ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 2 - Applied Research	PE NUMBER AND TITLE 0602211A Aviation Technology

COST (*In Thousands*)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	23854	30048	31080	31475	31536	32962	32793	Continuing	Continuing
A47A Aeronautical and Aircraft Weapons Technology	20793	26790	27502	27795	27721	28993	28725	Continuing	Continuing
A47B Vehicle Propulsion and Structures Technology	3061	3258	3578	3680	3815	3969	4068	Continuing	Continuing

A. Mission Description and Justification: The objective of this program element (PE) is to conduct applied research in rotary wing vehicle (RWV) technologies for transition to advanced development technology demonstrations that support development of new and / or upgraded DoD / Army rotorcraft systems in support of Joint Vision 2010 and Army After 2010. RWVs offer a practical solution to many of the DoD / Army's operational needs because of their ability to take off and land vertically, and to operate efficiently and effectively at or below tree top level for nap-of-the-earth (NOE) missions. Accordingly, RWVs present unique design challenges and require significantly different analysis compared with traditional fixed wing vehicles, which do not have rotors and do not hover or fly in NOE. The Army Aviation Science and Technology program's 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 aeromechanics, aerodynamics, flight controls, aeroacoustics, structures, propulsion, reliability and maintainability, safety and survivability, mission support equipment, aircraft system synthesis, advanced helicopter analysis, flight simulation, aircrew-aircraft integration, avionics and aircraft weapons integration. The work in this PE is consistent with 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 development of rotorcraft science and technology), the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, 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 at least matched by industry. Army, NASA, Navy, and Federal Aviation Administration (FAA) provide staffing and support for the NRTC operations. Technology developed in this PE will support the future DoD Joint Transport Rotorcraft (JTR) identified to potentially replace the aging Army CH-47D Chinook and Navy CH-53 Super Stallion helicopters. Upgrade activities [as applicable] of Army systems such as the AH-64 Apache, RAH-66 Comanche, UH-60 Blackhawk, Navy SH-60 Seahawk and USMC AH-1 Cobra are supported 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, Lynn, MA; Allied Signal Engines, Phoenix, AZ; Sikorsky Aircraft, Stratford, CT; Rolls Royce, Indianapolis, IN; Kaman Aerospace Corp., Bloomfield, CT; Pratt & Whitney, Hartford, CT; Raytheon STX, Washington, D.C.; 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,

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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.

Primary in-house developers include Aviation and Missile Command (AMCOM), Redstone Arsenal, AL; Aeroflightdynamics Directorate / AMCOM, NASA Ames Research Center, Moffett Field, CA; Aviation Applied Technology Directorate / AMCOM, Ft Eustis, VA; Vehicle Technology Directorate (VTD) /Army Research Laboratory (ARL), NASA Langley Research Center, Hampton, VA; and Vehicle Technology Directorate / ARL, NASA Glenn Research Center, Cleveland, OH.

Technology products from this PE directly transfer to technology demonstrations conducted under PE 0603003A (Aviation Advanced Technology). Joint coordination of efforts, where applicable, is conducted with the NASA Aeronautics Program; PE 0602122N, Aircraft Technology; and PE 0602201F, Aerospace Flight Dynamics. To eliminate duplication, the PE efforts are coordinated throughout the rotorcraft community by joint program reviews, exchange of program data sheets, research and technology resumes, technical reports; inter-service liaison; government/industry/academia participation in the annual program development and refinement process for NRTC projects; attendance at scientific meetings and conferences; participation in the Joint Aeronautical Commander's Group, The Technical Cooperation Program (TTCP), NASA Research and Technology Committees, and the North Atlantic Treaty Organization (NATO) Advisory Group on Aerospace Research and Development (AGARD). Efforts under this PE transition to programs supported by PE 0603801A (Aviation - Advanced Development), PE 0604801A (Aviation - Engineering Development) and PE 0604270A (Electronic Warfare Development). Some efforts also transition to the field through PE 0203752A (Aircraft Engine Component Improvement Program). In addition, this PE's deliverables provide technical support to PE 0604223A (RAH-66 Comanche), PE 0604816A (AH-64D Longbow Apache), and PE 0203744A (Aircraft Modifications / Product Improvement). Active Joint Service programs supported: The Tri-Service Integrated High Performance Turbine Engine Technology (IHPTET) program and Navy / Army Joint Advanced Health and Usage Monitoring System (JAHUMS) Advanced Concept Technology Demonstration (ACTD) program. International Cooperative Agreements include Information Exchange Agreements with the Netherlands, Israel, Japan, Germany, France and the United Kingdom (UK).

