NASA NDE WORKING GROUP NEWSLETTER

January 1996 Quarterly Newsletter VOL. 4, NO. 1

WWW URL address: http://ndeaa.jpl.nasa.gov/

CONTENTS ***PAGE NO.***

NASA HQ CODE Q MESSAGE

Joseph Siedlecki, 202-358-0205, jsiedlec@cc.hq.nasa.gov

I am pleased that the planning for the annual workshop is proceeding. The workshop is planned for February 21 thru 23 at the Kennedy Space Center. It will provide an excellent opportunity to discuss current important NDE topics such as the on-going RTOPs, the final version of the proposals for FY'97, and the NDE program plan currently being developed by LaRC. Your inputs and support of the development of the NDE plan is vital to the process of orderly transferring the NDE function to Langley.

Edward Generazio is the new NASA Code Q NDE Program Manager.

NEW CODE Q NDE PROGRAM MANAGER MESSAGE

Edward R. Generazio, 804-864-4970
Ed_Generazio@qmgate.larc.nasa.gov

The 1996 fiscal year has proven to very unusual. Each of us had to handle the furloughs in our own way. To some it had been a life experience that effected how they view their roles in family, work, and life. I know several people that are still trying to get close to where they were before the

furloughs occurred. It is important for all of us to keep focused on our goals and maintain the best path to get there. We are all in this together, and I'll do my best, with your help, to keep us at the leading edge as we go forward through these rough waters. We will get through this and we will be stronger.

During these difficult times, we have kept close to our planned schedule. NDE issues absolutely can not wait. Your drive to march forward is a clear demonstration of your commitment to your critical role in assuring mission success. We must continue to maintain a sharp eye on all the issues before us, and prioritize and address those issues until we are satisfied that we have done our very best. I look forward to working with each of you, and to having a very productive FY'96.

NNWG HIGHLIGHTS

Yoseph Bar-Cohen, 818-354-2610, yosi@jpl.nasa.gov

NASA NDE MANAGEMENT TRANSFERRED TO LaRC - Michael Greenfield, deputy to the Assistant Administrator of Code Q, has named Ed Generazio, LaRC, as the new NASA NDE Program manager, Ed Generazio, LaRC, that he is the new NASA NDE Program Manager. Ed Generazio conveyed his resignation as Vice-Chair of the Code Q Standing Committee. He expressed his desire to see broader participation members of NNWG in the overall NASA NDE activity, including RTOPs, telecons and meetings. He intends to use the Code Q Standing Committee priority list as an important recommendation when selecting RTOPs.

3rd NNWG WORKSHOP - The NNWG is planning to hold its 3rd NNWG Workshop at KSC, Florida from Feb. 21 to 22, 1996, with a tour of the KSC facility on the morning of Feb. 23rd. The theme of the brainstorming meeting is "where we are and where are we going". During the meeting, current and proposed RTOPs will be presented and reviewed. If the launch of the Space Shuttle Mission: STS-75 -TETHERED SATELLITE - 1R & USMP-3 stays on schedule, we will have the opportunity to view it on Feb. 22 at 3:18 p.m. We have to be sure that we are paving our future with the input and consideration of the needs of all the Centers. LaRC is currently preparing a plan for the future of the NASA Code Q NDE and it is helpful/critical to all the field Centers that we discuss these plans openly and assist in both input and direction

NNWG 1996 DIRECTORY - The NNWG Directory for 1996 was completed in December, 1995. The cover page of the Directory shows the Mars Pathfinder, which is being developed at JPL for launch in Dec. '96. It represents the new NASA approach of taking risks. NDE is playing an important role in minimizing the risk associated with this Mission as well as future missions. Copies of the Directory were distributed to all the members of the NNWG, as well as selected individuals throughout NASA.

COMING ASNT SPRING CONFERENCE WILL BE HELD NEXT TO LaRC - The coming ASNT Conference will be held from March 18 to 22, 1996 near NASA LaRC in Norfolk, Virginia. The meeting will have four tracks: (1) General NDE Topics and Applications, (2) Process Monitoring and Control Track, (3) Life Cycle Inspectability and (4) Infrastructure.

MS-WORD FILES TAINTED WITH A VIRUS COMMUNICATED OVER THE NETWORK - Some of the MS-Word file attachments that were sent in recent months via e-mail were found tainted with the virus known as Concept. This virus is activated when the "Save As" option is selected and it affects the file macros. The only option that is given is to save renamed files into the program template. To eliminate this virus contact your Center software administrator or obtain a copy of the MS-file ***scanprot.dot*** which needs to be read by MS-Word.

NNWG Code Q Standing Committee

Bob. Neuschaefer 205-544-7382, bob.neuschaefer@msfc.nasa.gov

Committee activities were severely impacted by the furlough; however, the end date for completion of the candidate pre-POP RTOP evaluation process

has remained firm due to the need to maintain the critical NASA NDE infrastructure, and support the yearly budget cycle.

