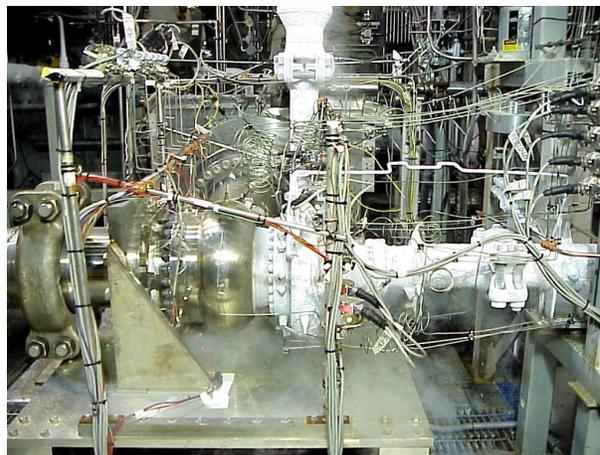

PROPULSION DIRECTORATE

Monthly Accomplishment Report June 2003



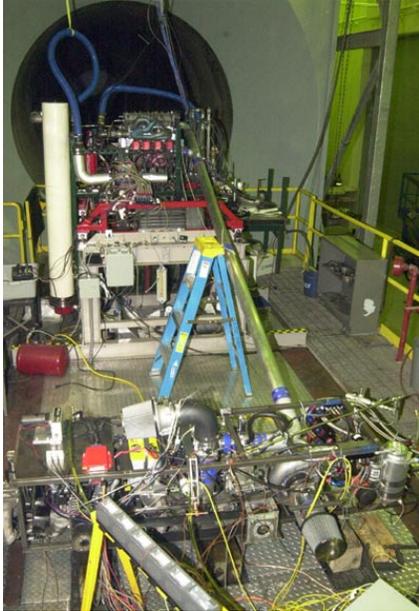
<u>Contents</u>	<u>Page</u>
<i>Turbopump Testing Successfully Completed.....</i>	<i>1</i>
<i>Pulsed Detonation Engine Shipped for Vehicle Integration</i>	<i>1</i>
<i>MacArthur Honored for Contributions to Turbine Engine Technology.....</i>	<i>3</i>
<i>Air Force Secretary Roche Visits PR.....</i>	<i>4</i>
<i>Wright Scholar Intern Program Expands</i>	<i>5</i>
<i>Compressor Technology Keeps Flowing at Virginia Tech.....</i>	<i>5</i>
<i>Hawkins Recognized for Leadership in Propellant Development.....</i>	<i>6</i>
<i>PR Hosts Workshop of UAVs.....</i>	<i>7</i>
<i>Stange Named Instrumentation, Systems, and Automation Society Fellow</i>	<i>7</i>
<i>Edwards Honored for Fuels Expertise</i>	<i>8</i>
<i>Hojnacki Honored with Prestigious Management Awards.....</i>	<i>9</i>
<i>Carreiro Honored for Efforts to Support the Warfighter.....</i>	<i>9</i>
<i>Phillips Gives Keynote Address on Nanocomposites.....</i>	<i>10</i>

TURBOPUMP TESTING SUCCESSFULLY COMPLETED: On 3 June 2003, the Propulsion Directorate's Integrated Powerhead Demonstration (IPD) Program successfully completed the steady-state 95% power level test of the IPD liquid oxygen turbopump. This test marked the completion of the series of oxygen turbopump testing, and it was also the most challenging test of the hotfire test series. These tests were a significant step in mitigating risk to the IPD engine cycle demonstration. This turbopump is also noteworthy for being the first US designed and fabricated oxygen-rich turbine drive turbopump. Among the achievements of this testing were: validation of the material selection for the environment; demonstration of the clutching bearing and fully hydrostatic bearing supported turbopump rotor concepts; demonstration of the electrostatic discharge mitigation hardware concept; acquisition of valuable performance data for incorporation into the cycle demonstrator engine balance and transient models; and acquisition of information for anchoring or validating a number of analytical tools. A number of supporting technologies were also demonstrated during the test, such as the instrumentation installed in the turbopump. The IPD Program is the Integrated High Payoff Rocket Propulsion Technology (IHRPT) Program Phase 1 Cryoboost Engine Demonstrator and is a critical IHRPT technology demonstrator. The IPD Program has two main technical goals: (1) to increase turbine life by using a full flow cycle staged combustion design, and (2) to increase bearing lifetime and reduce wear by incorporating hydrostatic bearing technology in both the hydrogen and oxygen turbopumps. The IPD Program contributes to IHRPT goals of doubling cryogenic booster thrust-to-weight, achieving Mean-Time-Between-Overhauls of 100 missions, and reducing hardware costs by 35%. (J. Thornburg, AFRL/PRSE, (661) 275-5320)