B. Program Change Summary	FY 1999	FY 2000	FY 2001
Previous President's Budget (FY 2000/2001 PB)	24943	30165	31184
Appropriated Value	25160	30165	
Adjustments to Appropriated Value			
a. Congressional General Reductions	-217		
b. SBIR / STTR	-333		
c. Omnibus or Other Above Threshold Reductions		-64	
d. Below Threshold Reprogramming	-656		
e. Rescissions	-100	-53	
Adjustments to Budget Years Since FY 2000/2001 PB			-104
Current Budget Submit (FY 2001PB)	23854	30048	31080

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BUDGET ACTIVITY: 2 - Applied Research	PE NUMBER AND TITLE: 0602211A Aviation Technology — PROJECT: A47A

COST (*In Thousands*)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
A47A Aeronautical and Aircraft Weapons Technology	20793	26790	27502	27795	27721	28993	28725	Continuing	Continuing

Mission Description and Justification: The objective of this project is to conduct research and mature advanced RWV technologies for DoD / Army rotorcraft that significantly increases strategic and tactical mobility / deployability, air-to-ground and air-to-air combat, improved fire power, increased aircraft and aircrew survivability, increased reliability and reduced maintenance, and increased combat sustainability. Areas of research focused on fluid mechanics, dynamics, weight reduction, advanced materials applications, infrared (IR) / visual electro-optical (EO) signatures, internal / external cargo handling, combat damage repair, vulnerability reduction, ballistic tolerance and crashworthiness will provide higher performance, improved survivability and sustainability, and reduced cost for propulsion and air vehicle subsystems. The propulsion technology in this project supports the goals of the DoD IHPTET / Joint Turbine Advanced Gas Generator (JTAGG) program. Advanced active controls, aerodynamics, handling qualities, acoustic signatures and smart materials 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 development 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 also supports work done under the auspices of the 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 developed 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 developed by this project will transition to advanced development technology demonstration programs with application to current as well as future DoD / Army rotorcraft systems.

FY 1999 Accomplishments:

- 6850 - Conducted extensive sling-load flight-test and simulation studies, and documented in a US national conference paper the accurate prediction of sling load envelope prediction and critical handling-qualities metrics.
  - Validated and optimized Rotorcraft Aircrew Systems Concepts Airborne Laboratory (RASCAL) control laws using the Control Designer's Unified Interface Tool (CONDUIT) tool and successfully ported the optimized RASCAL control laws into the Rapid Prototyping Simulation Environment (RIPTIDE).
  - Successfully validated in an extensive motion-based piloted simulation the capability to achieve improved handling qualities for UH-60 partial authority control systems.
  - Used hybrid computational methods to develop approaches for reducing rotorcraft adverse aerodynamic forces and increasing range and speed.
  - Completed first version and training of Man-machine Integrated Design Analysis System (MIDAS) cockpit design tool with new human operator cognitive models and performed part-task simulation studies to verify predictions of crew station awareness measures.

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- Performed simulation evaluation of situation awareness measures to minimize spatial disorientation and improve symbology designs; transitioned results to RAH-66 Comanche.

