AD ASTRA KANSAS NEWS

To the stars through high-tech / space-tech R & D

Fall 2005 *Vol. 4, No. 2*

WSU friction-stir welding project has space applications

The flight of the Discovery last July illustrates the importance of astronauts being able to do repairs in flight.

Mechanical engineers at Wichita State University are working on a NASA-sponsored project to enable astronuts to fix leaks to spacecraft in flight by developing a portable friction-stir welding machine.

This unique project is one of only two such projects supported by NASA.

Friction-stir welding (FSW), is a technology patented in 1994 by a consortium of companies lead by TWI (The Welding Institute) in the United Kingdom, Friction-stir welding (FSW) research at WSU was started in 2001 by Dr. George Talia based on an idea of Dr. Art Nunes of NASA. Specifically, the studies focused on High Rotational Speed-Friction Stir Welding (HRS-FSW). WSU was the first institution to prove the high-speed concept for this technology, according to Talia.

WSU's Advanced Joining Technologies Lab at WSU followed in 2004. The aerospace industry is taking interest due to the potential benefits over conventional joining techniques. These benefits include reductions in weight, cost, and manufacturing.

Dr. Talia, principal investigator, recently answered some questions for Ad Astra Kansas News:

Q: Basically, how does the friction-stir process work?

A: To join two pieces of material, a hardened steel-pin rotating tool is forced along the weld seam.The action between the tool and the material creates frictional heat, (for aluminum alloys, the opeating temperature would be between 430 to 500 degrees C.) This softens the material, but does not melt it. The plasticized material is then consolidated to create one piece of material instead of two. This process allows plate and sheet materials to be joined without any significant joint preparation, filler material, or shielding gas. Also, since FSW is a solid-state process (i.e., no melting) there is little distortion when compared to more conventional arc welding processes and no porosity or solidification-related cracking.

Depending on the material to be joined, a FSW weld can actually have higher mechanical properties than the base material being joined, as is the case for some aluminum alloys.

Q: What kind of materials can this process be used on?

A: FSW can be used for joining many types of materials and material combinations. Industry research has demonstrated that a number of aluminum alloys could be successfully welded to yield reproducible, high integrity welds within defined parametric tolerances.

Also preliminary welds were successfully produced with copper, titanium, magnesium and their alloys; lead, zinc, plastics, mild steel, magnesium to aluminum,metal matrix composite based on aluminum and other aluminum alloys.

Q: How does joint strength compare to regular riveted seams?

A: The welds are several times stronger than regular riveting. However, some of the good properties of riveting are lost, i.e., corrosion, stress corrosion cracking, etc. (which are not important in outer space).

Q: Is the friction-stir process used now in the production of any space shuttle parts? Could this be used to build a whole shuttle?

A: Yes, it is being used to partially weld parts of the external fuel tank of the Space Shuttle. No. The Space Shuttle needs thousand of technologies. But, FSW and HRS-FSW may be used to join 50% to 60% of the structural parts of the shuttle.

Q: Has this process ever been used in space before? What would be its uses?

A: No. It is expected that this type of technique will be used to fabricate additional modules for the space station (not only as a repair tool in case of damage.) It will be much easier to assemble the modules in outer space instead of putting them in orbit fully or partially assembled.

Q: What size are we talking when we mean portable?

A: The first portable machine was developed in 2001 by Dr. Talia's research group. Focusing on the need of a first level machine for professional reference, they [designed] a portable high-speed friction-stir welding machine with manual feed. The spindle speed was between 10,000 rpm to 22,000 rpm at no load condition.The machine in the AJT lab is for industrial application and the size is large, that is 10 by 10 by 20 feet

For low speed friction-stir welding, the friction pressure has to be relatively large to input the necessary energy for the process to occur. Hence the machine is large and massive, i.e. ten by six by 4 feet. Rigid machines provide a robust platform for low rotational speed friction-stir welding.

However, the advantage of high rotational speed friction-stir welding [which will be used in space] is the ability to input most of the energy by the high rotational speed, reducing the size and mass of the machine and reactive tooling, i.e., 1.5 by 1.5 by 3 feet. Preliminary experiments and calculations indicate that the friction pressure forces is inversely proportional to the rotational speed.

Cont. "friction-stir" page 4

Topeka company is Kansas' newest NASA Connection

When watching with fascination the images fed back throughout the Discovery flight last July, little did America know that a Topeka company was behind those visuals.

Last February, QuVis, Inc., Topeka, bested a number of other competitors to be chosen for the NASA's Return to Flight program and as such, their equipment is used for "quick look" and tracker applications.