Hotfire testing of the Integrated Powerhead Demonstration Program liquid oxygen turbopump was successfully completed on 3 June 2003.

PULSED DETONATION ENGINE SHIPPED FOR VEHICLE INTEGRATION: As part of a joint Propulsion Directorate/Air Vehicles Directorate program to evaluate the feasibility of using pulsed detonation engine (PDE) propulsion with manned aircraft, PR recently shipped a complete engine assembly to Scaled Composites in Mojave, California, for vehicle integration. The engine was shipped following successful testing of a prototype flight-worthy pulsed detonation engine. It is believed that the test demonstrated the first self-contained PDE in operation. The prototype engine consists of a PDE assembly and pod which contains everything required to make a self-contained propulsion system. This includes an auxiliary power unit, oil system, fuel pumps and



Prototype flight PDE (in background on test stand) and pod (foreground) which supplies air to the integrated engine.



Royce Bradley (left) and Curt Rice (right) prepare to ship a complete PDE to Scaled Composites. The PDE and tubes will replace a conventional pusher prop engine on an experimental Long-EZ aircraft. The pod below and forward of the PDE contains the APU, alternator, pumps, etc. required to make a self-contained propulsion system. This pod will be contained in a bomb or ventral-tank like structure underneath the Long-EZ.

fuel injection system, alternator, battery, throttles, and control computers, as well as superchargers to enable static starts and non-self aspirated operation. The complete engine is constructed from off-the-shelf components and is designed to meet FAA durability requirements for experimental propulsion systems. The shipped engine assembly consists of a PDE and pod integrated together to create the second of three flight engines. This engine is

currently being integrated with an experimental Long-EZ airplane using a mount designed by Burt Rutan's company, Scaled Composites. Following fabrication of the engine mount, a duplicate mount will be shipped back to Wright-Patterson AFB for installation on a ground test Long-EZ using flight engine number three. Engine number one, which has additional test instrumentation, will take part in outdoor acoustic testing and be used as a spare. Although the current joint program between PR and VA is studying integration issues with a manned subsonic airframe, pulsed detonation technologies are expected to have performance benefits in the Mach 0-4+



Integration of the Pulsed Detonation Engine with a flight test Long-EZ aircraft at Scaled Composites. The first-stage wingtip of Burt Rutan's X-Prize entry is overhanging the PDE powered experimental aircraft.

regime and for hybrid/combined-cycle applications. The current program addresses structural, acoustic, and durability concerns while maturing this potentially revolutionary propulsion technology. (F. Schauer, AFRL/PRTS, (937) 255-1554)

MACARTHUR HONORED FOR CONTRIBUTIONS TO TURBINE ENGINE TECHNOLOGY:

The Propulsion Directorate's Dr. Charles D. MacArthur received the Meritorious Civilian Service Award on 11 June 2003. Dr. MacArthur was recognized for his distinguished service from January 1985 to September 2001, during which time he served in many key roles for PR's Turbine Engine Division (AFRL/PRT). These positions included Turbine



Dr. Charles MacArthur



Dr. MacArthur receives the Meritorious Civilian Service Award from Col Mike Heil, PR Director