A Telecon for presentation of proposed RTOPs was held Jan. 25,1996 and all field centers were represented. Ed Generazio of LaRC conveyed his resignation as Vice-Chair of this committee due to his appointment as the new NASA Code Q NDE Program Manager. New guidelines were transmitted from Generazio related to strengthening support for Programs and assuring proper research in order to lay a foundation for each RTOP. It was announced that one RTOP per Center was too restrictive and two submissions per Center would now be accepted for consideration

Committee members submitted five candidate RTOPs for consideration, each followed by a lively question and answer session. In light of the new guidelines, a submission date for revisions to previously submitted RTOPs and additional new RTOPs was set for February 8 to be followed by a Telecon Q&A on February 12.

ORBITER NDE SUB-COMMITTEE (ONSC)

Rick Russell, 407-861-4168
rrussell@tvnet.ksc.nasa.gov

ORBITER NDE SUB-COMMITTEE (ONSC) HELD A TELECON ON OCTOBER 23, 1995 - The entire Telecon was devoted to discussions of current issues and new developments of the various applications of ultrasonic bolt stretching. There are three applications where ultrasonics are used for bolt stretching measurements for the Orbiter. They are:

1. The Orbiter/ET (External Tank) attach bolts.
2. The Orbiter/SCA (Shuttle Carrier Aircraft) attach bolts.
3. The Orbiter Vertical Tail attach bolts.

Most of the current difficulties involving the Orbiter/ET attach bolt measurements can be attributed to a slot on the back end of the bolt which creates signal distortion. These efforts are intended to assist in modifying the design of the attach bolts. KSC Engineering is also investigating the effect of bending loads on the ultrasonic properties of these bolts. Currently, the Orbiter/SCA attach bolts are also under review for a design change to improve the ultrasonic measurements. Problems which have been encountered with the Orbiter Vertical Tail attach bolts were in the transferring of calibration from one equipment to another and in repeatability. It is felt that we now have a good handle on these techniques.

William St. Cyr, SSC, honored for his contribution to JANNAF

NNWG PERSONNEL NEWS

JANNAF HONORING TWO MEMBERS OF NNWG - NNWG would like to congratulate Eric Madaras and William St. Cyr for receiving the JANNAF Executive Committee Certificate of Recognition in recognition of their outstanding contribution. Congratulations Eric and Bill!

The JANNAF award is presented annually to a few select individuals in the propulsion community in recognition of their contributions to advancing the state-of-the-art of chemical and electrical rocket propulsion science and technology and their efforts to further the goals and objectives of JANNAF.

ASNT APPOINTED BAR-COHEN TO CHAIR TWO UT COMMITTEES - Y. Bar-Cohen was appointed as the Chair of the ASNT Sonics and Ultrasonic P&Q Committees.

Eric Madaras (center, LaRC) received the JANNAF Executive Committee Certification of Recognition, which was presented by Lee Jones (left, MSFC), the NDES liaison, and Jamie Fisher (right), the outgoing NDES Chair.

NASA CENTERS NEWS

ARC

John Segrato 425-604-4112
john_segreto@engr.arc.nasa.gov
REVERSE GEOMETRY X-RAYÒ (RGXÒ) IMAGING - RGX*Ò* is finding increasing NDE applications to aerospace structures. In contrast to conventional radiography, RGX*Ò* reverses the relative sizes of source and detector as well as the placement of the object. The object is placed adjacent to the large, computer controlled raster scanning source at a distance from the point detector. This arrangement allows scattered radiation to bypass the detector, thereby increasing the contrast sensitivity (signal-to-noise ratio).

Application of RGX*Ò* at LaRC and McClellan Air Materiel Command (Sacramento, California) include finding defects such as corrosion, impact damage, and water entrapment in aluminum and composites. In the case of corrosion on aging aircraft, it was possible to detect the loss of material down to as little as 1.0%, even when the material loss is disguised by the presence of corrosion products. RGX's sensitivity reveals excess resin or water entrapment. The distance between object and detector can be easily increased to reduce parallax effects and increase throughput for large area honeycomb and/or thick honeycomb inspection.

LaRC plans to use its RGX system for work in the area of *in situ* detection of corrosion in aging aircraft/spacecraft and the development of new, advanced materials and structures. Like ultrasound, RGX is suited for research into the failure modes of metal matrix composites at "high stress levels." NASA and Digiray signed a partnership agreement to improve the technology in such areas as precise 3D measurements, detector miniaturization, and laminography.

