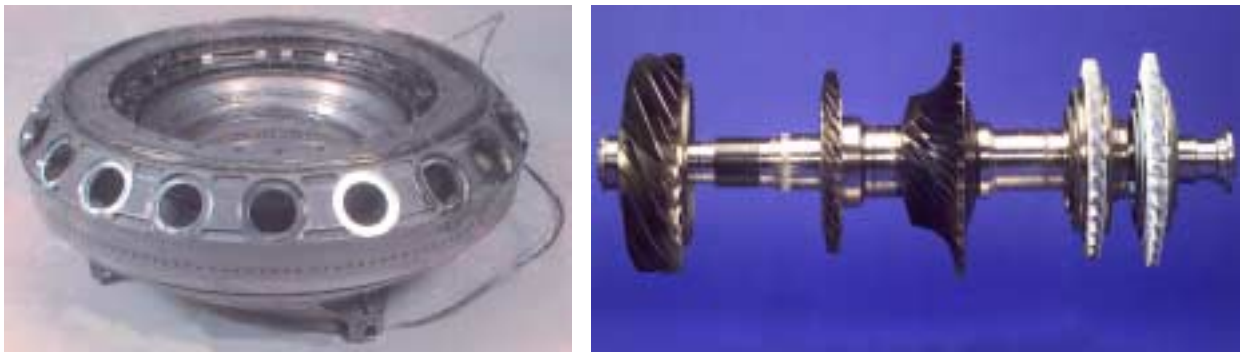
PROPULSION DIRECTORATE

Monthly Accomplishment Report
February 2001

Contents ***Page***

JTAGG DEMONSTRATION TESTING COMPLETED: The Integrated High Performance Turbine Engine Technology (IHPTET) Phase II Joint Turbine Advanced Gas Generator (JTAGG) XTC56/1 core engine demonstration was completed on 22 January 2001. This demonstration was performed at Honeywell Engines & Systems in Phoenix, Arizona. This testing demonstrated a splittered rotor, which offers increased performance and durability in fewer stages. Other technologies demonstrated include a TiAl centrifugal compressor, a rich-burn quench-quench lean-burn (RQL) combustor, and niobium low pressure turbine (LPT) vanes. Mechanical checkout of the core engine was also performed. JTAGG Phase II goal demonstration is planned on the XTC56/2 later this year. JTAGG Phase II goals include an 80% increase in horsepower to weight, a 30% reduction in specific fuel consumption, and a 20% reduction in both production and maintenance costs. The technology being developed in this program has direct relevance to Unmanned Combat Air Vehicle (UCAV) applications under the Precision Strike ITTP. (M. Huffman, AFRL/PRTP, (937) 255-2278)



Components of the IHPTET Phase II JTAGG demonstrator

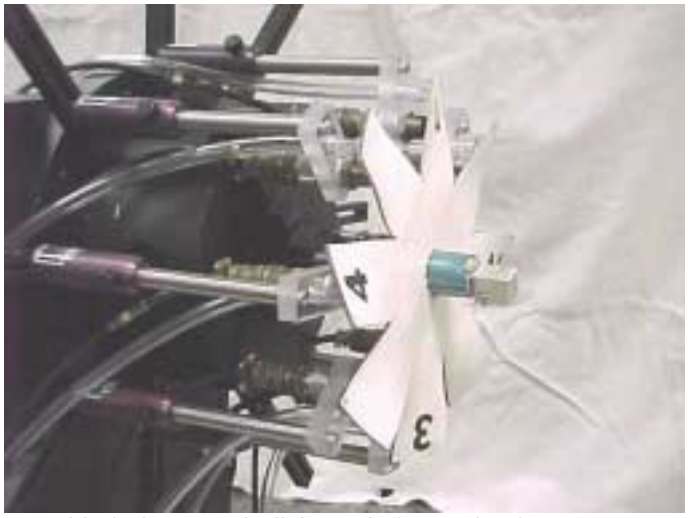
FRIES-CARR WINS PRESTIGIOUS YATES AWARD: Ms. Sandra Fries-Carr of the Propulsion Directorate has won the 1999 General Ronald W. Yates Award for Excellence in Technology Transfer. Ms. Fries-Carr, an electrical engineer in the directorate's Electrical Technology and Plasma Physics Branch (AFRL/PRPE), was recognized for her work in the successful transition of Fluorene Poly Ester (FPE) dielectric capacitor film technology to the commercial and military marketplace. These new high temperature, high performance dielectric films fill a critical need in the state of the art for the production of high temperature capacitors for military weapon systems. These films will dramatically increase the performance, reliability, and applicability of the capacitors upon which modern electric systems rely. The Yates Award honors General Yates' numerous and lasting contributions to the Air Force Science and Technology Program. The award was established upon General Yates' departure from active duty as the first Commander of Air Force Materiel

