AO Connections

April 30, 1997

Information for the NASA Ames Aeronautical Test & Simulation Community

CH-53 Accident Investigation

by Chris Sweeney

Computer Simulation of IAF CH-53D Helicopters from investigation tape.

The Division was recently given the opportunity to provide unique support to the analysis of a helicopter accident when Ames was asked to support an Israeli accident investigation committee. The accident involved the air-to-air collision of two Israeli Air Force (IAF) CH-53D helicopters ferrying troops and resulted in a large loss of life. Members of the committee contacted NASA and the Vertical Motion Simulator (VMS) Complex for assistance with the following Simulation Goals:

1) To recreate the last two minutes of flight of the IAF CH-53D helicopters to help give insight into the accident.

CH-53 Accident continued on page 7

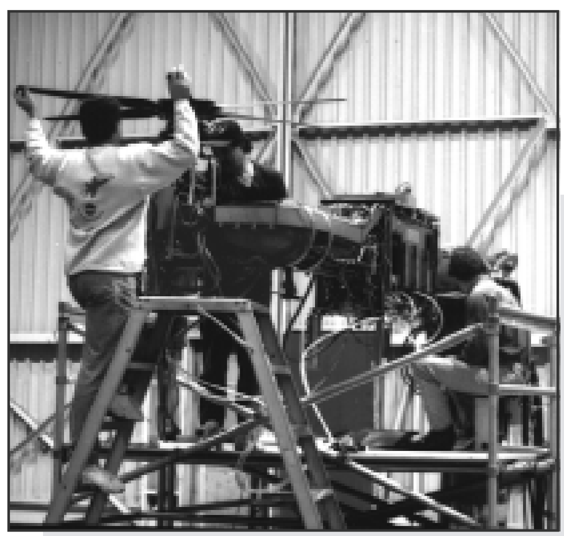
Tilt Rotor Aeroacoustic Model Research Program

by Larry Young

NASA continues to sustain long-term tiltrotor research programs to meet national requirements for military and civilian tiltrotor aircraft. To accomplish these goals, moderate-to-large scale wind tunnel testing of tiltrotor models is required. This testing will provide the data necessary to confirm aeroacoustic prediction methodologies, and to investigate and demonstrate advanced civil tiltrotor and high-speed rotorcraft technologies.

NASA established in 1991 that it had a requirement to gain an improved understanding of the aeroacoustic characteristics of tiltrotor aircraft, and therefore initiated

TRAM Research continued on page 5



Gavin Botha (Test Manager), Mike Derby (Project Engineer) and Scott Torok (Aircraft Mechanic) inspect TRAM model propeller blades and the cooling system.

MD-11 Semi-Span Test Techniques Development

by Dale Satran

The 4.7% MD-11 semi-span model in the 12-Foot PWT.

The NASA Advanced Subsonic Transport (AST) program has developed an aggressive technology development program for improving the affordability of subsonic transports. As part of the AST program, the Integrated Wing Design element, High Lift sub-element is developing tools and technology to provide at least a 33% reduction in design cycle time with a 5% improvement in maximum lift coefficient. Many semi-span tests have been scheduled through the year 2000 to calibrate the tools and methodology produced by the High Lift sub-element. When the AST program was initially defined, the 12-Foot Pressure Wind Tunnel did not have a semi-span test capability. To support the AST program, a semi-span test techniques development team was formed with members from Langley, Boeing, McDonnell Douglas, and Ames.

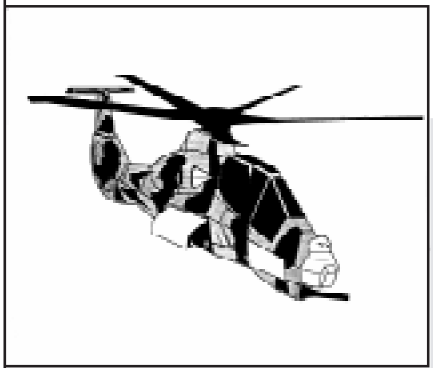
To develop the semi-span test capability for the 12-Foot Pressure Wind Tunnel, a series of tests of the MD-11 configuration were defined and facility hardware was built or reconfigured to provide a semi-span test capability in the 12-Foot. To provide adequate angle-of-attack capability, an image plane is installed about 2 feet above the floor of the test section. The image plane provides most semi-span models with at least ±25 degrees of rotation with adequate clearance between the fuselage and the wall of the tunnel. The rear strut model support was removed to eliminate aerodynamic interference with semi-span models.

The initial MD-11 test was of the 4.7% full-span configuration mounted on the bi-pod model support. This test was conducted during July and August of 1996. Force and moment data, pressure data from both wings, and pressure sensitive paint data were acquired on the full-span model. The next test, which occurred in October of 1996, was to take the left wing of the 4.7% full-span model, mount it to a half fuselage, and then test it in the tunnel as a semi-span model. This minimized any differences in the model geometry and minimized the wall interference effects since the model only had a span of 4 feet. Force and moment data, the pressures in the left wing, and pressure sensitive paint data were acquired. Preliminary analysis of the data for the 4.7% models indicate that the semi-span model is producing the same aerodynamic performance the full-span model produced.

The upcoming test in May of 1997 will be to test a 7.25% semi-span MD-11 model which has been built by MicroCraft. The new model was designed to match the original model as closely as possible. The new model has a span slightly greater than 6 feet. The model is designed for a dynamic pressure of 350 lb./sq.ft. which corresponds to 6 atmospheres at Mach =0.2. The pressure tap locations of the full-span model are completely reproduced in the new 7.25% semi-span model while the 4.7% model only had the left half. Force and moment data, pressure sensitive paint data, pressure data, and hot film data will be acquired during the test period. The effect of the walls on the larger model will be studied to determine if the wall interference corrections are adequate. The AST tests that are scheduled to begin in FY 98 will be dependent upon the test techniques developed in these tests.❖

RAH-66 Comanche Simulation

by Chuck Perry and Girish Chachad



The RAH-66 Comanche, being developed by the Boeing/Sikorsky team, is a reconnaissance/attack helicopter.