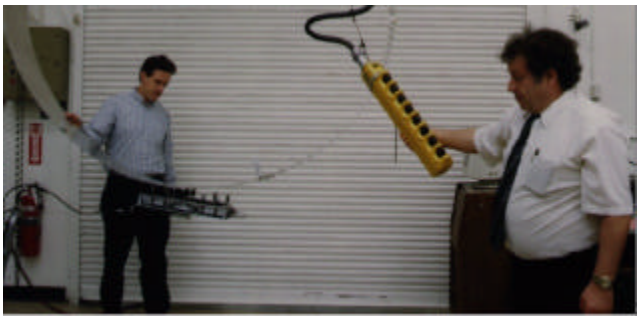
Phase I of a NASA-funded Small Business Innovative Research grant has allowed Digiray Corporation to increase RGX penetrating potential from 100 KeV to 125-135 KeV. Under Phase II, the penetrating potential has now been increased to 160 KeV. This opens up new potential applications. A second phase II NASA contract has as its objective to improve portability and laminography of the RGX*Ò* system. Recently, an Air Force Phase I contract demonstrated that the Lawrence Livermore National Laboratory computed tomography (CT) is feasible with the RGX configuration. LaRC is continuing this CT work. For more information you can contact ***Richard D. Albert (510) 838-1510, Digiray Corporation, DIGIRAY@delphi.com***

GSFC

James Chern 301-286-5836,
james_chern@ccmail.gsfc.nasa.gov
CAPOZZI LEADS MATERIALS ENGINEERING BRANCH TECHNOLOGY DEVELOPMENT EFFORTS - Victor F. Capozzi, Staff Scientist of the Materials Engineering Branch, Assurance Technologies Division, Office of Flight Assurance, will lead materials technology development efforts for the Branch. Capozzi is the Branch focal point and coordinator for materials related technology programs such as 998, DDF, RTOP, and SBIR, etc. His effort includes NDE research, development, engineering, application and technology transfer. Prior to joining the Branch in October 1995, Capozzi was the Office of Flight Assurance Directorate contract monitor for the

Unisys support contract. Capozzi can be reached at 301-286-1971 and 301-286-1646 (fax).

HEAD OF THE MATERIALS ENGINEERING BRANCH COMPLETED PH.D. - R. Marriott has successfully defended his Ph.D. thesis at the Department of Materials and Nuclear Engineering, University of Maryland on January 23, 1996. He is now Dr. Richard S. Marriott.



JPL's MACS unit is crawling on the bottom of a circular fixture simulating an aerospace surface.

JPL

Yoseph Bar-Cohen, 818-354-2610, yosi@jpl.nasa.gov

DEVELOPED A NOVEL MULTIFUNCTION AUTOMATED CRAWLING SYSTEM (MACS) - A 10x19-in, 10-lb crawler was designed and fabricated to carry miniature instrumentation payload to perform a wide variety of tasks while being attached to the surface of the structure of interest. MACS was developed under a contract with the Robotic and Automation Center of Excellence at Kelly Air Force Base. The immediate application of MACS is to inspect aircraft and for this purpose various inspection modules can be used. MACS employs ultrasonic motors for mobility and suction cups for surface adherence. The crawling system was designed for continuous mobility while in motion allowing high speed operation. It has a set of two legs for linear traveling and a rotation element for maneuvers and turning. The use of ultrasonic motors, composite materials construction, miniature computer and video imagers enabled the production of a small, light weight crawling system with an effective carrying capability of about 1:10. This carrying capability surpasses any known similar system. The team that developed MACS consists of P. Backes, Y. Bar-Cohen and B. Joffe with assistance of W. Proniewicz and M. Lih.

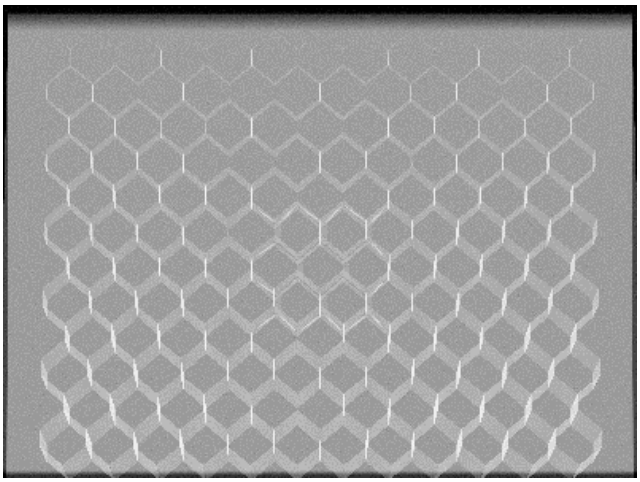
DISCUSSIONS OF COOPERATION JPL/ LaRC - On October 26, 1995, Y. Bar-Cohen and P. Backes visited NESB, LaRC, to discuss cooperation and coordination of general NDE issues as well as potential joint development of miniature inspection payloads for JPL's recently developed crawler, MACS.

Note: The following is a description of a new development at CNDE having potential cost saving in process development. It was demonstrated to Bar-Cohen and Backes during their visit in October at CNDE.

