UNITED STATES AIR FORCE MATERIALS TECHNOLOGY HIGHLIGHTS

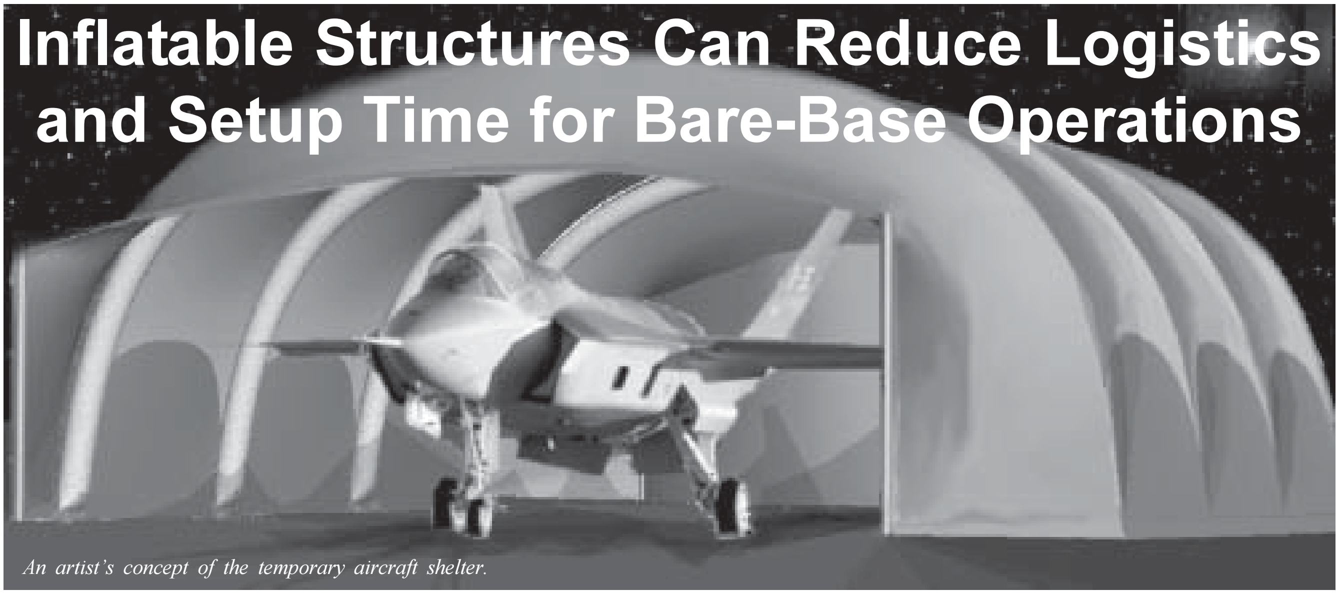
AIR FORCE RESEARCH LABORATORY

Air Force Research Laboratory

Materials & Manufacturing Directorate

Wright-Patterson Air Force Base • Dayton, Ohio **Winter 2002**

Inflatable Structures Can Reduce Logistics and Setup Time for Bare-Base Operations



An artist's concept of the temporary aircraft shelter.

Researchers here are developing a new type of temporary shelter that is significantly lighter, faster to transport, and easier to construct than existing shelters.

Scientists at the Air Force Research Laboratory Materials and Manufacturing Directorate, in conjunction with the Army, are developing inflatable textile air beam technology to provide deployed forces with a quick, lightweight, and easily constructed alternative to current temporary aircraft shelters.

Air beam technology emerged from nearly six years of cooperative research and development between the directorate's Deployed Base Systems Branch and the Army's Soldier and Biological Chemical Command. Researchers hope to replace the heavier aluminum structural frame of current shelters with the lightweight air beam.

Reza Salavani, AFRL program manager, said he expected the technology to reduce deployment time by 75 percent, labor hours by 85 percent, and the number of people required to put up the shelter by nearly half. He also anticipates the shelters will be 60 percent lighter and require a single shipping container in lieu of three, which will allow twice as many shelters to be shipped per aircraft.

"Many of the current shelters being used are based on old-fashioned pole tent technology," said Salavani. "They take several airmen anywhere from several hours to days to construct. With air beam technology, we can significantly reduce deployment logistics, including the amount of time, people, and aircraft required to set up bare-base operations."