FY 1999 Accomplishments: (continued)

- Integrated SBIR Phase II, Pilot-Rotorcraft Intelligent Symbology Management Simulator (PRISMS) into a laboratory virtual prototyping environment for developing helmet mounted display symbology.

- 500 - Conducted preliminary design studies for advanced rotor core concepts, including on-blade control, high-lift devices, active twist, and variable diameter rotor to guide critical component fabrication and evaluation.
- 2174 - Performed preliminary design efforts for advanced precision kill weapon system aircraft integration concepts.
  - Completed airborne unmanned-to-manned systems functional definition and transitioned results to Airborne Manned Unmanned System Technology (AMUST) demonstration program.
  - Analyzed pertinent OSD open systems directives, emerging electronics industry standards and specifications, and Joint Technical Architecture (JTA) and DoD avionics requirements to define a low cost, common mission processing system for current and developmental rotorcraft. Identified technical issues and preliminary design information for implementation of plug-and-play modules, reusable software, and COTS electronics.
  - Conducted analysis to update cargo lift study data in support of JTR Integrated Concept Team mission needs assessment and JTR Technical and Operational Concept Development.
- 1882 - Conducted testing on composite fuselage joints to validate structural integrity; develop methods to co-cure complex composite rotorcraft assemblies to reduce cost; conducted structural validation testing of dynamic models of airframe fittings for improved structural integrity and structural weight; developed landing gear concepts capable of heavy gross weight performance; conduct preliminary studies of smart materials for vibration/stress reduction in airframes.
- 1355 - Completed fabrication of monolithic ceramic low pressure (LP) turbine airfoil and attachment configuration consistent with IHPTET / JTAGG Phase III providing higher temperature capability and increased horsepower to weight ratio; fabricated advanced high pressure (HP), reduced stage count compressor for IHPTET / JTAGG Phase III providing higher pressure ratio, lower weight, reduced specific fuel consumption and reduced operation and support costs; completed design of inter-metallic composite (IMC) spar / shell HP turbine blade providing higher temperature capability and increased horsepower-to-weight ratio; conducted detailed design of advanced ceramic matrix composite (CMC) JTAGG III combustor providing higher temperature capability and increased horsepower to weight ratio; completed preliminary design of high strength, lightweight shaft providing a reduction in the number of bearings required resulting in reduced JTAGG III engine weight.
- 2165 - Completed evaluation of ceramic and polymer based leading edge materials for low dielectric, long life rotor blade protection in sand and rain environments.
  - Bench tested preliminary high-efficiency engine IR suppressor that reduces engine performance penalty to signature reduction ratio by 50%.

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- 4934 - Completed component development / demonstration / test / validation and transition of NRTC technology to government / industry partners in the areas of: corrosion sensors evaluation; integrated helicopter design interface tools; composite swashplate fabrication; validated interior noise reduction methodology; tail rotor buffet alleviation; fasteners and installation for composites; composite life prediction methodology.
  - Continued NRTC advanced technology development efforts in water and soil crash dynamics; crashworthy fuel tank design concepts / criteria; active side stick controllers; smart and multifunction rotorcraft antennas; flight management computer technology; and rotorcraft collision avoidance technology.

FY 1999 Accomplishments: (continued)

- 933 - Provided payment for DFAS services.

Total 20793

FY 2000 Planned Program:

- 6473 - Conduct comprehensive flight test demonstration / validation of ADS-33 requirements applied to the UH-60 with and without a sling load.
  - Begin piloted evaluation of RASCAL flight control laws in hardware in-loop RASCAL development facility.
  - Conduct detailed analytical study of control law concept for advanced rotor control based on 2/rev inputs to active pitch links.
  - Create and analyze conceptual designs of advanced rotorcraft in response to evolving Army After 2010 operational concepts. Provide characteristics of these designs for input to war game simulations.
  - Continue verification, validation and accreditation for MIDAS human operator models. Transition tool to industry through cooperative R&D agreements.
  - Perform in-flight validation of performance, workload, and situation-awareness improvements with panoramic (100 degree Field of View (FoV)) night vision goggles (NVG) vs. standard 40 degree for FoV NVG's.
  - Develop and / or tailor government / industry low cost, common, open system architecture design standards and specifications for DoD rotorcraft platform avionics.
  - Conduct preliminary evaluation of the MIDAS human operator models on a major Army project.
  - Perform PRISMS simulation evaluation of situation awareness measures to minimize spatial disorientation and improve symbology designs; transition results to RAH-66 Comanche and future rotorcraft systems.
- 7595 - Evaluate Variable Geometry Advanced Rotor Technology (VGART) core concepts applicability based on initial small- scale demo testing; conduct parametric analysis to determine core concept technology mix potential for transition to 6.3 Variable Geometry Advanced Rotor Demonstration (VGARD) program.
  - Fabricate large-scale critical components and begin bench tests for VGART core concept candidates.
  - Evaluate core concept initial wind tunnel data to guide variable geometry rotor candidate selection and prioritization for VGARD.
- 2019 - Fabricate complex rotor components in single co-cure to demonstrate lower production cost; conduct durability tests of drive shafts to demonstrate high temperature capability; select smart rotor control concept for improved blade performance; design primary structural concepts for ballistic protection.

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- 1330 - Complete rig testing of ceramic LP turbine; complete combined rig testing of advanced HP compressor for IHPTET / JTAGG Phase III demonstrating improved engine performance capability and reduced weight; complete fabrication and rig testing of advanced CMC JTAGG III combustor ; complete detailed design of high strength, lightweight shaft providing a reduction in the number of bearings required resulting in reduced JTAGG III engine weight; complete detailed design of advanced fuel control providing improved engine/airframe performance and affordability to future turbine engines.
- 2769 - Complete preliminary concept screening, design and fabricate light weight, high-efficiency engine IR suppressor components that reduce suppressor weight by 20%

FY 2000 Planned Program: (continued)

- Conduct detailed comparisons of predictive vs. test structural behavior based on results full-scale Advanced Composite Airframe Program (ACAP) crash tests and execute code modifications if necessary; perform component test and evaluation to support load adaptive crashworthy landing gear strut for 40% increased gear energy absorption; perform analysis of crashworthy fuel system components and alternative materials to support 30% system weight reduction; re-design rotorcraft assemblies for cocured composite manufacture to reduce cost.

- 6200 - Complete component development / 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.
  - Conduct NRTC advanced technology development 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.
- 404 Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Program

Total 26790

FY 2001 Planned Program:

- 7214 - Conduct analytical / simulation demonstration of active / passive external cargo load stabilization allowing higher operational speeds.
  - Conduct flight test evaluation of CONDUIT / RIPTIDE optimized control laws to achieve a high bandwidth in-flight simulation capability.
  - Demonstrate real-time rotor state measurement / estimation capability on RASCAL.
  - Complete analytical / simulation study of benefits of on-blade control using CONDUIT / RIPTIDE tools.
  - Develop hardware and perform flight test evaluation of envelop limiting / cueing concepts.
  - 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).
  - Provide expert analysis and critique of advanced platform designs from the rotorcraft community and assess their applicability to DoD needs.
  - Incorporate human modeling modifications into MIDAS identified by prior year evaluation testing.
  - Demonstrate reductions in crewstation design cycle and crewmember error potential resulting from full-scale application of MIDAS tool.
  - Complete development and tailoring of government / industry low cost, common, open system architecture design standards and specifications based on COTS plug and play common modules and reusable software for rotorcraft platform avionics

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- Continue evaluation of MIDAS human operator models. Transition tool to industry through cooperative R&D agreements and/or commercialization.
- Develop virtual reality interface for MIDAS.

• 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 Variable Geometry Advanced Rotor Demonstration (VGARD) program.
- Complete core concept applicability based on small scale demo testing.