Component Panel Chief in the Integrated High Performance Turbine Engine Technology (IHPTET) Initiative, leader of the Turbine Research Laboratory, and Chief of PRT's Turbine Branch (AFRL/PRTT). Dr. MacArthur was a strong advocate for many key turbine technologies vital to the success of the IHPTET Program, and his guidance was crucial to many decisions and technical successes within the IHPTET Program. He demonstrated outstanding leadership when he spearheaded the design, construction, and activation of the Air Force's one-of-a-kind Turbine Research Facility (TRF). The TRF is the only facility of its type in the world, and is an invaluable asset for both DoD and civilian turbine engine development. As a result of his aggressive drive for superior facilities and methods, the Air Force continues to save tens of millions of dollars per year over less efficient research methods while accelerating the research, test, and development process. He was also instrumental in transforming the IHPTET Program's decision-making process through his role as co-developer of the "Goals-Objectives-Technical Challenges-Approaches" or "GOTChA" method of planning. This GOTChA approach to problem solving and program planning established a blueprint for logical, data-driven decision making, and it has served as a model for other programs. Dr. MacArthur's research and technical leadership has had, and will continue to have, a strong influence on turbine engine design and development. The impact of his work will be evident in the superior performance of our next generation of military turbine engines and their derivatives for years to come. (Lt Col J. Nees, AFRL/PRT, (937) 255-4100)

AIR FORCE SECRETARY ROCHE VISITS PR: The Secretary of the Air Force, Dr. James G. Roche, visited the Propulsion Directorate's Headquarters at Wright-Patterson AFB, Ohio, on 4 June 2003. Dr. Roche was accompanied on his visit by Lt Gen Charles H. Coolidge, Jr., AFMC Vice Commander; Maj Gen Paul Nielsen, AFRL Commander; Brig Gen Jay Jabour, ASC Vice Commander; and Dr. Jacqueline R. Henningsen, Director of the Air Force Studies and Analyses Agency. During his visit, Dr. Roche was briefed on PR's efforts in a number of areas, including hypersonic propulsion, advanced capacitor research, and support for improvements to the Battlefield Air Operations (BAO) kit used by Special Tactics Combat Controllers. All of the individuals involved in providing briefings and tours did an outstanding job of representing PR. Special recognition is due to Ms. Sandra Fries-Carr and Capt David Pfahler of the Power Division (AFRL/PRP), and Dr. Tom Jackson and Mr. Parker Buckley of the Aerospace Propulsion Division (AFRL/PRA), for the special roles they played during this visit. Thanks to the professionalism and dedication displayed by everyone involved, Dr. Roche left PR with a positive impression of PR's people, programs, and facilities. (Col M. Heil, AFRL/PR, (937) 255-2520)



Ms. Sandra Fries-Carr (top) and Capt David Pfahler (bottom) brief Secretary Roche



Mr. Parker Buckley (top) and Dr. Tom Jackson (bottom) discuss hypersonic technology with Secretary Roche

Want more information?

- ❖ A picture from Secretary Roche's visit to PR was featured on the cover of the 6 June 2003 edition of the Wright-Patterson AFB *Skywrighter* and is available on-line [here](#).

WRIGHT SCHOLAR INTERN PROGRAM EXPANDS: A program to expose high school students to science and engineering careers has expanded substantially in only its second year of operation. This program, called Wright Scholars, began last year as a pilot program in the Propulsion Directorate with participation from the Air Vehicles and Human Effectiveness Directorates. The program was a great success in its first year and, as a result, has expanded substantially for 2003. This year the program participants have grown to include AFRL's Sensors and Information Directorates, the Air Force Institute of Technology, and the Aeronautical Systems Center Engineering Directorate (ASC/EN). As a result, the number of students in the

program has nearly doubled from 2002 with 48 students participating. These students serve a 10-12 week paid internship where they have the unique opportunity to assist with actual research and apply their knowledge to real-world engineering challenges under the mentorship of researchers at Wright Patterson AFB, Ohio. This year the students are involved in research on a wide array of topics such as modeling of turbine engines, fuel composition analysis, and hydrocarbon-fueled supersonic combustion engines. Students who express an interest in



Gen Nielsen, AFRL Commander, meets with some of this year's Wright Scholars

continuing to work for the Air Force are encouraged to apply for college intern or co-op positions at the base. (J. Horner, AFRL/PROP, (937) 255-6710)

Want more information?

