# Books & Reports

## Reduction of Flap Side Edge Noise — the Blowing Flap

A technique to reduce the noise radiating from a wing-flap side edge is being developed. As an airplane wing with an extended flap is exposed to a subsonic airflow, air is blown outward through thin rectangular chord-wise slots at various locations along the side edges and side surface of the flap to weaken and push away the vortices that originate in that region of the flap and are responsible for important noise emissions. Air is blown through the slots at up to twice the local flow velocity. The blowing is done using one or multiple slots, where a slot is located along the top, bottom or side surface of the flap along the side edge, or also along the intersection of the bottom (or top) and side surfaces.

*This work was done by Florence V. Hutcheson and Thomas F. Brooks of* **Langley Research Center**. *Further information is contained in a TSP (see page 1). LAR-16946-1*

## Preventing Accidental Ignition of Upper-Stage Rocket Motors

A report presents a proposal to reduce the risk of accidental ignition of certain upper-stage rocket motors or other high-energy hazardous systems. At present, mechanically in-line initiators are used for initiation of many rocket motors and/or other high-energy hazardous systems. Electrical shorts and/or mechanical barriers, which are the basic safety devices in such systems, are typically removed as part of final arming or pad preparations while personnel are present. At this time, static discharge, test equipment malfunction, or incorrect arming techniques can cause premature firing. The proposal calls for a modular "out-of-line" ignition system incorporating detonating-cord elements, identified as the donor and the acceptor, separated by an air gap. In the "safe" configuration, the gap would be sealed with two shields, which would prevent an accidental firing of the donor from igniting the system. The shields would be removed to enable normal firing, in which shrapnel generated by the donor would reliably ignite the acceptor to continue the ordnance train. The acceptor would then ignite a through bulkhead initiator (or other similar device), which would ignite the motor or high-energy system. One shield would be remotely operated and would be moved to the armed position when a launch was imminent or conversely returned to the safe position if the launch were postponed. In the event of failure of the remotely operated shield, the other shield could be inserted manually to "safe" the system.

*This work was done by John Hickman, Herbert Morgan, and Michael Cooper of* **Goddard Space Flight Center** *and Marcus Murbach of Ames Research Center. Further information is contained in a TSP (see page 1).*
*GSC-14691-1*

## Designing Flight Deck Procedures

Three reports address the design of flight-deck procedures and various aspects of human interaction with cockpit systems that have direct impact on flight safety. One report, "On the Typography of Flight-Deck Documentation," discusses basic research about typography and the kind of information needed by designers of flight-deck documentation. Flight crews reading poorly designed documentation may easily overlook a crucial item on the checklist. The report surveys and summarizes the available literature regarding the design and typographical aspects of printed material. It focuses on typographical factors such as proper typefaces, character height, use of lower- and upper-case characters, line length, and spacing. Graphical aspects such as layout, color coding, fonts, and character contrast are discussed; and several cockpit conditions such as lighting levels and glare are addressed, as well as usage factors such as angular alignment, paper quality, and colors. Most of the insights and recommendations discussed in this report are transferable to paperless cockpit systems of the future and computer-based procedure displays (e.g., "electronic flight bag") in aerospace systems and similar systems that are used in other industries such as medical, nuclear systems, maritime operations, and military systems.

Another report, "Human Factors of Flight-Deck Checklists: The Normal Checklist," analyzes aircraft checklists (which are regarded as the foundation of pilot standardization and cockpit safety). The improper use, or non-use, of the normal checklist by flight crews is often cited as the probable cause or contributing factor to many aircraft accidents. The report addresses the functions, format, design, length, usage of cockpit checklists, and the limitations of the humans who must interact with it. The development of the checklist from certification of a new aircraft to its delivery and use by the customer is also discussed in the report. A list of design guidelines for normal checklists is also provided.

Finally, the "On the Design of Flight-Deck Procedures" report examines the general topic of flight-deck procedures, which are the backbone of cockpit operations and a critical aspect of flight safety, and provide a general framework (called the 4 P's) for developing procedures. The report argues that the procedures are not only hardware/software dependent, as traditionally believed, but are also dependent on the operational environment, the type of people who operate them and the culture of the company they work for, and the nature of the companies' operations. Four factors are emphasized throughout the document: compatibility, consistency, quality management, and feedback. Although the report is based on airline operations, the issues addressed in the report have already been applied to other complex and high-risk systems, such as nuclear power production, manufacturing process control, space flight, military operations, and high-technology medical practice.

*This work was done by Asaf Degani of* **Ames Research Center** *and Earl Wiener of the University of Miami. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to the Technology Partnerships Division, Ames Research Center, (650) 604-2954. Refer to ARC-15248-1.*

## Update on High-Temperature Coils for Electromagnets

A report revisits the subject matter of "High-Temperature Coils for Electromagnets" (LEW-17164), *NASA Tech Briefs*, Vol. 26, No. 8, (August 2002) page 38. To recapitulate: Wires have been developed for use in electromagnets that operate at high temperatures. The starting material for a wire of this type can be either a nickel-clad, ceramic-insulated copper wire or a bare silver wire. The wire is covered by electrical-insulation material that is intended to withstand operating temperatures in the range from 800 to 1,300 °F (≈430 to ≈700 °C): The starting wire is either primarily wrapped with S-glass as an insulating material or else covered with another insulating material wrapped in S-glass prior to the winding process. A ceramic binding agent is applied as a slurry during the winding process to provide further insulating capability. The turns are pre-bent during winding to prevent damage to the insulation. The coil is then heated to convert the binder into ceramic. The instant report mostly reiterates the prior information and presents some additional information on the application of the ceramic binding agent and the incorporation of high-temperature wire into the windings.