FY 2001 Planned Program: (continued)

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

• 2530 - Conduct full-scale validation testing of complex, smart rotor components to demonstrate structural integrity and cost reduction; fabricate sub-scale structural armor specimens for ballistic testing.

• 1480 - Complete fabrication of high strength, lightweight shaft providing a reduction in the number of bearings required resulting in reduced JTAGG III engine weight; complete fabrication of advanced fuel control providing improved engine/airframe performance and affordability to future turbine engines.

• 2838 - Demonstrate 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; demonstrate 50% assembly labor reduction for complex composite rotorcraft assemblies; apply smart materials to adaptive airframe structures to reduce vibration; develop 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.

• 6417 - Complete component development / test / validation and transition of NRTC technology to government/industry partners in the areas of: lightning protection for rotorcraft with composite airframes, and flotation stability of rotorcraft active/passive rotorcraft interior noise reduction, crash safety, rotorcraft exterior noise methodology, behavior of fastened airframe joints, high temperature composite applications, composite nondestructive testing, resin properties affecting marcel generation, low cost composite structures, high speed machining of titanium composites, and high speed blade core carving.
- Continue NRTC advanced technology development efforts in advanced rotor ice protection system, low noise and improved bearing contact bevel cages, rotorcraft antenna technologies, variable speed vapor cycle cooling system, helicopter decision aiding system, helicopter operations and approaches.

Total 27502

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BUDGET ACTIVITY: 2 - Applied Research	PE NUMBER AND TITLE: 0602211A Aviation Technology / PROJECT: A47B

COST (*In Thousands*)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
A47B Vehicle Propulsion and Structures Technology	3061	3258	3578	3680	3815	3969	4068	Continuing	Continuing

Mission Description and Justification: The objective of this project is to conduct research and mature advanced RWV engine, drivetrain and airframe technologies for DoD / Army rotorcraft that significantly increase strategic and tactical mobility / deployability, increase reliability, reduce maintenance costs and increase combat sustainability. Propulsion research focuses on fluid mechanics and high temperature materials for significantly improved small airflow turbine engines and components. This propulsion research supports the goals of the DoD IHPTET / JTAGG program. Research areas focused on aerodynamic loads, aeroelastic interactions, integrated composites, structural integrity, low cost manufacturing and crashworthiness will provide improved rotor and airframe structures subsystems. Gears, bearings, and shaft component research develops advanced drivetrains at significantly reduced weight and cost. Research support the Rotorcraft Drivesystems for the 21st Century technology demonstration.

FY 1999 Accomplishments:

- 1763
  - Completed speed and durability testing of oil-free bearing and seal technologies for revolutionary oil-free auxiliary power units and aeropropulsion engines.
  - Completed design and fabrication of hardware for centrifugal compressor surge control experiments.
  - Analyzed readiness of micro electromechanical systems (MEMS) micro sensor and actuator technology applied to engine components for control and diagnostic purposes which will improve lightweight engine performance and reliability.
  - Completed analysis and performance testing of an advanced compressor stage for IHPTET / JTAGG Phase III.
  - Conducted validation tests on thermal behavior of high speed gearing in support of advanced lightweight gearing systems.
  - Completed high temperature rig testing of magnetic bearings system.
- 1298
  - Analyzed soft inplane tiltrotor rotor/hub/wing model system in hover tests at Langley Transonic Dynamics Tunnel to compare stability characteristics with stiff inplane tiltrotor model system.
  - Tested active twist concept in hover at the Langley Transonic Dynamics Tunnel; fabricated active twist rotor model components for tests in FY00.
  - Incorporated Regenerative Electronics technology power and control for Aeroeleastic Rotor Experimental System (ARES) active blade control system evaluation.
  - Acquired modal data for a baseline fuselage aluminum testbed cylinder (ATC) for correlation with finite element model (FEM).
  - Investigated full scale crashworthy fuselage with chosen energy absorbing subfloor.
  - Fabricated and tested low-cost structurally efficient concepts for helicopter fuselages.
  - Evaluated methodology for prototype instrument for bond strength measurements.