- ❖ An article on the Wright Scholar program was included in the 27 June 2003 edition of the Wright-Patterson AFB *Skywrighter** and is available online [here](#).

COMPRESSOR TECHNOLOGY KEEPS FLOWING AT VIRGINIA TECH: A novel flow control technique for increasing the diffusion and turning of turbine engine compressor stators was tested at Virginia Tech's transonic blow-down tunnel. This concept was developed as part of a Propulsion Directorate in-house High Impact Technology (HIT) Program for the Versatile Affordable Advanced Turbine Engines (VAATE) Program. The length of time from concept to

* Horner, John, "Wright Scholar Intern Program Expands Across Base," *Skywrighter*, Vol. 44, No. 22, June 27, 2003, p. 6A.

test was 6 months which included: concept development, blade design, Computational Fluid Dynamics (CFD) evaluation, preliminary system study, test apparatus design, specification and fabrication, test plan development, and test execution. This flow control technique consists of a blade section in which an inset cavity is created in the suction surface. In this cavity a continuous co-flowing jet (i.e., in the direction of the core flow) is established which transmits momentum to the core flow increasing the turning and diffusion capability of the cascade section. This idea is similar to that found in fluidic nozzle vectoring in which shear layers are used to modify the main jet flow exit angle. In this concept, the cavity jet is supported through a secondary flow system



Experimental apparatus used to examine a novel flow control technique

which injects flow near the leading edge of the blade section and then later re-entrains the flow near the trailing edge. Preliminary analysis shows that the flow controlled section provided substantially more diffusion over the baseline, but not to the levels anticipated. This may be due to secondary flow effects within the cascade section. This implies that the aerodynamic design of the secondary flow delivery needs as much focus on design as the aerodynamics of the primary flow that is being controlled. A

detailed analysis of the cascade section will be conducted, including the secondary flow system, to determine the choking location and to propose a redesign in order to achieve the desired conditions for a follow-on test. The long-range payoff of this concept would be the reduction and/or elimination of compressor variable geometry. (D. Car, AFRL/PRTF, (937) 255-7326)

HAWKINS RECOGNIZED FOR LEADERSHIP IN PROPELLANT DEVELOPMENT: The Propulsion Directorate's Dr. Tommy W. Hawkins was recently selected to receive the Exemplary Civilian Service Award. Dr. Hawkins was recognized for his distinguished service as the leader of the Propellant Development Group in PR's Space and Missile Propulsion Division (AFRL/PRS) at Edwards AFB, California, from 1 March 2001 to 31 December 2002. As the leader of a group of 11 researchers and technicians, Dr. Hawkins has been responsible for a number of impressive gains in the discovery, synthesis, and initial testing of both liquid and solid energetic substances. These advances have the potential for revolutionizing the propulsion subsystems of current and future Air Force space boost, spacecraft, and weapons systems. In addition, he has generated significant positive relationships with external agencies that have led to new technology business for the Space and Missile Propulsion Division. As an example, he is developing lower cost and lower toxicity propellant formulations for Air Force aircraft auxiliary power units (APUs), and monopropellants developed by his team are being considered as a replacement for hydrazine in F-16 APUs. The new monopropellants are much less toxic than hydrazine, which not only benefits the environment but also offers significant savings relative to the time and expense associated with

the handling of hydrazine. Moreover, Dr. Hawkins has made important contributions to this nation's propellants database system, and he has served as a mentor to younger colleagues, both in his specialty technology area and in coaching for acquisition planning and execution. Dr. Hawkins was also honored with PR's prestigious Don Ross Award for 2003 which is awarded for technical achievement in rocketry. (R. Channell, AFRL/PRSP, (661) 275-5762)



Dr. Tommy Hawkins recently received the Exemplary Civilian Service Award

PR HOSTS WORKSHOP ON UAVs: The Propulsion Directorate's Energy Storage and Thermal Sciences Branch (AFRL/PRPS) conducted a "Power Technologies for Small UAVs" workshop on 20 May 2003 at Wright-Patterson AFB, Ohio. The objective of the workshop was to communicate with potential users, other AFRL directorates, and System Program Office (SPO) organizations to establish requirements for further development programs and to provide the user community with the latest information on power technologies.