Sandra Fries-Carr

Command (AFMC) as a tribute to his achievements and his support of technology transfer. (J. Weimer, AFRL/PRPE, (937) 255-6235)


FPE dielectric capacitor film

BLADED DISK EVALUATED USING A NEW WAVE EXCITATION SYSTEM: The first evaluation of a gas turbine engine bladed disk using a new innovative traveling wave excitation system was performed in the Propulsion Directorate's Turbine Engine Fatigue Facility (TEFF). The traveling wave system was designed to simulate high cycle fatigue (HCF) excitation in stationary bladed disks to identify forced response localization and amplification due to mistuning. The goal of this research was to design and build a traveling wave excitation system with the flexibility to test different bladed disks. It was desirable that the excitation be non-contacting, high frequency, capable of any engine order excitation, and expandable to high blade counts at a reasonable cost. This system will provide the capability to quickly test and identify forced response localization and amplification due to mistuning in a number of bladed disks. It will allow for experimental mistuning research on new bladed disk designs such as those containing asymmetric but balanced hubs, splitter blades, or intentionally mistuned blades. The design of this system differs from previous traveling wave excitation systems in that it can test bladed disks of varying sizes and numbers of blades using either acoustic or magnetic excitation. With high cycle fatigue failures accounting for over 50% of the Class 1 failures in the Air Force, extensive testing is needed to validate durability and damage tolerance of components. If the loading and response that a gas turbine component experiences in operation can be simulated in a bench environment, a significant amount of testing and validation can be performed inexpensively resulting in a savings of two orders of magnitude over engine testing and one order of magnitude compared to spin pit or rig tests. (Capt K. Jones and C. Cross, AFRL/PRTC, (937) 656-5530)


An 8-bladed research disk ready for evaluation

PR TECHNICIANS WIN MISSION SUPPORT AWARD: The Technician Team of the Turbine Engine Research Center (TERC) was awarded the AFRL 2000 Mission Support Team Award at a ceremony held on 10 January 2001. Largely due to the expertise, ingenuity, and dedication of this team, the TERC has become the premier component evaluation center of the Air Force. The efforts of the TERC have contributed to the achievement of Integrated High Performance

Turbine Engine Technology (IHPTET) and High Cycle Fatigue (HCF) goals. Further contributions have been made to the evaluation of propulsion system components for the F-22, Joint Strike Fighter, and Unmanned Air Vehicles. With more than 180 years of combined experience, this team's contributions have been paramount to the advancement of the gas turbine technology base. The following individuals were members of the team honored by this award: Glen A. Boggs, Gary P. Dowen, David B. Elkins, Terry L. Gillaugh, Gary L. Howell, Charles W. Jordan, John A. Kaehler, Robert R. Maggio Jr., William D. Nilson, Mark E. Pennywitt, Bruce E. Tavner, Robert P. Wirrig, and Ronald G. Wolgast. (N. Poti, AFRL/PRTE, (937) 255-6802)

The TERC Technician Team won the AFRL 2000 Mission Support Team Award

AUXILIARY BEARING PROGRAM COMPLETED: Mohawk Innovative Technology Inc (MITI) recently completed an Air Force SBIR Phase II effort to develop an auxiliary bearing for high-speed turbogenerators. The use of magnetic bearings in turbine engines will remove the need for a bearing oil lubrication system, allow higher turbine exhaust temperatures, and allow higher operating speeds. However, magnetic bearings typically require a backup bearing that will support the rotor system in the event of electrical power loss. Under this program, MITI developed and tested its earlier design of a zero-clearance auxiliary bearing (ZCAB) matched to auxiliary bearing needs of the Air Force's More Electric Aircraft (MEA) Integrated Power Unit (IPU) Demonstrator built by Hamilton-Sundstrand. The ZCAB is innovative in its ability to "close down" on the rotor journal (thus the name "zero-clearance") to prevent potential backwhirl that can occur with typical loose-clearance auxiliary bearings. The ZCAB structure also has an inherent damper to control shock/impact loads from the rotor onto the bearing rollers. In the final rotor tests, the ZCAB was successfully demonstrated at the expected IPU operating speed (over 60 krpm). The final rotor tests also demonstrated the success of MITI's earlier prescreening tests to identify wear-resistant materials for the bearing journal and rollers. The robust design of the ZCAB