QuVis has developed software and hardware with the ability to capture digital imagery in real time at a higher defintion and lower distortion rate than ever before possible.

To handle this mission, more than 100 QuVis cameras/servers were installed on the shuttle and other sites. In providing equipment for analyzing every step of the shuttle launch, QuVis products were installed at Goddard Space Flight Center, Marshall Space Center, Kennedy Space Center and Johnson Space Center, as well as on two WB-57 jets that fly at an altitude of 60,000 feet to track the shuttle's launch.

QuVis servers caught the images and compressed them drastically, enabling simultaneous transmission with no loss of quality for instant analysis at NASA sites around the country.

QuVis, was founded in 1994, by Kansas native Kenbe Goertzen.

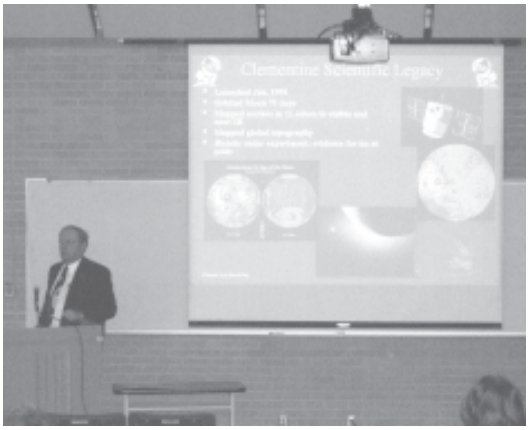
Source: www.quvis.com

In this issue

Ad Astra Kansas Day event looks to the stars

The third annual Ad Astra Kansas Day event held in Topeka at Washburn University on April 30 took a broad look at Kansas' space future.

Headlining was Dr. Trevor Sorenson, KU associate professor of aerospace engineering. Sorensen spoke on the milestone achievement of launching Kansas' first pico satellite, Pathfinder, in 2005. Looking forward to future applications, one project Sorensen mentioned includes using clusters of Pathfinder satellites, launched at two or three year intervals over the course of a dozen or more years to map a new and more accurate model of the Van Allen Radiation Belt.



Dr. Trevor Sorensen discusses the Clementine Mission to the Moon project with which he was involved.

Explanation of the electromagnetic spectrum by Dr. Paul Adams (right) included using handheld spectroscopes; also IR thermometer were used to compare temperatures of different surfaces. Following was a discussion on how this might be used in the classroom and how it relates to satellites.

Attendees at the Ad Astra Kansas Day event work with classroom activities provided by NASA solar system educator Terri McManus.

NASAinKansas is present at the Kansas State Fair

The NASA presence in Kansas is one with which most people are not familiar. With the goals of informing the public and inspiring new generations of scientists, NASA's official presence in Kansas--the Kansas Space Grant Consortium--hosted its first ever booth at the Kansas State Fair.

A focal point was a video highlighting people, programs and projects the KSGC supports with NASA funding.

"NASA in Kansas is about people who have chosen to work in the STEM (science, technology, engineering and math) fields-- who educate and do research to make us a competitive state in aerospace science," says KSGC coordinater Sue Suhler.

One program mentioned in the 27- minute video is NASA EPSCoR. "NASA EPSCoR is about technology and ideas and putting together the best people... talented people wherever you find them in the state to tackle problems of global significance and concern to NASA and the rest of society," says Richard Hale, associate director of the KSGC.

Featured was the cooperative effort between KU, KSU and Pittsburg State to develop a modular wireless avionics system for UAV (Unmanned Aerial Vehicles).

Also featured were KSGC grant recipients such as Michael Altenhofer, graduate of the 2005 NASA Goddard Robotics Internship Program and Loral O'Hara, graduate of the 2004 NASA Miicrogravity Academy.

KSGC coordinator Sue Suhler gives out materials to a teacher who stops by the Kansas State Fair booth.

Materials geared to educators and students of all ages were given out over the course of the ten-day fair. About 1600 NASA coloring books, 3,000 KSGC bookmarks and twenty teacher packets were distributed, says Suhler.

Cosmosphere premieres "Magnificent Desolation: Walking on the Moon"

HUTCHINSON, KAN. – "Magnificent Desolation: Walking on the Moon" premiered at the Kansas Cosmosphere and Space Center's IMAX® Dome Theater on Friday, Sept. 23 and continues through December.