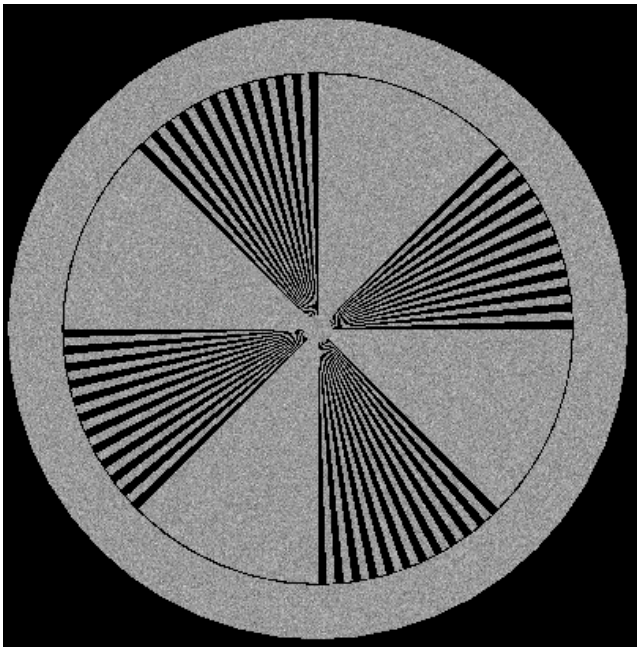
DEVELOPMENT OF NDE PROCESSES USING RAPID SIMULATION AT CNDE - The Iowa State University Center for NDE is developing computer models for the accurate, rapid simulation of NDI tests using x-ray, ultrasonics, and eddy currents. These models are being integrated into total software packages with user-friendly interfaces. They have been ported to UNIX and Windows NT systems and will be available in the future for PCs. The x-ray simulator models over 38 radiographic parameters, such as generator and film type, part geometry, setup distances, exposure value, material absorption, etc.

Compton scattering will soon be included as well. Many types of defects can be inserted anywhere into the CAD model part for realistic simulation of x-ray NDI. (See photo for example of simulated radiograph.) The ultrasonic simulator has both 3D ray models and a realistic beam model. Simulated A, B, and C scans can be generated. The ray-tracing model, with reflection, transmission and refraction, executes in real-time on a workstation. The eddy current simulator can give near real-time Real and Image output vs. position for air-core probes scanning over surface crack-like defects and impedance-plane output for corrosion thinning. For more information, please

Dale Chimenti, CNDE, Iowa State University, 515-294-7771, chimenti@iastate.edu



Simulated radiograph of a honeycomb sandwich using the CNDE developed computer code.



Simulated radiograph of a penetrameter gauge.

INSTALLATION OF A LASER-ULTRASONIC SYSTEM IS SCHEDULED FOR COMPLETION AT McCLELLAN AIR FORCE BASE - UltraOptec has developed a laser induced ultrasonic system that performs C-scan of large structures without the need for couplant. A high-power short-duration laser source induces ultrasonic waves by exciting thermal expansion of the surface. The excited wave travels through the material in a similar form as pulse-echo and is received by a second laser that employs light modulation. The inspection is remote, non-contact and does not require a coupling medium as does conventional ultrasonics. The use of laser enables the inspection of complex structures since the requirement for surface normality is not critical. UltraOptec has a laboratory system installed at Aerospacial-Dassault Aviation in France and recently delivered a system to McClellan AFB. The system is currently being installed and is expected to became operational for inspection of large aircraft structures in March 1996. This system is expected to be the first service operational unit. For more information, please contact, ***Kevin Shannon, UltraOptec, 514-449-2096.***

MATERIALS DEGRADATION CHARACTERIZATION RESEARCH AT UCLA - The Materials Degradation Characterization Laboratory is one of the laboratories in the Mechanical and Aerospace Engineering (MAE) Department at UCLA. The laboratory is equipped with a Servo-hydraulic Test Frame (Instron), a Fracture Wave Detector (Digital Wave Corp.), an Ultrasonic C-Scan System (by Tektrend), and an Acoustic Microscope (by Olympus Corp.). The research team consists of faculty, post-doctoral scholars and graduate students with specialization in solid mechanics, structural mechanics and materials science, and associates from local aerospace industry. The research focuses on the NDE of materials degradation caused by corrosion and fatigue in structural materials including high strength metals (aluminum, steel, titanium and their alloys) and composites (polymer and metal-matrix). The research methodology includes theoretical modeling, numerical simulation and laboratory testing to detect and characterize the degradation process at an early stage and also to determine the effect of the evolving degradation on the fracture and failure of structural components. The ultimate objective is to develop the knowledge base required to extend the life of aging as well as newly built structures without jeopardizing their safety. The NDE topics under current study are:

1. Detection and characterization of material loss and pitting due to corrosion in aircraft

structural components using contact ultrasonics.
2. *In situ* characterization of the evolution of damage in notched and unnotched specimens of structural composites during fatigue tests.
3. Characterization of defects within riveted aluminum lap joints using guided waves.
4. Characterization of the internal damage to motorcycle helmets recovered from crashes.
5. Characterization of the mechanical properties of biological materials (e.g., bones).