Mohawk Innovative Technology Inc's zero-clearance auxiliary bearing

also makes it viable as a "load-sharing" bearing that can absorb the peak loads, thus allowing more optimal sizing of either a fluid-film (e.g., air-foil) bearing or magnetic bearing that would be used in conjunction with the ZCAB. The ZCAB is therefore an enabling technology for future magnetic bearing applications. It also provides the primary benefits of standard mechanical bearings, while being designed to control the standard mechanical bearing life DN parameter and to operate without a separate lubricating oil subsystem. (E. Durkin, AFRL/PRPG, (937) 255-6241)

PR SCIENTISTS PROMOTE YOUTH INTEREST IN S&T CAREERS: Personnel from the Propulsion Directorate's Space and Missile Propulsion (AFRL/PRS) and Integration & Operations (AFRL/PRO) Divisions participated in the Math and Science Odyssey 2001 held at Antelope Valley College (AVC) in Lancaster, California, on 26 January 2001. Students from 19 local schools attended this event, which is jointly sponsored by NASA Dryden Flight Research Center's Education Office and AVC. The purpose of this annual event is to encourage students to continue their studies in math, science, and technology and to promote career interest in those fields. As part of the program, personnel from AFRL/PR gave a chemistry presentation that included demonstrations of polymers, propellants, and propulsion. These demonstrations were well received by students and teachers alike, as well as local press covering the Odyssey. (R. Blanski, AFRL/PRSM, (661) 275-5391 and P. Jones, AFRL/PRSP, (661) 275-5414)

Want more information?

- A NASA Dryden press release on this event is available at http://www.dfrc.nasa.gov/PAO/PressReleases/2001/01-01.html.

KLM BEGINS TRIALS USING THE +100 FUEL ADDITIVE: KLM Royal Dutch Airlines recently began operations using the +100 fuel thermal stability improver additive. Trials using the +100 additive commenced on 22 December 2000 on two Boeing 747-400s that are part of the KLM Asia fleet. Fuel containing the additive is being used in the GE CF6-80 engines and in the PW901 auxiliary power units (APUs). The aircraft are receiving fuel containing the additive in Amsterdam, Singapore, and Bangkok; however, since the aircraft fly to other destinations, they are not operating with the additive at all times. The goal is to have these aircraft operate with the additive between 60% and 70% of the time. Prior to the commencement of this trial, video borescope inspections were performed on the engines and APUs of both aircraft to record baseline conditions. Repeat inspections will be performed in the spring to give an early indication of the performance of the additive. The +100 additive was originally developed under a program sponsored by the Propulsion Directorate's Fuels Branch (AFRL/PRTG). The goal of the program was to develop an additive that would extend the useful operating temperature of JP-8 fuel by 100°F (thus the +100 name) through the addition of a low-cost additive package. Though already