Featured in the film is the Cosmosphere's Lunar Module, and the Lunar Roving Vehicle, commissioned for use by Tom Hanks, producer and narrator of the film. Other Cosmosphere items were made available including the ALSEP (Apollo Lunar Surface Experiment Package), and a collection of tools and equipment used by the astronauts in the film.

"We're excited to premiere this great film and proud that we were able to contribute to its production through the use of our Lunar Module and Lunar Rover," said Jeff Ollenburger, president and CEO of the Cosmosphere. "The historical accuracy of these artifacts, right down to the labels under each switch and the etching on the windows, gives this film added credibility and enhances the understanding audiences have of what it was like to perform a mission on the Moon."

"Magnificent Desolation: Walking on the Moon" focuses on the lunar adventures of the twelve men who walked on the moon and brings their stories to life on the large screen format using previously unreleased NASA footage, newly revealed photographs, and live renditions of their activities on the lunar surface.

The Lunar Module and Lunar Rover are currently on display at the Cosmosphere.

Published through the Ad Astra Initiative of
Space Age Publishing Company, 220 California Avenue, Palo Alto, CA 94306
to promote and publicize Kansas high tech / space tech research and development.

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The following list is part of an ongoing reference directory featuring representative research projects in Kansas. Ad Astra Kansas' goal is to serve as an information hub in Kansas focusing on different areas of high-tech and space research for networking and educational purposes.

AVIATION

"Crashworthiness of Composite Material Dynamic Properties," $200,000 S. Keshavanarayana and H. Lankarani, WSU NIAR. FAA funding suresh.keshavanarayna@ wichita.edu 316-978-5939

General Aviation Icing Research Program—Phase II," $901,577, M. Papadakis, WSU Dept. of Aerospace Engineering. NASA funding 4-05 michael.papadakis@ wichita.edu 316-978-5936

"Rocketplane ALS Wind Tunnel Model Testing," $42,200, John Laffen, WSU National Institute of Aviation Research (NIAR). Rocketplane Lt. funding 6-05. 316-978-3569 john. laffen@wichita,edu

BIOTECHNOLOGY

"Unified Data Format for Mass Spectrometry Analysis UDF," John Gauch, KU Dept.of Electrical Engineering/Computer Science. Kansas Idea Network of Biomedical Research Excellence (KINBRE)-NIH funding 1-13-05 gauch@gmail.com 785-864-8819

ENERGY

"**Supramolecular Nano Structures for Light Driven Energy Transfer,"** $128,000, F. D'Souza, WSU Dept. of Chemistry. NSF funding awarded 6-05 316-978-7380 francis.dsouza@wichita.edu

"Composite Fabrication Testing and Verification," $100,00, J. Locke, WSU Dept. of Aerospace Engineering. DOE/Sandia Labs funding 2-05 james.locke@wichita.edu 316-978-3410

INFORMATION TECHNOLOGY

"Index Switchable III-Nitride Planar Lightwave Circuits for Optical Communications," Ronqing Hui, KU Dept. of Electrical Engineering and Computer Science. NSF funding 8-17-05 hui@eecs.ku.edu 785-864-8814

"Modular Wireless Avionics System for Autonomous UAV," Xue-Wen Chen, KU ITTC. Cooperative effort between KU, KSU and PSU. NASA-EPSCoR / KTEC funding 1-20-05 785-864-8825 xwchen@ittc.ku.edu

"Development of a Spatial Frequency Domain Interometry Rad System for Measurement of Sea Ice Thickness," Sivaprasad Gogineni, KU Dept. of Engineering and Computer Science. NASA funding 8-30-04 785-864-8800 gogineni@rsl.ku.edu

MANUFACTURING and ADVANCED MATERIALS

"AMRI: Development of an Ultra Speed Camera Capable of Simultaneous Full-field Deformation and Temperature Measurements," $172,190, V. Madhavan and H. Hijazi, WSU Dept. of Industrial and Manufacturing Engineering. NSF fundng 7-04. vis.madhavan@wichita.edu 316-978-5913

"Evaluation of Friction Stir Welding Process and Properties for Aircraft Application," $300,000, D. Cope, George Talia and B. Kumar, WSU Dept. of Mechanical Engineering. george.talia@wichita.edu; 316- 978-6343

"Next Generation Ice Protection Technologies for Unmanned Aerial Vehicles, Engineering Study," $909,004, M. Papadakis, WSU Dept of Aerospace Engineering. DOD/Miltec Corp. funding 3-05 michael. papadakis@ wichita.edu

"Thermal Spray Coatings for Composite Structures in Aviation," $50,000, I. Ahmed, WSU Dept. of Mechanical Engineering. ADMRC award 1-05 ikram.ahmed@wichita.edu 316-978-6292

Sources: WSU Office of Research Administration Research and Sponsored Projects Fiscal Year 2005 Report, KU ITTC Project and KSU research listings.