For more information, please contact ***Ajit Mal 310-825-5481, ajit@seas.ucla.edu***

JSC

Marie Havican, 713-483-7134 mhavican@gp101.jsc.nasa.gov

RTOP on NDE of Orbiter structure efforts are continuing in the testing of the latest NDE methods that have potential to find corrosion through Orbiter tile. Nuclear Magnetic Resonance (NMR) and Digiray's Reverse Geometry X-ray (RGX) are in the process of being evaluated. If initial RGX testing is successful, further research may be conducted with the RGX system at LaRC, under the work being done by W. Winfree

KSC

Rick Russell (407) 861-4168 rrussell@tvnet.ksc.nasa.gov

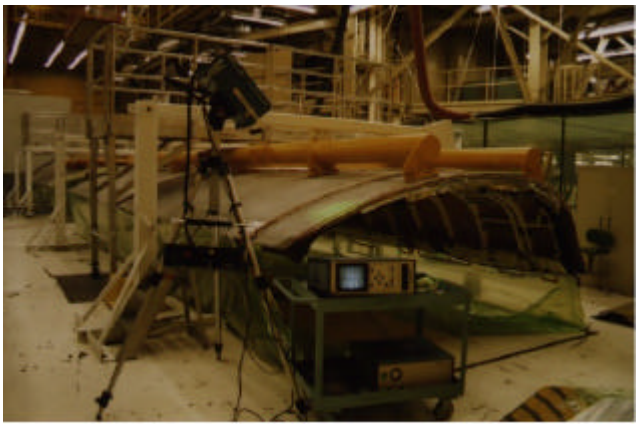
FACTORS THAT AFFECT READINGS OF ULTRASONIC BOLT-LOAD GAUGES - Three reports have been written which discuss the principles of operation and factors that affect the readings of ultrasonic extensometers used to measure preloads in bolts, studs and similar fasteners. These instruments measure "ultrasonic lengths" proportional to round-trip times of travel of ultrasonic pulses along fasteners. To a first approximation, the amount by which the ultrasonic length of a fastener under tensile load differs from the unloaded length is proportional to the load, and can thus be used to indicate the load. However, the reading of the ultrasonic instrument is complicated by such other effects as thermal expansion of the fastener, dependence of the speed of sound on temperature and stress, and variations in tension along the gripped portion(s) of the length of fastener.

The first report describes these effects; discusses measurement tolerances; presents equations for the propagation of errors in preload measurements; discusses uncertainties pertaining to the statistical variations in distributions of stresses, transducer coupling, and temporal as well as spatial variations of temperature; and discusses the many factors that affect the accuracy of instruments. The second and third reports address ultrasonic measurements of preload in a sleeve bolt, which expands upon installation to provide an interference fit in a hole. In this case, the measurements are affected by pressure from interference fit and by friction, which gives rise to hysteresis and to differences between the loads at the two ends of the fastener.

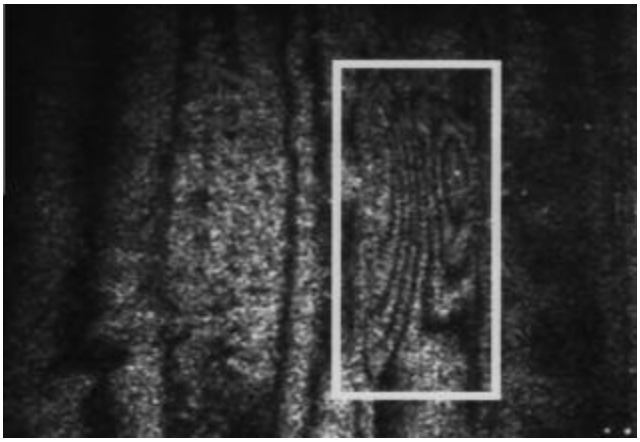
This work was done by **Ajay M. Koshti of Rockwell International Corp.** for JSC. To obtain copies of the reports, "Estimation of Accuracy in Ultrasonic Preload Measurements," "Preload Measurement in Sleeve Bolts Using An Ultrasonic Bolt Gage," and "Preload Measurement in Sleeve Bolts Using an Ultrasonic Technique," or any additional information call ***407-861-4594***.

TEST OF DISCOVERY PAYLOAD BAY DOOR USING SHEAROGRAPHY - From Dec. 4 to 7, 1995, shearography NDE was conducted on specified areas of the Payload Bay Doors (PLBD) removed from OV-103 (Discovery) during modifications at Palmdale, CA. The TPS on the PLBD had been partially removed for modification offering a unique opportunity for NDE of the composite structure for the first time since manufacturing. The two primary objectives of this test were first, to demonstrate large area inspection with very high sensitivity to disbonds. Second, to demonstrate the feasibility of future single side inspection of both bond lines in the honeycomb on the PLBD. Shearography with thermal stressing was used to inspect near skin-to-core bondline, ramp areas and solid graphite laminates. Vacuum stress shearography was used to examine both near and far side bond lines in the honeycomb areas. Vacuum shearography has been shown to have near and far side bondline inspection capability on

PLBD samples tested prior to the field test and in many other commercial and military aircraft applications. Verification of far side disbond detection capability was not feasible, however, since no disbonds were located in the honeycomb except in the ramp areas.



Tripod mounted shearography camera/laser is shown inspecting the aft end of PLBD #4 at location of delamination in a solid laminate frame member.



A view of a delamination (highlighted in the white frame) indication as seen on the image of processor. Flaw dimensions are 6.5x2.3 inches.