A 747-400 from the KLM Asia fleet

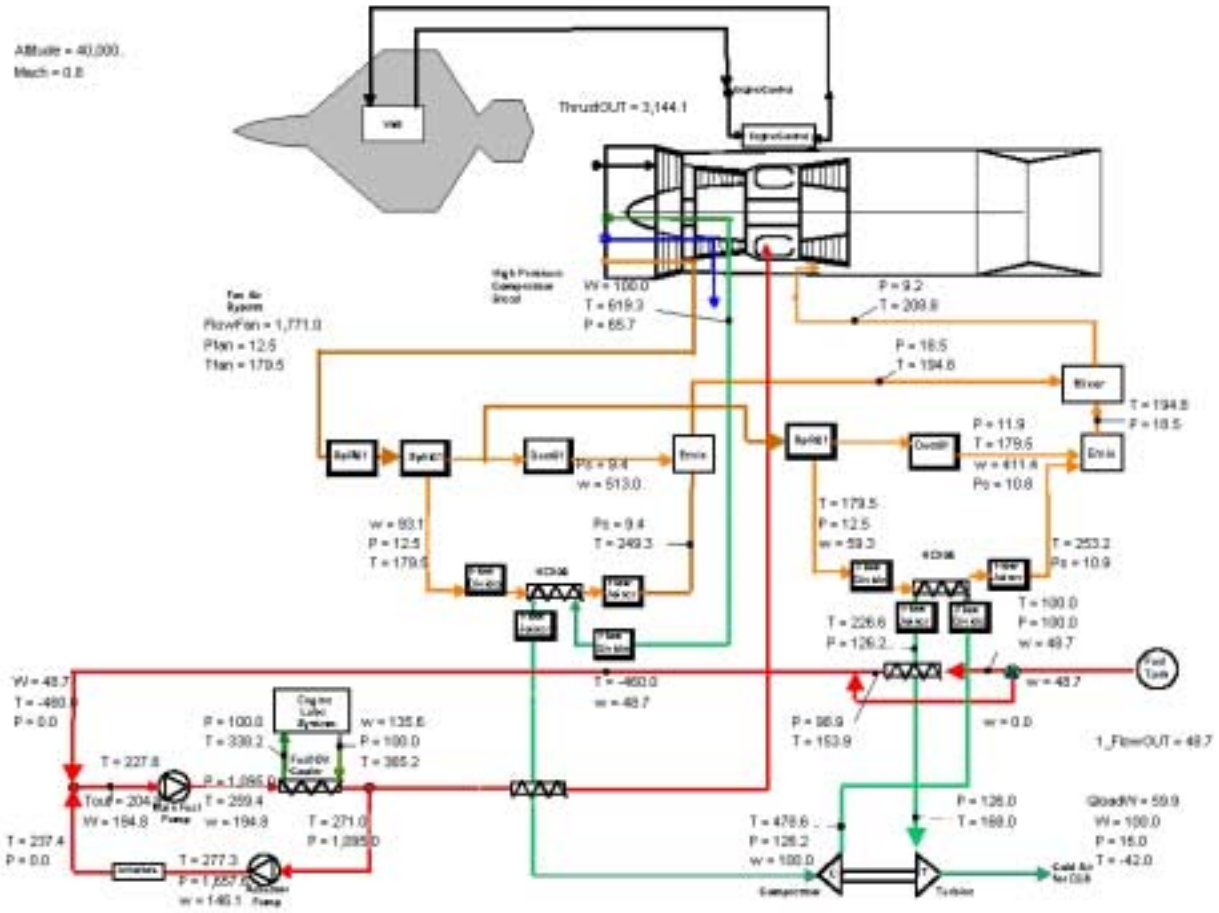
adopted by the Air Force and other military users in allied countries, adoption of the additive by a commercial carrier represents a huge step towards acceptance of the additive for worldwide use. (P. Pearce, AFRL/PRTG, (937) 255-6918)

SUPERCONDUCTIVITY WORK HONORED BY FLC AWARD: Dr. Paul Barnes of the Propulsion Directorate has been chosen to receive a 2001 Award for Excellence in Technology Transfer from the Federal Laboratory Consortium (FLC) for Technology Transfer. Dr. Barnes, a research physicist in the Power Generation Branch (AFRL/PRPG), is being honored for his groundbreaking work on YBCO (yttrium barium copper oxide) Coated Conductors, which are critical to the development of high temperature superconducting (HTS) generators. HTS generators are significantly lighter and more compact than their conventional counterparts, and they are an enabling technology for directed energy weapons (DEWs). The Air Force is currently placing emphasis on the development of DEWs for tactical and support operations. Dr. Barnes has been instrumental in performing in-house research and building partnerships with industry and academia to study coated conductor technology. Through these efforts, great advances have been made which are enabling the successful development of HTS generators. Dr. Barnes will be honored at the FLC award ceremony to be held on 1 May 2001 in Burlington, Vermont. (S. Rubertus, AFRL/PRPG, (937) 255-6241)