Technologies presented included batteries, fuel cells, micro-batteries, micro-fuel cells, thermal technologies, capacitors, prognostics, modeling and simulation, and advanced brake technologies. Over 70 people attended the workshop including representatives from: AFRL's Propulsion, Sensors, Air Vehicles, Information, and Materials and Manufacturing Directorates; Naval Air Systems Command, Patuxent River, Maryland; Naval Surface Warfare Center, Crane, Indiana; and Aeronautical Systems Center's F-16 SPO (ASC/YP), Air Combat SPO (ASC/FB), Mobility SPO (ASC/GR), and Engineering Directorate (ASC/EN). (J. Erbacher, AFRL/PRPS, (937) 255-2372)

STANGE NAMED INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY FELLOW: Mr. William A. Stange of the Propulsion Directorate's Turbine Engine Division (AFRL/PRT) was recently named a Fellow in the Instrumentation, Systems, and Automation Society (ISA). ISA Fellow status is conferred upon qualified senior members who have made exceptional engineering or scientific contributions to the ISA purpose of "...advancing the state of the art in instrumentation for the benefit of mankind." The demanding selection criteria and a history of making only a modest number of elections make the Fellow grade a coveted honor. Mr. Stange was one of only five new ISA Fellows to be elected for 2003. The citation for his ISA Fellow election reads: "*In recognition of development and advancement of non-intrusive stress measurement system technology as related to turbine engines.*" Mr. Stange and the other new ISA Fellows will be recognized at the Annual ISA Honors & Awards Banquet to be held in

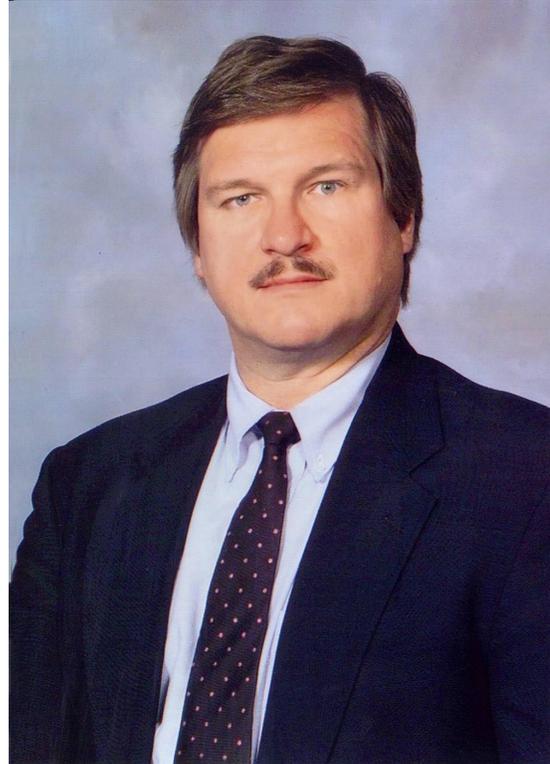
conjunction with ISA 2003 EXPO in Houston, Texas, on 20 October 2003. (Lt Col J. Nees, AFRL/PRT, (937) 255-4100)

Want more information?

- ❖ An ISA website listing the 2003 Fellows and other award winners is available [here](#).

