technologies, rotorcraft transmission casting technologies, and enhance non-destructive engineering development.

  - Perform NRTC advanced technology maturation efforts in improved bevel gear design concepts, advanced transmission technology, HUM smart transducer data bus maturation, antenna technology, composite durability and damage tolerance, non-deterministic fatigue life methodology, and integrated helicopter design technology.
- 4118 - Evaluate active on-blade control loads modeling upgrade for application to 6.3 VGARD design requirements and bench-test advanced actuator concept for swashplate-less rotor application.
- 5000 - Conduct applied research for rotorcraft UAV with industry, academia, and NASA through the NRTC.
- 3721 - Build and validate super lightweight thermal insulation components that reduce density by 50% over current state-of-the-art COTS insulation. Conduct analytic screening of advanced aircraft camouflage designs that reduce visual signatures in both desert and vegetated environments by 50% compared to current coatings.
- 2568 - Design, modify, test full-scale adaptive landing gear shock strut to affirm a 50% improvement in crash energy attenuation.

  - Perform detailed design of control and actuation concepts for an adaptive structure concept capable of reducing airframe loads/vibration at a 50% reduction in weight penalty compared to current parasitic approaches.

  - Conduct detailed design of high reliability adaptive structure hardware for transferring flight critical control signals.
- 12735 - Develop and evaluate NASA and NRTC designs for UAV heavy-fuel piston engines.

  - Develop and validate NASA and NRTC simulation models for candidate Unmanned Combat Armed Rotorcraft (UCAR) airframe concepts.

  - Define NASA and NRTC candidate autonomous modes of operation for UCAR.

  - Develop NASA and NRTC human systems interface alternatives for implementation in UCAR.

FY 2002 Planned Program (Continued)

- Develop concepts for integrating air-to-ground sensors, designators, and Netfires (LAM-A and PAM-A) to demonstrate cooperative manned-unmanned systems capabilities.

- Develop real-time synthetic vision-based guidance and trajectory capability for precision maneuvering in combat.

• 1745 - Test Metal Matrix Composite (MMC) shaft and validate weight reductions; upgrade simulation software/hardware and perform final closed loop bench test of advanced fuel control; design and fabricate advanced inlet particle separator providing increased separation efficiency and durability and reduced engine losses; design advanced power turbine providing increased cycle efficiency and reduced engine weight; design advanced compressor providing high pressure ratio in lightweight, low cost design.

Total 45584

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June 2001

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2 - APPLIED RESEARCH	**0602211A - Aviation Technology**	**47B**

COST (In Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
47B	VEH PROP & STRUCT TECH	3246	3545	3681	0	0	0	0	0	0	0

A. Mission Description and Budget Item Justification: The Vehicle Propulsion and Structure Technology project matures engine, drivetrain and airframe technologies for Army / DoD rotorcraft that significantly increase strategic and tactical mobility/deployability, increase reliability, reduce maintenance costs and increase combat sustainability. The problems being addressed in propulsion technology include increased fuel efficiency and reduced propulsion systems weight. Technical barriers include temperature limitations for materials, accurate modeling for flow physics, and accurate prediction of propulsion system mechanical behavior. The problem being addressed in structures is the inability to design for acceptable reliability and durability with current tools, which leads to heavier, more costly designs and poor life cycle management. Technical barriers include inadequate structural analysis design tools, inadequate structural dynamics modeling methods for the rotating and fixed system components, incomplete loads/usage data, and inaccurate inspection and tracking methodologies. Technical solutions are pursued through: 1) propulsion research focused on fluid mechanics, high temperature materials, and mechanical behavior for significantly improved small airflow turbine engines, transmissions, and gears, bearings, and shaft components for advanced drivetrains at significantly reduced weight and cost; and 2) structures research focused on aerodynamic loads, aeroelastic interactions, integrated composites, structural integrity, low cost manufacturing and crashworthiness that will provide improved rotor and airframe structures subsystems. This propulsion research supports the goals of the DoD integrated high performance turbine engine technology (IHPTET) / Joint Turbine Advanced Gas Generator (JTAGG) program. This program supports the Objective Force transition path of the Transformation Campaign Plan (TCP).

FY 2000 Accomplishments

- 1829 - Validated a 30% extension in centrifugal compressor flow range through controlled airflow injection, which offers the potential for substantial improvements in compressor design and fuel efficiency.

  - Analyzed advanced concept configuration for close coupled, compact 2-stage compressor system; and completed a multi-stage computational fluid dynamics (CFD) assessment that shows that the configuration out-performs current practice.