The directorate is currently evaluating two small-sized shelters that have air beams made with a lightweight, high-strength fiber (polyethylenenapthelate and Vectran®) outer material and a plastic inner tube. The beam's outer material is high strength, durable, moldable, and can be charged to a high air pressure to provide the rigid frame. After inflation, the beams are covered with a tan or camouflage polyvinylchloride-coated polyester.

"The high-performance beams for these shelters feature high strength under applied loads, high stiffness, low weight, and will deflect weight from an overload without damage," said Salavani. "When deployed forces face high-winds, snow, or other environmental effects, these shelters will be strong and sturdy enough to keep Air Force troops and assets safe."

The directorate is testing the shelters, made by two separate manufacturers and differing in several ways, to evaluate their advantages and differing characteristics. The tests will provide useful data on how well the shelters perform over extended periods of time, in adverse weather, and after being constructed and taken down several times.

Salavani said the Air Force will choose a manufacturer to design, build, demonstrate, and evaluate a large aircraft shelter in the near future. Researchers expect the shelters to be 72 feet wide, 135 feet long, and 24 feet high.

"This will be more than enough space to store an F-15, F-16, or F-22, and all of its support and maintenance equipment," Salavani said. "We'd eventually like to develop a shelter large enough to house larger aircraft; the idea is conceivable with this technology at our disposal."

Follow-on efforts will integrate next generation power utilities, and accelerate the transition of all other bare-base shelter support equipment. In addition, both the Air Force and air beam technology manufacturers anticipate technology spin-offs that will be useful to other military services.

The Army plans to use the technology for shelters, but they are also exploring the possibility of using it for break water systems, which would provide wave protection behind inflated textiles for ships. "Both the Navy and Marine Corps suggested that, with slight modifications

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Advancements In Carbon Nanofiber Composites Technology Could Dramatically Reduce Aerospace Materials Production Costs

Scientists at the Air Force Research Laboratory's Materials and Manufacturing Directorate (ML) are developing a cost-effective way of producing carbon nanofiber composites, which can be used to build military and commercial aerospace components.

The new production method uses vapor-grown carbon fiber technology to make composite materials capable of providing the high stiffness and thermal conductivity required for military and commercial aerospace applications, but at a fraction of the cost.

Aside from the defense aerospace industry and exotic sporting equipment applications, the use of carbon nanofiber composite materials has been severely limited due to the high production costs of carbon fiber, which averages $23 per pound. One solution is to use vapor-grown carbon fiber (VGCF) instead of conventional carbon fiber. VGCF should be much less expensive to produce but cannot be generated using a standard processing method. Hence, new fabrication methods are needed in order to exploit the properties of VGCF in applications such as electronic packaging and molded automotive components.

Researchers at ML, in collaboration with Applied Sciences, Inc., have agreed to develop polymeric (carbon nanofiber) composites incorporating VGCF technology. These composite materials are potentially much less costly to produce than those using conventional continuous fiber, and exhibit extremely high stiffness and thermal conductivity without high temperature heat treatment.

The vapor-grown carbon fibers could cost as little as $3 per pound and are approximately 150 times smaller in diameter than conventional fibers. The use of VGCF composite materials is expected to enable production cost reductions for both military and commercial applications. The combination of physical property enhancements of carbon fiber reinforced composites at significantly reduced weight and production costs promises to have a large impact on the weight, reliability and costs of electronics products, automobile parts and aerospace vehicle components. Electronics and computers will benefit from the superior heat transfer of these composites in chip substrates and heat sinks. Administered under a Cooperative Research and Development Agreement (CRADA), these recent advancements could also open new markets for Applied Sciences, Inc. Success in this research and development effort could lead to expanded markets for Applied Sciences, Inc. As a result of the CRADA, fiber surface properties inhibiting composite fabrication are being identified and the correlation of growth parameters with fiber surface properties is becoming better understood as improved fibers are grown. New improved fibers have already been delivered to the Materials and Manufacturing Directorate by Applied Sciences, enabling the fabrication of higher quality composites.

The Air Force will benefit from the use of cost-efficient carbon nanofiber materials in military aircraft and through royalties earned as a result of the Directorate's role in this innovative development effort. The gains in physical properties realized through carbon nanofiber composite materials at reduced weight, combined with significant reductions in production cost, could have a substantial impact on the weight, reliability and cost of aerospace vehicles, as well as electronics and automobiles.