Total 3061

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FY 2000 Planned Program:

•	1829	- Validate centrifugal compressor flow range improvement through controlled mass flow injection at the impeller leading edge and in the diffuser vaneless space on both hub and shroud surfaces. - Analyze advanced concept configuration for close coupled, compact compressor system; complete multi-stage CFD analysis of configuration. - Complete design and fabrication of cooled ceramic matrix composite turbine nozzle airfoils for application to IHPTET/JTAGG phase III. - Complete rotordynamic feasibility and conceptual design analysis of bearing system for oil-free small turbine engine core. - Complete installation and baseline testing of unique, high temperature gas path seal rig. - Characterize performance of cost effective, low noise spiral bevel gear. - Complete testing of silicon carbide (SiC) compressor pressure sensor and lateral resonators up to 400°C and 1000°C, respectively.
•	1417	- Investigate active control technology for stability augmentation of soft inplane tiltrotor in hover, and conduct first Transonic Dynamics Tunnel tests of 'active twist' rotor model for vibration control. - Test and evaluate 'Regenerative Electronics' power and control system on the ARES for application to future on-blade active rotor concepts. - Complete tension-torsion fatigue testing of Bell ducted tail rotor flexbeam to correlate with finite element analysis (FEA) predictions. - Complete FEM and tension-bending tests of hybrid composite flexbeam laminates to validate failure criteria. - Evaluate barely visible impact damage test and analysis methods for thin-skin composite sandwich structures. - Complete development of a local 2D - global 3D analysis for delamination from matrix cracks in stringer pull-off specimens. - Complete FEA and fabrication of combined load test specimens and conduct testing of tailored composite panels. - Validate microwave non-destructive evaluation (NDE) for moisture detection in adhesively bonded composite panels to determine relationship between moisture content and bond quality.
•	12	Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Program
Total	3258	

FY 2001 Planned Program:

•	1986	- Conduct performance and particle image velocimetry (PIV) experiments on close coupled compact compression system to validate fluid dynamic concepts. - Analytically predict performance of selected configuration for close coupled compact compression system; verify performance via rig test. - Complete thermomechanical fatigue structural durability testing of cooled ceramic matrix composite turbine nozzle airfoil to support IHPTET readiness requirements. - Complete performance testing and validate optimum configuration for thermal management of advanced helical gear drive system. - Formulate surface fatigue database for spur gears with advanced surface coatings. - Conduct Weibull statistical analysis of fracture strength in SiC membranes using experiments and finite-element analysis.

- Conduct a 3 hour turnaround time full combustor simulation using National Combustor Code, representing a 1000:1 reduction in turnaround time relative to 1992 baseline.
- Conduct a 3 hour turnaround time full compressor simulation using APNASA, representing a 2400:1 reduction relative to 1992 baseline.

FY 2001 Planned Program: (Continued)

•	1592	- Collaborate with industry in aeroelastic stability evaluation of Variable Diameter Tiltrotor concept in Langley Transonic Dynamics Tunnel. - Complete tests of 'active twist' rotor blade control for vibration in the Langley tunnel using closed loop control algorithms. - Conduct experiments on finite element model of composite helicopter and correlate with modal test data. - Explore delamination failure prediction methodology for hybrid composite flexbeam laminates under combined tension and bending loads. - Establish experimental and analytical methodology for composite stringer pull-off prediction. - Complete thin-skin sandwich residual tension/compression biaxial tests to predict compression after impact strength. - Validate strength and stiffness predictions of tailored composite panels and crew bulkhead combined load test specimens. - Investigate prototype microwave NDE instrument for measuring bondline strength and quality based on adhesive electrical parameter changes and/or moisture contamination.
Total	3578	