EDWARDS HONORED FOR FUELS

EXPERTISE: The Propulsion Directorate's Dr. J. Timothy Edwards received the Exemplary Civilian Service Award on 11 June 2003. Dr. Edwards was recognized for his outstanding service as the Senior Research Scientist in PR's Fuels Branch (AFRL/PRTG) from 1 October 2001 through 15 January 2003. During this period, Dr. Edwards brought his expertise to bear in a number of different areas. He provided superb technical leadership to government scientists and engineers, as well as on-site contractor teams, conducting revolutionary in-house fuels research. He also led an Air Force Office of Scientific Research (AFOSR) sponsored STAR team in developing the fundamental understanding of the behavior of fuels at supercritical conditions. Furthermore, Dr. Edwards crafted the technical framework, developed roadmaps, and led the branch in the development of advanced high heat sink fuels to provide cooling for advanced turbine engines. He then aligned the branch's exploratory and advanced development research efforts with emerging requirements of the Versatile Affordable Advanced Turbine Engines (VAATE) Program. Dr. Edwards provided expert leadership in the development of high temperature endothermic fuels for use in hypersonic propulsion systems, and he offered technical guidance to the development of an endothermic fuel system for the HySET (Hypersonic Scramjet Engine Technology) test engine. He has also been the technical leader in the development of a new generation of advanced fuels for combined cycle propulsion systems, with a central focus on a fuel dubbed "JP-RP" which is intended to be a single fuel that can fulfill the requirements for jet and rocket propellants. In



Mr. William Stange was named a Fellow of the Instrumentation, Systems, and Automation Society



Dr. Tim Edwards recently received the Exemplary Civilian Service Award

addition, Dr. Edwards co-authored the chapter titled “Liquid Hydrocarbon Fuels for Hypersonic Propulsion” in the new *Scramjet Propulsion* reference book published by the American Institute of Aeronautics and Astronautics. Dr. Edwards is respected worldwide as a technical pioneer for advanced fuel technologies and advanced propulsion cycle cooling systems and is well deserving of this honor. (W. Harrison, AFRL/PRTG, (937) 255-6601)

HOJNACKI HONORED WITH PRESTIGIOUS MANAGEMENT AWARDS: The Propulsion Directorate’s Corporate Development Officer, Mr. John Hojnacki, recently received the Gold Knight of Management Award from the Buckeye Council of the National Management Association (NMA). The NMA was founded in Dayton, Ohio, by Charles Kettering in 1925 and currently has over 22,000 members in over 180 chapters around the country. Chapters in a geographic area form a council, and the Buckeye Council consists of chapters from the Columbus, Dayton, and Cincinnati areas. Councils can only present one Gold Knight Award each year. The award is given to individuals whose reputation for outstanding leadership is well known in the area served by the council, and they must have participated in programs intended to promote understanding of the management profession. The award was presented to Mr. Hojnacki by Mr. Bill Mahaffey, the current NMA Vice Chairman and Buckeye Council Treasurer, at a National Board meeting held in Dayton, Ohio, on 7 June 2003. Notably, Dr. Vince Russo, Executive Director of ASC, also received a Gold Knight of Management Award from the Buckeye Council in 2001. Mr. Hojnacki was also the first recipient of an award created by the NMA’s Wright Chapter. This award, entitled the John T. Hojnacki Hall of Fame Leadership Award, will continue to be given to individuals in recognition of significant contributions to the field of leadership and management and through exemplary personal behavior. The Wright Chapter was organized in 1982 at Wright-Patterson AFB, and Mr. Hojnacki has been a member of the Wright Chapter for almost 20 years. During this time, he has served as chapter president, chairman of the board, and chairman of the professional development committee besides facilitating a supervisory and management skills program for the past decade. This award was presented to Mr. Hojnacki at the chapter’s Top Management Night on 5 June 2003. (Col M. Heil, AFRL/PR, (937) 255-2520)