Dr. Paul Barnes

MODEL ENGINEER/THERMAL SYSTEMS ANALYSIS TOOL DEMONSTRATED: With ever increasing performance demands placed on emerging systems such as the F-22 and JSF, subsequent demands placed on thermal management systems are increasingly challenging. To meet the goals of these and future systems, it is critical to incorporate intelligent thermal management system designs in future engine systems, such as those developed in VAATE (Versatile Affordable Advanced Turbine Engine). To help accomplish this, the DUS&T Thermal Systems Analysis Tool (TSAT) Program was initiated in late 1999 with Modelogics, Inc. On 25 and 26 January 2001, Modelogics demonstrated their Model Engineer toolkit, the workhorse of TSAT, to representatives of the Thermal Management Networking Council and the Propulsion and Air Vehicles Directorates. Included in the demonstration was a running model of an engine combined with fuel and lubrication systems. This particular model is being used in conjunction with Pratt & Whitney's High Heat Sink Fuels Program and will also serve as a benchmark for validating the thermal library components. A parallel program is also under way with Northrop Grumman with different components and cooling circuit. Discussions included how Model Engineer can be used to integrate various types of models on a local intranet or from a remote site. Pratt & Whitney believes that this tool will not only be of benefit within their company, but will also improve modeling and coordination with airframers and component vendors. One of the key points demonstrated was the relative ease of creating components and models which allows

engineers to spend more time conducting subsystem and top-level system parametric trade assessments and less time programming. The tool will also provide engineers with the opportunity to see the effects of their component/subsystem and subsequent performance changes on the rest of the network on the current system configuration. Furthermore, the system allows component/subsystem models to be created to protect company proprietary data. (V. Van Griethuysen, AFRL/PRTA, (937) 255-2121)



Engine/airframe thermal management model for High Heat Sink Fuels Program

STUDENT RESEARCHER HONORED BY AIAA: Ms. Amanda Green of the University of Southern California (USC) was awarded the AIAA Foundation National Undergraduate Student Award at the 39th AIAA Aerospace Science Meeting held in January 2000 in Reno, Nevada. Ms. Green's research, entitled "Demonstration and Quantitative Characterization of a MEMS Fabricated Propulsion System for the Next Generation of Microspacecraft," was performed at USC and the Jet Propulsion Laboratory under the advisement of

Free Molecule Micro-Resistojet

Dr. Andrew Ketsdever of the Propulsion Directorate's Aerophysics Branch (AFRL/PRSA). As part of this research, Ms. Green fabricated the Free Molecule Micro-Resistojet (FMMR) at the Jet Propulsion Laboratory using MEMS (micro-electromechanical systems) techniques. Initial heat transfer measurements and thin film temperature sensor calibrations were also performed at USC as part of her research. Her award validates that useful and valuable research can be performed with appropriate collaborations between AFRL and local universities. (A. Ketsdever, AFRL/PRSA, (661) 275-6242)

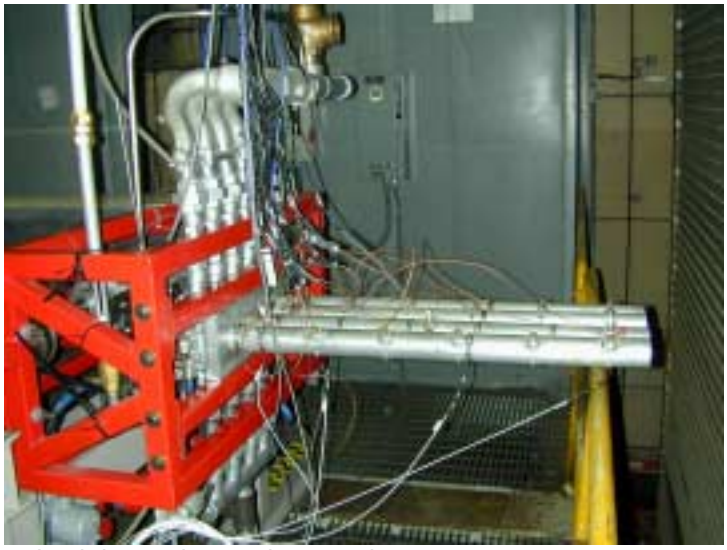
MURI AWARDED FOR HIGH TEMPERATURE SUPERCONDUCTORS: A Multiple University Research Initiative (MURI) proposal on high temperature superconductors for compact power systems has been selected for funding at $1 million per year for five years. The collaborating institutions will focus on basic research in support of High Temperature Superconducting (HTS) coated conductor development. Dr. Paul Barnes and Dr. Charles Oberly of the Propulsion Directorate's Power Division (AFRL/PRP) have been instrumental in working with Dr. Harold Weinstock of AFOSR to incorporate HTS coated conductors as a MURI topic. The HTS generators and motors are expected to provide the most compact, efficient high power delivery to air and ground based weapons systems currently being designed. As a result, this technology has been declared as an enabling technology for its new generation of high-power directed energy weapon systems. HTS motors are also of major interest to the Navy because they are more energy efficient, acoustically quiet, and more compact. The key to making the HTS-based compact motors and generators required for these DoD missions is the development of a successful coated HTS conductor technology that will produce long lengths of high current density tape that can operate in sizable magnetic fields. (P. Barnes, AFRL/PRPG, (937) 255-2923)