  - Completed design and construction of cooled ceramic matrix composite turbine nozzle airfoils for application to IHPTET/JTAGG phase III.

  - Completed rotordynamic feasibility and conceptual design analysis of bearing system for oil-free small turbine engine core.

  - Completed installation of unique, world-class, high temperature gas path seal rig facility.

FY 2000 Accomplishments (Continued)

- Completed successful testing of silicon carbide (SiC) compressor pressure sensor and lateral resonators up to 400°C and 950°C, respectively.

• 1417

- Investigated active control technology for stability augmentation of soft inplane tiltrotor in hover, and conducted first Transonic Dynamics Tunnel tests of 'active twist' rotor model for vibration control.
- Investigated Regenerative Electronics' power and control system to assess use with on-blade rotor system actuators.
- Completed tension-torsion fatigue testing of Bell ducted tail rotor flexbeam to correlate with finite element analysis (FEA) predictions and FEA and tension-bending tests of hybrid composite flexbeam laminates to validate failure criteria.
- Evaluated barely visible impact damage test and analysis methods for thin-skin composite sandwich structures.
- Completed local 2D - global 3D analysis for delamination from matrix cracks in stringer pull-off specimens and FEA and establishment of combined load test specimens and conducted testing of tailored composite panels.
- Validated microwave non-destructive evaluation (NDE) for moisture detection in adhesively bonded composite panels to determine relationship between moisture content and bond quality.

Total 3246

FY 2001 Planned Program

• 2131

- Conduct air injection feedback control experiments on a centrifugal compressor stage to improve turbine engine performance by extending its stable operating range.
- Evaluate engine components for a compact two-stage compressor to reduce engine size and weight.
- Evaluate cooled ceramic matrix composite turbine nozzle airfoil to support IHPTET very high temperature operating requirements.
- Complete thermal management assessment of the advanced helical gear drive system and SiC pressure sensor for engine component applications that will contribute to drive train and advanced engine reliability and durability.
- Conduct engine combustor and compressor simulations using improved software to validate substantial reductions in engine design time.

• 1397

- Assess aeroelastic stability of variable diameter tiltrotor concept in support of the Vertical Take-off and Landing capability for the Objective Force.

FY 2001 Planned Program (Continued)

- Conduct initial closed-loop hover tests of active twist rotor and prepare for forward flight closed-loop tests for improved rotor vibration control.

- Evaluate use of "Regenerative Electronics" power and control system with on-blade rotor system actuators to improve response time performance and reliability.
- Evaluate bondline interfacial effects on adhesive bond strength of composite structures for improved vehicle structural reliability.
- Validate strength and stiffness predictions of tailored composite panels to improve the prediction accuracy for future tiltrotor thin wing designs.

• 17 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs.

Total 3545

FY 2002 Planned Program

• 2020 - Conduct experiments using innovative Micro Electro Mechanical Sensor (MEMS) air injection technology (zero net mass flow) in the diffuser of a centrifugal compressor to extend compressor stability operating range.
- Conduct performance experiments on compact high performance two-stage compressor to enable reduced engine weight and size.
- Optimize processing parameters for fabrication of ceramic matrix composite turbine nozzles in support of high temperature IHPTET requirements.

- Complete baseline experiments of unique, high speed/high temperature gas path seal rig to enable reduction of engine secondary air flow losses, thereby improving efficiency.
- Complete thermal experiments on alternate high-speed helical gear design to enhance future drive system reliability.

• 1661 - Assess the 'closed-loop' control actuation capability of Active Twist Rotor (ATR) for vibration reduction and determine its potential for noise reduction.

- Investigate concepts for a Low Cost Active Rotor (LCAR) which provides for "Full Authority' control, eliminating the need for a rotor swashplate.

- Perform comparison studies of soft-inplane blade and hub loads versus conventional stiff-inplane hub to improve understanding of the tiltrotor stability boundary and to extend its performance envelope and investigate 3D finite element model of hybrid rotor hub flexbeam concept for improved rotorcraft structural integrity.

FY 2002 Planned Program (Continued)

- Perform component experiments using thermal non-destructive evaluation (NDE) measurements to correlate bondline geometry with bond strength for an improved understanding of vehicle structural reliability and durability.
- Investigate airframe concepts for application to large-scale, pressurized rotorcraft fuselages in support of the Objective Force rotorcraft.

Total 3681