"Friction-stir" cont.

The reduction of the friction pressure forces will also permit the design and fabrication of small portable machines capable to be used for "in-space" repairs, i.e., 1 by 1 by 1.5 feet.

Q: What are some challenges in developing this portable machine?

A: It is not a simple task to bring out a new machine for space repairs, since the process itself is not fully understood. The principal problem is the weight of the machine. Additional problems are the internal balance, the absence of gravity to hold the machine, attachment points, and, of course, the safety of the astronauts.

[By the way] the lack of oxygen is highly beneficial for the process.

Q: How long have you and your colleagues been working on this specific project?

A: The work started around May of this year. Most of the work was and is done on the development of the machine by Dr. Talia (WSU) and Mr. Callahan (ECS). It is expected to be fully developed by the end of this year. In addition, ECS is designing/developing a high efficient mini power plant to be used in outer space for this machine.

The two principal support centers/company are Marshal Space Flight Center – NASA in Alabama and Engineering Consulting Service, a company in North Carolina which provides technical advice, personnel expertise and use of some proprietary technologies.

KTEC also has provided some funding. Besides Dr. Talia, Kurt Soschinske and Hamid Lankarami of WSU and Bruce Babin of KSU are connected with the project.

Wichita middle school is Kansas NASA Explorer School

One of only 150 schools selected nationwide, Jardine Diversified Leadership and Technology Middle School in Wichita is Kansas' only NASA Explorer School.

Selected in 2004, the school is in the second of three years of funding from NASA.

In year one, technology and distance learning equipment enabling hook-ups with NASA sites were installed. Activities this year include a connection to an Arizona lab working with NASA's Jet Propulsion Lab in California. Students were able to watch testing of prototypes for vehicles that may be used on the moon or Mars. Students also were able to observe astronauts suiting up and ask personal questions of them.

Over 600 students a year at Jardine are impacted by this NASA designation, according to Mary Robillard, NASA Explorer School team leader. Every science teacher there is using NASA curriculum to supplement school district curriculum. NASA curriculum focuses on science, technology, engineering and math (STEM). The intent is to eventually go cross-curricular and have every teacher at Jardine incorporating the NASA curriculum in some manner.

A goal for year three is to spread the NASA curriculum and related activities outside Jardine and involve the feeder elementary schools, other middle schools, even high schools, Robillard says.

The Explorer School program started with a five-member team of teachers who went to Houston and returned to share what they learned, with results being an imaginative and educational series of school and community events to further awareness of science and space.

A current project that involves both students and family is "Footsteps to the Moon--A NASA Explorer School Physical Fitness Project."-- with one goal being to walk the distance from the Earth to the Moon in one school year.

"[At the first event this year] in 2 1/2 hours 112 walkers walked almost to the International Space Station, 413 kilometers. They still have 383,587 kilometers to go," says Robillard. A series of community walking events are being planned, including one at Cessna Stadium (WSU) with participation of community leaders.

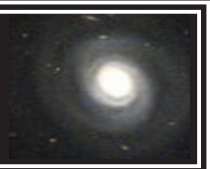
Also coming in October is the Red, White and Blue Family Night--Red being Mars, White the Moon and Blue Earth with over 20 presenters including NASA education specialists.

Jardine has also been selected to put an experiment on the International Space Station. Students from the WSU Dept. of Engineering, area high schools and aerospace professionals are being asked to advise the students in designing and making an experiment.

Jardine has also applied for a downlink to the ISS. Jardine will always be a NASA Explorer School, even when NASA funding ends, according to Robillard.

Interstellar R&D

Ad Astra Kansas News



This "Interstellar R&D" eighth-time feature in this ***Ad Astra Kansas News*** *eighth issue continues an enterprise to research and gather information on the most important developments preparatory to humanity's greatest adventure — voyaging to the stars. Now, at millennium's turn, is an appropriate time for grand vision and forward thinking, and there are strong signs of a renaissance in interstellar travel thought and activity. This new feature and newsletter, thus, now set forth to develop a national / international / global clearing center and storehouse of knowledge and know-how for travel to the stars: Ad Astra. — Steve Durst, Michelle Gonella*

OBSERVATION

Submillimeter Astrophysics

Submillimeter wavelengths enable astrophysicists to study the cosmos with extraordinary sensitivity, allowing sharpest views yet of obscured cold and dusty regions of the universe where stars and planets are being formed. Receiving submillimeter and millimeter radiation in wavelengths 0.25 to 1.7 millimeters, submillimeter technology can resolve the complex chemistry of molecular clouds which generate organic molecules, precursors of life.