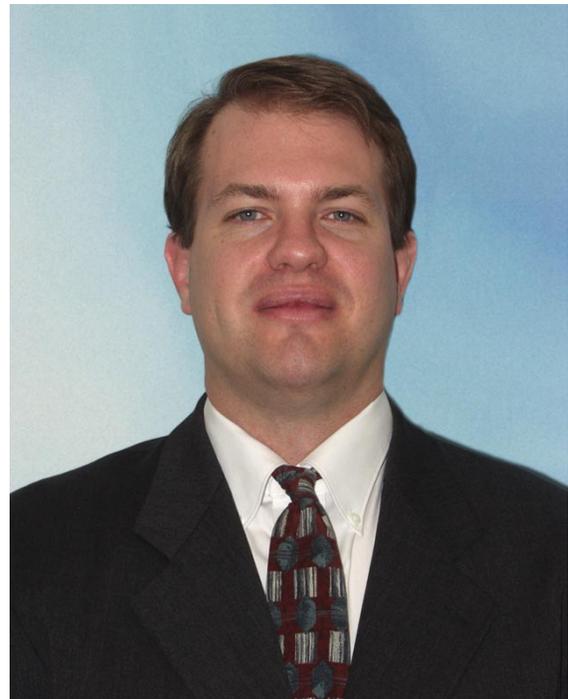
Mr. John Hojnacki (right) receives the NMA Gold Knight of Management Award from Mr. Bill Mahaffey, the current NMA Vice Chairman and Buckeye Council Treasurer

CARREIRO HONORED FOR EFFORTS TO SUPPORT THE WARFIGHTER: The Propulsion Directorate’s Mr. Louis R. Carreiro was recently selected to receive the Exemplary Civilian Service Award. Mr. Carreiro was recognized for his distinguished service as a senior aerospace engineer in the Advanced Concepts Office, Plans and Programs Division, Air Armament Center

(AAC) at Eglin AFB, Florida, from 13 August 1999 to 31 December 2002. Mr. Carreiro is collocated at AAC from PR's Aerospace Propulsion Division (AFRL/PRA) at Wright-Patterson AFB, Ohio. Mr. Carreiro's knowledge of both propulsion systems and vehicle performance analysis and design has proved to be invaluable. His expertise has been applied to develop advanced concepts for AFMC and generate new capabilities for the warfighter. Working as part of a multi-disciplinary design team, he provided the key analysis that led to weaponizing the RQ-1B Predator Uninhabited Aerial Vehicle (UAV). Mr. Carreiro was able to quickly gather information and conduct the necessary analysis to prove the feasibility of this concept, and as a result, the Predator-Hellfire system has already played a role in combat and added directly to the warfighters' arsenal. Mr. Carreiro has become *the* person to turn to for propulsion, power, and overall system performance information, not only at Eglin AFB, but across the entire Department of Defense. He provides analytical support, guidance, and historical data, and takes part in complete system design studies. Recent activities range across the performance spectrum from low-speed systems using 4-horsepower internal combustion engines and propellers, to rocket-boosted penetrating weapons, to supersonic cruise and hypersonic long-range missiles. In addition, Mr. Carreiro has continuously acted as an information conduit between the Air Armament Center and AFRL's Propulsion and Munitions Directorates. This liaison role ensures that researchers in the laboratory understand and meet the needs of the warfighter. (P. Buckley, AFRL/PRA, (937) 255-7083)



Mr. Lou Carreiro recently received the Exemplary Civilian Service Award



Dr. Shawn Phillips presented the keynote lecture in the Nanocomposites Session of the recent Manufacturing Problem Prevention Program (MP3) Meeting on the Fabrication and Testing of Advanced Space Composites

PHILLIPS GIVES KEYNOTE ADDRESS ON NANOCOMPOSITES: The Propulsion Directorate's Dr. Shawn H. Phillips presented the keynote lecture in the Nanocomposites Session of the recent Manufacturing Problem Prevention Program (MP3) Meeting on the Fabrication and Testing of Advanced Space Composites. This

annual conference was organized by The Aerospace Corporation and held on 3-4 June 2003 at the facilities of Hitco Carbon Composites, Inc in Gardena, California. Topics discussed at the meeting focused on the manufacture and reliability of thick composite structures, advanced structural composites including nanocomposites, and deployable shape memory composites. The subject of Dr. Phillips' lecture was an overview of Air Force activities on nanocomposites. In his talk, Dr. Phillips discussed materials and processing issues as well as applications to advance space systems. (S. Phillips, AFRL/PRSM, (661) 275-6270)

Want more information?

❖ More information on the MP3 meeting is available [here](#).