For more information, contact the Materials and Manufacturing Directorate's Technology Information Center at techinfo@afrl.af.mil or (937) 255-6469. Refer to item 00-378.

Advanced Composites Design Training Aids Aspiring Olympic Athletes

A unique composites design training effort may carry an Air Force officer to victory in the 2002 Winter Olympics.

Engineers at the Air Force Research Laboratory's Materials and Manufacturing Directorate redesigned the aerodynamic component of an Olympic-racing sled using advanced aerospace composites. The project enabled a new member of the Directorate's Advanced Composites Office (ACO) to acquire and hone additional computer aided design skills, while transferring Air Force composite processing technology to a non-military application.

Skeleton sled racing is the oldest known competitive downhill sled racing sport in the world. It originated in St. Moritz, Switzerland in the late 1800's, and developed into two Winter Olympic events: the bobsled and luge. Skeleton sled racing has traditionally been an Olympic event only when St. Moritz hosted the Winter Games but in 2002, it will be included in the Winter Olympic Games in Salt Lake City.

The skeleton sled is comprised of a steel chassis and steel runners. The athlete lies face down on top of the sled in a head first position. The bottom of the sled or "pod" is comprised of a steel (sometimes fiberglass) sheet affixed to the underside of the chassis to provide aerodynamic benefits, much like the underside of a Formula One racing car. Engineers at the ACO at Hill AFB, Utah, selected the skeleton sled pod redesign project as a training aid for computer aided design (CAD) three-dimensional (3-D) modeling. The project (continued on page 3)

Olympic hopeful, Air Force Maj. Brady Canfield, begins a practice run.

Inflatable Structures
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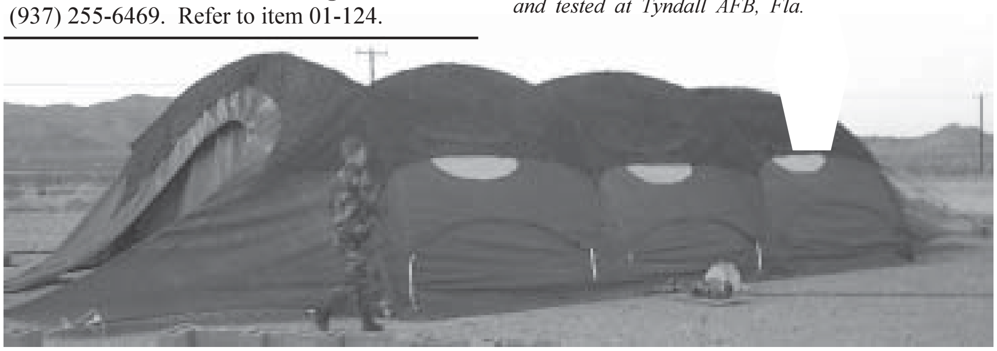
to the polymer used in manufacturing, the technology might be useful as fuel bladders," Salavani said.

"What started as technology for deployable shelters has evolved into several outstanding possibilities," he added. "It is obvious to several branches of the Department of Defense that this is a technology with wide application possibilities."

For more information, contact the Materials and Manufacturing Directorate's Technology Information Center at techinfo@afrl.af.mil or (937) 255-6469. Refer to item 01-124.

The frame of a temporary aircraft shelter that uses inflatable textile air beam technology.

One of the two types of small-shelters that were erected and tested at Tyndall AFB, Fla.



Olympic Sled
(continued from page 2)

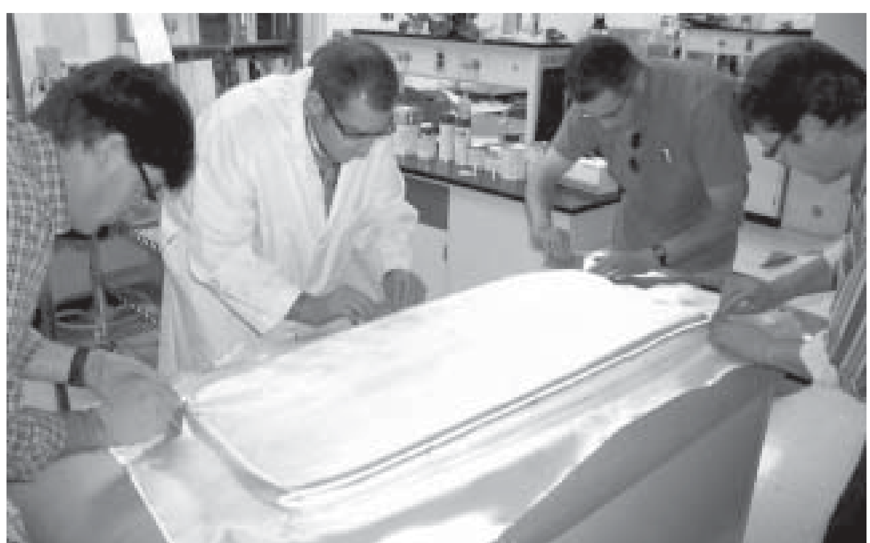
provided valuable hands-on computer aided design and three-dimensional modeling experience. The redesign effort also proves and advances several composite materials concepts that may have application to aerospace vehicles.