Earth's first submillimeter array SMA, an eight 6-meter antenna dish interferometer operational November 2003 at 4,140 meters atop Hawaii's Mauna Kea, literally has "seen what Hubble can't see". The first scientific paper on SMA observations published March 20, 2003, reported on the "flaring emission from the radio source surrounding the black hole in the center" of our Milky Way galaxy.

Submillimeter astronomy is coming of age, and the SMA, operated by the Harvard Smithsonian Center for Astrophysics, enabled "exquisite resolution" of the molecules released by NASA's Deep Impact on the nucleus of Comet Tempel 1 on July 4, 2005. The SMA also is used to monitor Mars weather and atmospheric chemistry, and to analyze Titan's thick, hazy atmosphere, climate and seasonal change — which is highly important for astrobiology and in studying new planets around other stars.

The future of submillimeter astrophysics is upward, toward higher and drier places where less and less water vapor in the atmosphere blocks incoming submillimeter radiation. At 5,500 meters above the sea on Chile's northern desert, the European-North American-Japanese Atacama Large Millimeter Array ALMA of sixty-four 12-meter antenna operational late this decade will achieve a resolution of 10 milliarcseconds — 10 times better than the SMA and the Hubble Space Telescope.

COMMUNICATION

M Stars Hold New Promise for SETI

The discovery of a planet orbiting an M star only fifteen light years from Earth may identify a new class of planets as good candidates for SETI activities. Jill Tarter, Director of the Center for SETI Research at the SETI Institute, points out, "Simple theory said that terrestrial planets in orbit around M stars will be uninhabitable and uninhabited. But we are not confined to simple theory any more."

M stars were previously considered unsuitable SETI candidates because they were thought to be too small to host planetary systems similar to our own. New observations however, indicate that rocky planets with mass similar to that of Earth can be found orbiting M stars. "It may well be that there are far more habitable planets orbiting M dwarfs than orbiting all other types of stars combined," states the Director of the SETI Institute's Center for the Study of Life in the Universe, Frank Drake.

A series of workshops conducted by the SETI Institute will bring together forty participants from academia and NASA Astrobiology Institute (NAI) to determine whether M stars should be included in SETI observation. "Most of the stars out there are M stars," Tarter notes. "They haven't been on our target list. Maybe they should be. And if that's the case, the list just got a whole lot bigger."

TRANSPORTATION

Will Opposites Propel?

Steven D. Howe, a nuclear engineer from Los Alamos National Laboratory, is now acting as founding director at the Center for Space Nuclear Research. The Center opened 19 September 2005 in Idaho Falls and will be coordinating a small grant program to promote research focused on nuclear power and propulsion.

"We have to have nuclear for a Mars mission," Howe states. Much of his career at Los Alamos was focused on a human mission to Mars. However, in 2000 Howe left Los Alamos and founded Hbar Technologies, LLC. There he focused on a solar sail spacecraft capable of reaching Alpha Centauri. The solar sail was driven by a power pack of 17 g of antihydrogen, a mirror image of ordinary hydrogen.

The NASA Institute for Advanced Concepts (NIAC) provides six month seed grants for feasibility studies of concepts which may be decades ahead of their time. Positron Drive is a propulsion concept which NIAC believes may offer a quantum leap forward in travel capabilities throughout the solar system and beyond. The positron is the mirror twin of the electron. Positrons are extremely rare due to their attraction to electrons, which culminate in annihilation and a burst of gamma rays. However the energy from the burst of gamma rays can be controlled and utilized for a wide variety of applications.

Gamma rays can be applied to a propellant or shot into tungsten plates to superheat and push air out the back of aircraft. Gerald A. Smith, Principle Investigator for Positronics Research, LLC of Santa Fe, New Mexico points out that, "the energy density of antimatter is ten orders of magnitude greater than chemical and three orders of magnitude greater than nuclear fission or fusion energy." This is significant in that fuel would no longer comprise over half the weight of spacecraft.

Electron-positron pair production is accomplished by acceleration of an electron beam through dense tungsten. According to Smith, "Only one millionth of the positrons survive. Our long-range goals are five quad-trillion positrons per second. At this rate we could fuel up for our first positron-fueled flight into space in a matter of hours."

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