Using thermal stress shearography, small disbond indications measuring up to 0.75x0.30 inches were located along honeycomb ramp area and in many areas the honeycomb was imaged. A large 6.5x2.3 inch delamination was located at the aft end of Door #5 in a graphite laminate rib. Using ultrasonics, the delamination was confirmed and the depth measured as 0.053 inch deep in a skin thickness of 0.182 inches. Thermal stress shearography was also shown to be capable of inspecting large areas of composite and honeycomb materials at a rate of 60 sq. ft/hour. All images were stored on optical disc.
Sam Russell of MSFC NDE Branch provided the laser shearography system, a Model SC-4000 with a 400-mW diode laser manufactured by LTI. The test was supervised by C. Davis of KSC TV-MSD-4 with the support of A. Koshti, M. Anderson, E. Sallee, and K. O'Connor of Rockwell as well as J. Newman and A. Peterson of LTI. For more information, please contact ***J. Newman, Laser Technology, Inc. (LTI), 610-631-5043***

LaRC

Edward R. Generazio, 804-864-4970
Ed_Generazio@qmgate.larc.nasa.gov

CHARLES RICHARDSON VISITS NESB - C. Richardson from NDRI Detachment Bethesda Research Dept. visited LaRC to discuss recent progress on the Mapping Periodontal Structure project. Results and plans to commercialize were reviewed at that time. This work is being lead by Eric Madaras.

STAFF OF BABCOX & WILCOX VISIT NESB - W. Latham, L. Lauderdale, and D. Sclader of Babcox & Wilcox, Lynchburg, Virginia, visited M. Namkung and E. Generazio on to discuss electromagnetic based NDE technologies. The focus of the visit was the transfer of NDE technologies for off-shore platform and pipe integrity applications. Discussions on the initiation of a Memorandum of Agreement were held.

BILL WINFREE ATTENDS AFOSR SPONSORED WORKSHOP - B. Winfree attended an AFOSR sponsored workshop on Current Technologies and Open Problems in NDE of Corrosion in Aging Aircraft. At the workshop he presented an overview of current efforts at LaRC for development of NDE techniques for detection and quantification of corrosion in aircraft structures. The purpose of the workshop was to identify areas where data inversion and computational simulations would enhance techniques for corrosion detection and

quantification. The conclusion of the workshop was current efforts for conventional techniques are adequate. Potential payoffs exist in areas of emerging technologies involving global measurements on the aircraft.

FAA VISITS NESB - FAA visited NESB, to review programs related to aviation safety at LaRC. NDE program for aging aircraft were discussed including new NDE technologies for airframe systems and commercialization approaches used to transfer NESB NDE technology to industry. The FAA was very impressed by the work done in NESB.

YOLANDA HINTON ATTENDS IN-PROGRESS REVIEW OF THE ARMY - Y. Hinton of NESB attended the 6th In-Process Review (IPR) of the Army's Composite Armored Vehicle (CAV) Advanced Technology Demonstrator contract at United Defense in San Jose. The contractor reviewed progress to date on the design of an armored vehicle whose structure is primarily fiber-reinforced polymers. Among the objectives of the program are a weight savings of 33 percent over a similar metal vehicle with equivalent ballistic performance. Two quarter section test structures have been manufactured, and structural and ballistic testing of these sections is commencing now. One of these quarter section tests will be conducted at Aberdeen Proving Ground, and NESB has been asked to support this test with nondestructive evaluation before, during and after static load tests, after dynamic loading simulating firing of a 105 mm gun, and after foreign object damage, which includes a standard toolbox drop, as well as, brush and tree impact loads. The 2-day IPR was followed by a Composites/Structures Product Development Team (PDT) meeting. This team consists of government, contractor and subcontractor personnel collaborating on the design and analysis of the vehicle. The technology demonstrator is due to be delivered to the Army at the end of 1996 for a 6,000 mile field test over 2 years. Further support by NESB will be required for the field test.

JET PROPULSION LAB (JPL) VISITORS - Thursday, October 26, 1995, NESB was visited by Y. Bar-Cohen and P. Backes from JPL. The purpose of the meeting was two-fold. The first was to discuss opportunities for integrating NESB's NDE technologies with robotics under a new program being proposed by JPL. The second was to discuss the new Code Q joint RTOP between LaRC (E. Madaras) and JPL (Y. Bar-Cohen) which is to start in FY 96.

E. Generazio, E. Madaras and Y. Bar-Cohen (left to right) during the visit to LaRC.

Dr. Generazio Gives Presentation on Technology Benefit Estimator - On September, 1995, Dr. Edward R. Generazio of NESB gave a presentation entitled "Technology Benefit Estimator (T/BEST) for Aerospace Systems" to approximately 30 LaRC researchers involved in Multidisciplinary Optimization (MDO). The presentation was well received and generated numerous detailed questions. Dr. Generazio will continue to represent the Materials Division's optimization interest, as well as, provide lessons learned from the development of the T/BEST system to the LaRC MDO community.