*This work was done by Albert F. Kascak and Gerald T. Montague of* **Glenn Research Center** *and Alan Palazzolo, Jason Preuss, Bart Carter, Randall Tucker, and Andrew Hunt of Texas A&M University. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17467-1.*

## SMART Solar Sail

A report summarizes the design concept of a super miniaturized autonomous reconfigurable technology (SMART) solar sail — a proposed deployable, fully autonomous solar sail for use in very fine station keeping of a spacecraft. The SMART solar sail would include a reflective film stretched among nodes of a SMART space frame made partly of nanotubule struts. A microelectromechanical system (MEMS) at each vertex of the frame would spool and unspool nanotubule struts between itself and neighboring nodes to vary the shape of the frame. The MEMSs would be linked, either wirelessly or by thin wires within the struts, to an evolvable neural software system (ENSS) that would control the MEMSs to reconfigure the sail as needed. The solar sail would be highly deformable from an initially highly compressed configuration, yet also capable of enabling very fine maneuvering of the spacecraft by means of small sail-surface deformations. The SMART Solar Sail would be connected to the main body of the spacecraft by a SMART multi-tether structure, which would include MEMS actuators like those of the frame plus tethers in the form of longer versions of the struts in the frame.

*This work was done by Steven A. Curtis of* **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1).*
*GSC-14762-1*

## Further Developments in Microwave Ablation of Prostate Cells

A report presents additional information about the subject matter of "Microwave Treatment of Prostate Cancer and Hyperplasia" (MSC-23049), *NASA Tech Briefs*, Vol. 29, No. 6 (June 2005), page 62. To recapitulate: the basic idea is to use microwaves to heat and thereby kill small volumes of unhealthy prostate tissue. The prostate is irradiated with microwaves from one or more antennas positioned near the prostate by means of catheters inserted in the urethra and/or colon. The microwave frequency, power, and exposure time, phasing, positions, and orientations of the antennas may be chosen to obtain the desired temperature rise in the heated region and to ensure that the location and extent of the heated region coincides with the region to be treated to within a few millimeters. Going beyond the description in the cited previous article, the report includes a diagram that illustrates typical placement of urethra and colon antenna catheters and presents results of computationally simulated prostate-heating profiles for several different combinations of antenna arrangements, frequencies, and delivered-energy levels as well as experimental results within phantom materials. The advantage of the two-antenna technology is that the heat generated at each antenna is significantly reduced from that associated with only one antenna. The microwave energy radiated from each antenna is focused at the tumor center by adjusting the phasing of the irradiated microwave signal from the antennas.

*This work was done by G. Dickey Arndt and Phong Ngo of* **Johnson Space Center** *and Jim R. Carl and George W. Raffoul, independent consultants.*

*This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23427.*

## Imaging Dot Patterns for Measuring Gossamer Space Structures

A paper describes a photogrammetric method for measuring the changing shape of a gossamer (membrane) structure deployed in outer space. Such a structure is typified by a solar sail comprising a transparent polymeric membrane aluminized on its Sun-facing side and coated black on the opposite side. Unlike some prior photogrammetric methods, this method does not require an artificial light source or the attachment of retroreflectors to the gossamer structure. In a basic version of the method, the membrane contains a fluorescent dye, and the front and back coats are removed in matching patterns of dots. The dye in the dots absorbs some sunlight and fluoresces at a longer wavelength in all directions, thereby enabling acquisition of high-contrast images from almost any viewing angle. The fluorescent dots are observed by one or more electronic camera(s) on the Sun side, the shade side, or both sides. Filters that pass the fluorescent light and suppress most of the solar spectrum are placed in front of the camera(s) to increase the contrast of the dots against the background. The dot image(s) in the camera(s) are digitized, then processed by use of commercially available photogrammetric software.

*This work was done by A. A. Dorrington, P. M. Danehy, T. W. Jones, R. S. Pappa, and J. W. Connell of* **Langley Research Center**. *Further information is contained in a TSP (see page 1).*
*LAR-16596-1*

## Development of Flexible Multilayer Circuits and Cables

A continuing program addresses the development of flexible multilayer electronic circuits and associated flexible cables. This development is undertaken to help satisfy aerospace-system-engineering requirements for efficient, lightweight electrical and electronic subsystems that can fit within confined spaces, adhere to complexly shaped surfaces, and can be embedded within composite materials. Heretofore, substrate layers for commercial flexible circuitry have been made from sheets of Kapton (or equivalent) polyimide and have been bonded to copper conductors and to other substrate layers by means of adhesives. The substrates for the present developmental flexible circuitry are made from thin films of a polyimide known as LaRC™-SI. This polyimide is thermoplastic and, therefore, offers the potential to eliminate delamination and the need for adhesives. The development work undertaken thus far includes experiments in the use of several techniques of design and fabrication (including computer-aided design and fabrication) of representative flexible circuits. Anticipated fu-