PULSED DETONATION RESEARCH NAMED PROJECT OF THE QUARTER: "Pulsed Detonation Engine (PDE) Development" has been named the Propulsion Directorate In-House Project of the Quarter for the 1st Quarter of FY01. The PDE project team is made up of Dr. Frederick Schauer and Mr. Jeffrey Stutrud of the Combustion Science Branch (AFRL/PRTS). This team is working to demonstrate that PDEs are realistic propulsion system options for missiles, unmanned aerial vehicles (UAVs), and even manned aircraft. Significant technical achievements over the past year have helped to remove looming questions


Dr. Frederick Schauer


Jeffrey Stutrud

regarding the validity of the PDE concept and its viability as a practical propulsion system. These achievements include the validation of PDE performance through carefully measured and calculated specific impulse values, the ability to run a PDE for indefinite periods of time, and detonation of propane without excess oxygen. Furthermore, the PRTS team is poised to become the first research group to detonate liquid hydrocarbon fuels without excess oxygen in a practical PDE. This would be a huge achievement, as it would pave the way for PDEs to operate on commonly used Air Force fuels. (R. Hancock, AFRL/PRTS, (937) 255-6814)


Pulsed detonation engine test rig

SUPERCONDUCTING AC ISSUES ADDRESSED AT ANNUAL WIRE WORKSHOP: The Department of Energy (DoE) sponsored the annual Coated Conductor Development Roadmapping Workshop at St. Petersburg, Florida, on 18-19 January 2001. The purpose of the workshop was to address the critical need to develop a roadmap that builds on prior efforts and incorporates the latest achievements in continuing processing of High Temperature Superconducting (HTS) coated conductors. The DoE's need for HTS coated conductors is for the electric power industry, but there is also an Air Force need for the conductor for high power generators and high field magnets in support of such applications as directed energy weapons and hypersonics. The roadmap developed at the workshop focused on defining R&D priorities and pathways to achieve the vision of a suitable conductor configuration and assembly. The workshop also provided the opportunity for the Air Force to introduce its needs into the overall DoE plan. During planning sessions, Dr. Paul N. Barnes introduced issues associated with ac losses in the conductor, which are of vital importance to the Air Force for HTS generators. This issue was chosen as one of the top five issues for consideration and discussion, and during the closing meeting of the workshop, it was the issue most discussed out of the selected presentation topics for coated conductor development. Consequently, the ac losses subject will be included in the DoE roadmap for HTS coated conductors benefiting both DoE and the Air Force. (P. Barnes, AFRL/PRPG, (937) 255-2923)

LEONARD NAMED DECEMBER EMPLOYEE OF THE MONTH: Mr. John Leonard of the Power Division (AFRL/PRP) was named the Propulsion Directorate's Employee of the Month for December 2000. For December, the Employee of the Month Award was given in the category of Staff Support/Technician. Mr. Leonard was honored for his outstanding efforts as the directorate's focal point for Environmental Safety and Occupational Health (ESOH). In this capacity, he coordinates and directs all aspects of the directorate's HazMat and Environmental Safety programs. Largely due to his efforts, the directorate always passes environmental inspections with flying colors. Mr. Leonard was also instrumental in the recent replacement of

the liquid nitrogen tank used by directorate researchers in the Building 450 complex. Changes in safety requirements had caused the Building 450 nitrogen tank to be ruled as "unsafe," and Mr. Leonard's innovative approach to replacing the tank kept research going while saving money. (Maj J. McNamee, AFRL/PRP, (937) 255-6226)

John Leonard