TECHNOLOGY DEMONSTRATION AT STODDARD HAMILTON AIRCRAFT, INC. - Two NESB technologies under investigation for application to fiberglass general aviation aircraft were demonstrated at Stoddard Hamilton Aircraft, Inc. in Seattle. Applications of the technologies (Thermochromic Liquid Crystal Sheets and Shadow Moiré Imaging) are being investigated as potential low-cost alternatives to current

inspection methods as part of NASA's Advanced General Aviation Transport Experiments (AGATE) program. Following the technology demonstration, a 3-day program planning workshop was attended aimed at developing focused 5-year research plans for the Integrated Design and Manufacturing Work Package in the AGATE program. This work is being lead by E. Cramer.

BOEING VISITORS DISCUSS TECHNOLOGY TRANSFER OF THERMAL IMAGING WITH NESB - Boeing's Defense and Space Group in Wichita, Kansas, visited NESB on Thursday, September 28, 1995, to discuss the application of Thermal NDE to Boron/Epoxy repair patches being developed by Boeing for use both in commercial and military applications. Demonstrations of the disbond detection capabilities of the Thermal Bond Inspection System were provided on Boron/Epoxy repair patches provided by Boeing. This work is being lead by Elliott Cramer of LaRC

OPTICAL FIBER FTIR EVANESCENT WAVE ABSORPTION SPECTROSCOPY OF NATURAL ALUMINUM CORROSION - A technique for remote detection of natural corrosion of aluminum alloys is presented. This technique combines optical fibers and a Fourier transform infrared interferometer spectrometer to make evanescent wave absorption measurements. Absorption spectra of powered samples of naturally occurring corrosion, in the spectral region around three micrometers, 3450 wavenumbers, have been collected. The samples were obtained from discarded corroded aircraft components. For reference and comparison, spectral data of the same powdered samples of natural corrosion were also collected using a zinc selenide(ZnSe) crystal as the total attenuated reflection(ATR) optical element. High instrumental sensitivity and simple geometric optical path are advantages of the ATR experiment using the ZnSe crystal. The experimental arrangement with this crystal was used to collect spectra of several powdered corrosion samples from three different aircraft components, obtained from different locations on the components. The positions, halfwidths, and shape of the spectral features in each spectra indicates that the corrosion product is the same in all of the samples (see attached figure). Simple theoretical arguments and calculations have been employed to establish the consistency of the data collected using the two variations of the techniques, with chalcogenide optical fibers and a zinc selenide crystal. It was shown that even though the components were made of different alloys, from different aircraft, and corroded under different environmental conditions, this technique can detect the corrosion without being interfered by other materials present. The results of these experiments were presented at the International Symposium on Optical Remote Sensing for Environmental and Process Monitoring in September 1995. (This work is being lead by R. Rogowski of LaRC.

TRANSITION ZONES IN BEDSORE TISSUES IDENTIFIED - Working at Deaton Hospital with patients of G. Taler, clinical partner, W. T. Yost and J. H. Cantrell of NESB were able to noninvasively locate the transition zones in bedsore wounds. This identification opens the possibility for imaging the critical surfaces for accurate surgical debridement of dead and dying tissue, thus assuring successful surgical closure of the bedsore wound.

ASIP ELECTROMAGNETIC FIELD TESTS - A series of field tests have been performed during the second week of Nov. at FAA/ANCC NDI Validation Center in Sandia National Lab. The goal of these tests was to prove the crack detection capabilities of the second version of NASA's rotating self-nulling probe prototype instrument using Sandia's POD panels. The Sandia panels are the FAA benchmark standard for the aging aircraft NDE community. The test results obtained with 360 rivets confirmed the superior capability and unique advantages of NASA's NDE technology over commercial instruments: the NASA rotating self-nulling probe detected 38 mil fatigue cracks under rivets with a 90% of probability of detection with less than 1% false call rate (48 mil is the critical size limit for a crack to

be hidden under a rivet); NASA's NDE instrument detected fatigue cracks, as small as 32 mils, under rivets with 90% POD. The false call rate increased by about 1% in this case; the best results of commercial instruments showed that the fatigue crack size to be 53 mils and larger for 90% POD. Five individuals, with varying degrees of experience, equally shared the task of self-nulling probe test. The results do not show any trend related to user experience. In contrast, the tests results of the other commercial instrument have shown a strong dependence on individual expertise. It has now been demonstrated and confirmed that the application of NASA's self-nulling probe instruments does not require user training. This work is being lead by M. Namkung of LaRC.

ERIC MADARAS HONORED BY JANNAF FOR HIS CONTRIBUTION - At the JANNAF Propulsion meeting in Tampa, FL last Dec., L. W. Jones, MSFC, presented E. Madaras, LaRC, with the JANNAF Executive Committee's Certificate of Recognition. This recognition was in part for E. Madaras leadership as JANNAF Propulsion's NDE Subcommittee (NDES) Chair for the previous two years. Dr. Madaras also Chaired or co-Chaired the NDES meeting for the previous four years and he was the co-chair of the Solid Propulsion Panel for the past seven years. He has actively participated in the NDES since its inception and helped with its recent re-organization.