The sled component was an ideal choice, since two active-duty military personnel at the base are active competitors in skeleton racing and can readily apply and test the results of the redesign effort. A hand built model of the pod was used to generate a 3-D representation, which was then placed into the CAD program and used to change the part's shape. To optimize the contour for airflow, ACO engineers made two different part designs, each conforming to the standard two-foot wide by three-foot long dimensions.

Next, the 3-D model was downloaded to a five-axis router and a wooden master was cut. Then, the master was used to make a fiberglass female mold, which in turn was used to produce a hand lay-up part, using the same graphite epoxy employed on the C-17 transport aircraft. Since strength is a critical factor in skeleton sleds, the sled pod was autoclave cured to ensure it was optimized. The skeleton sled has no steering, braking or propulsion capability. It moves only by the pushing force provided by the athlete at the beginning of the race and the force of gravity as it winds through the course, sometimes at speeds in excess of 80 mph.

Maj. Brady Canfield and Senior Airman Trevor Christie, both assigned to Hill AFB, qualified in round one of the U.S. Nationals during October 2000. Ten men and eight women, including Canfield and Christie, were selected from a field of 41 hopefuls to compete in round two held in Calgary, Canada during November 2000, and to qualify for the World Cup team. Canfield finished second in the men's races with a best heat time of 49.44 seconds—no less than a Silver Medal finish, and is now considered one of the top four skeleton sled athletes in the United States. With more rigorous training and a bit of luck, Canfield and the new skeleton pod may advance to the 2002 Winter Olympic Games.

For more information, contact the Materials and Manufacturing Directorate's Technology Information Center at techinfo@afrl.af.mil or (937) 255-6469. Refer to item 00-499.



Engineers at the Advanced Composites Office at Hill AFB work on a skeleton sled redesign, hand lay-up.

CONTRACTS

COMPLETED

- Resin Transfer Molded Black Glass Composites - MDA972-93-2-0007
- Novel High Performance Polymers - F33615-95-D-5044
- Composite Preburner and Turbopump Housing Materials and Process - F33615-98-C-5051
- Low Temperature Plasma Coatings For Aircraft - F33615-96-C-5055
- Development of Resin Transfer Molding Technology - F33615-96-C-5057
- Low Cost Spray Form Processing - F33615-96-2-5262
- Superconductor Material For Infrared Detector Arrays - F33615-93-C-5355
- Smart Sensors Using Optical Fiber Interconnects and Distributed MEMS - F33615-98-C-5410
- Superpolished Calcium Flouride - F33615-00-C-5413
- Scanning, High Resolution, Probe Of Optical Anisotropies For Materials Characterization - F33615-01-M-5416
- Aluminum Gallium Nitride Junction Testing - F33615-00-C-5417
- Terahertz Optical Modulator - F33615-98-C-5430
- Direct Write Epitaxy - F33615-95-C-5440
- Development of Anti-Fretting Tribological Coatings - F33615-00-C-5506
- ASEM-Electronic Packaging And Interconnects - F33615-95-2-5562
- High Performance MIL Product Realization of Lean Aircraft Implementation - F33615-95-2-5564
- Thermodynamic Databases: Critical Tools For Developing and Processing High Performance Materials - F33615-00-C-5514

New

- Carbon Nanotubes For Electromagnetic Packaging - F33615-01-M-5033
- Accelerated Metals Development By Computation - F33615-01-C-5225
- Scanning High Resolution Probe For Optical Anisotropies - F33615-01-M-5425
- Development Of An Advanced Laser-Based Processing Method - F33615-01-C-5700

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