LeRC

George Baaklini, 216-433-6016
george.y.baaklini@lerc.nasa.gov
or D. J. Roth, 216-433-6017

ACOUSTO-ULTRASONICS ESTABLISHED FOR MONITORING MECHANICAL PROPERTY DEGRADATION IN THICK MMC - Condition requirements for acousto-ultrasonic decay measurements in metal matrix composites (MMC) as a function of panel thickness were established. The MMC panels had fiber architectures and cross-sectional thickness corresponding to those designed for aerospace turbine engine structures. The wavelength-to-thickness ratio produced by the combination of experimental frequency settings and specimen geometry was found to be a key parameter for identifying optimum measurement conditions for acousto-ultrasonic decay evaluation of these composites. A NASA TM 106972 entitled, "Acousto-Ultrasonic Decay in Metal Matrix Composite Panels," was published in August 1995. Plate wave analysis and decay rate measurements, as well as advanced instrumentation, is being extended to polymer matrix composite evaluation.

NDE OF NEXTELTM 312 AND NICALON FIBER REINFORCED BLACKGLAS COMPOSITES - NextelTM 312/BlackglasTM composite densification via repeated cycles of infiltration with the Blackglas precursor materials and pyrolysis were studied. Nicalon/ Blackglass composite specimens with graphite foil as simulated delaminations in various layer locations were evaluated. Results show unique capabilities of nondestructive X-ray micro-tomographic and ultrasonic evaluation in characterizing processing- and failure- related microstructures. This work was done in cooperation with Allison Engine Company and was presented at the American Ceramic Society 1996 Conference & Exposition on Composites, Advanced Ceramics, Materials and Structures , Jan. 1996, Cocoa Beach, FL.

MSFC

Sam Russell 205-544-4411,
sam.russell.msfc.nasa.gov

THERMOGRAPHIC INSPECTION OF COMPOSITE NOSE CONE - The first flight Composite Nose Cone was inspected with both the Lockheed Martin's Thermovision 760 and EH13's Bales Scientific Inc. (BSI) thermographic systems. The nose cone was mounted with the apex bolted to an electric turntable and during rotation a quartz lamp heated the inside of the part 90 degrees from the center of the field of view of the thermography systems. The NDT standard nose cone (NPU#3), containing Teflon inserts at various locations and depths in the plies, was inspected prior to inspection of the production nose cone to verify the performance of the inspection methods and calibrate the equipment by detecting the simulated defects. Two 3x3-in^2 of scrap material that had

impact damage were clamped in the vent opening in NPU# 3. These impact zones were clearly detected in the transient pattern and appeared very similar to Teflon inserts. Comparing the two thermography systems, the BSI system was slightly more capable of detecting the smallest Teflon inclusions. The BSI system does not output standard video, but stores transient activity as an ensemble of digital images which can be replayed, recorded, or printed. The Thermographic Inspection Procedure (QA-NDE-001) presently requires recording the transient heat patterns on VHS taped. Hence, to use the BSI system to inspect flight hardware the procedure is being amended to allow the BSI data storage format.

SSC

William St Cyr, 601-688-1134,
bstcyr@wpogate.ssc.nasa.gov

SUPPORT JANNAF's NDE EFFORTS - The JANNAF NDE Subcommittee activity has been primarily under the responsibility of the "Inspection Standards Panel" chaired by J. Sparrow (NIST) and B. Strauss (US Army Materials Lab, Watertown). Back in 1991-92, as a panel activity, SSC developed an "Index of Nondestructive Testing Standards," in which a PC database consisting of all the standards was identify. In 1992, this database was turned over to NTIAC for further development and distribution. A paper describing the database was presented at the JANNAF NDES meeting in May of 1991 at KSC (CPIA Publication 559, p. 237-245). Recently, JANNAF recognized this contribution with an award.

COMING EVENTS

- Feb. 21-22, 1996 - 3rd NNWG Workshop - KSC, Florida, Y. Bar-Cohen, 818-354-2610.
- Feb. 20 - 23, 1996 - Structural Materials Technology NDE Conference, San Diego, CA, Phil Stolarski, 916-227-7242.
- Mar. 18-22, 1996 - ASNT Spring Conference - Norfolk, VA, ASNT Headquarters, 614-274-6004.
- Dec. 8-13, 1996 - 14th World Conference on NDT - New Delhi, India, Baldev Raj, 04117-40301.

NASA NDE Working Group (NNWG) Newsletter

Editor: Yoseph Bar-Cohen, JPL

This NNWG Newsletter is published quarterly by the NNWG and NASA HQ, Code QT.

NASA HQ, Code Q Coordinator of the NDE program: Joseph Siedlecki.

All communications should be addressed to:
NNWG Newsletter, JPL, M.S. 82-105, 4800 Oak Grove Dr., Pasadena, CA 91109-8099
Phone: (818)-354-2610, FAX (818)-393-4057 or E-mail: yosi@jpl.nasa.gov