The RAH-66 Comanche is a reconnaissance/attack helicopter being developed by the Boeing-Sikorsky team as a replacement for the Army's OH-58 Kiowa Warrior and AH-1 Cobra helicopters. The U.S. Army Aeroflightdynamics Directorate (AFDD) here at Ames began an effort in 1993 to acquire a real-time, pilot-in-the-loop Comanche simulation. The contract was awarded to Boeing-Sikorsky in 1994 to provide engineering documentation and check cases for the Comanche math model. Subsequently, SimLab engineers were assigned to code and verify the complete computer model. The major subsystems modeled were: the airframe, rotor (using blade element approach), engine/fuel control, drive train, core and mission Primary Flight Control System (PFCS), and the Automatic Flight Control

RAH-66 Comanche continued on page 4

WICS Prototype Development

The development of the theory and the prototype software for WICS has been the all consuming work of Norbert Ulbrich of Calspan Corp. for several years. His mission at NASA has been to develop procedures and write a set of computer programs that drive the WICS measuring system and produce wall interference corrections continuously as tests are in progress.

The prototype program has already demonstrated the speed necessary to feed corrections to the 12 Ft PWT's control system, which will set corrected test conditions and model angle of attack in 'real-time.' In addition, the prototype program generates corrections that are very repeatable and agree in most instances with other correction schemes. Where differences are noted between WICS and other methods, the WICS corrections appear to have been better estimates. Further validation testing will be necessary to demonstrate the correctness of the WICS results for all test cases.

Ulbrich is currently finishing a research document that describes the methodology for WICS and some experimental results in detail. This will soon be available to wind tunnel Test Engineers, customers and others in the NASA community.

Ulbrich stresses that WICS will only provide meaningful wall interference corrections if boundary flow measurements are good. The WICS development team members, including engineers, programmers, technicians and others, have been working together to create an environment where valid test data could be acquired. In some cases structural changes were needed — such as new hardware to measure wall pressures, requiring a whole new infrastructure to be installed in the 12 Foot PWT. The combined effort of the entire WICS team has made substantial progress possible in the development of WICS in the recent months.❖

Wall Interference Correction System (WICS) Test

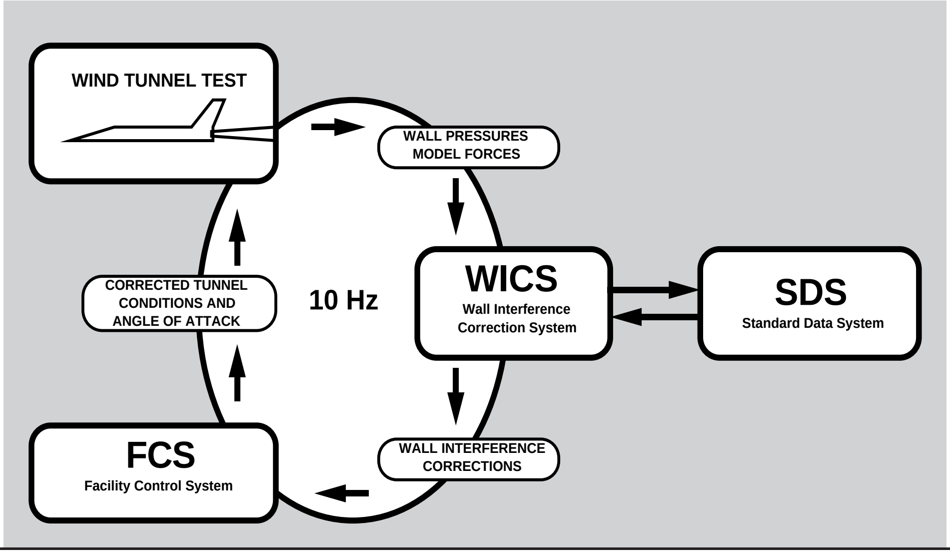
by Alan Boone

WICS is a Wall Interference Correction System that is undergoing development in the 12 Foot Pressure Wind Tunnel (PWT). The goal of wind tunnel testing is accurate predictions of real flight performance. However, the walls of a wind tunnel alter the results measured within the tunnel by subtle and normally small amounts. In order to make accurate predictions of flight performance from wind tunnel results, corrections must be estimated and applied to measured test data to account for the presence of the walls in close proximity to the model.

The WICS system uses 240 pressures measured over the surface of the 12 Ft. PWT test section during all model tests to estimate aerodynamic corrections that are used to correct test data. Corrections are normally computed for tunnel velocity and model angle of attack. These basic corrections are known in the wind tunnel testing world as "model blockage corrections" and "wall upwash corrections". WICS will have additional capability for estimating more subtle changes to model pitching moment and drag.

The current WICS test has been described as 'about as exciting as watching paint dry', since the tests will be run with the tunnel test section empty or with only the model supports installed. The test is nevertheless very important to the development of WICS. Improved instrumentation has been installed in the tunnel to provide better wall pressure repeatability. Data taken during the test will be used to assess the instrumentation improvements. In addition, the primary test product is a set of data files that are stored in the WICS computer. These files provide a wall velocity for each of the 240 wall measurements, for the empty tunnel and for each model support that is used in the 12 Ft. PWT. Since the objective of WICS is to determine the effect of the walls on the test model, the 'baseline' WICS files are subtracted from the wall velocities measured during model tests. The result is the model's velocity 'signature' on the tunnel wall. The WICS analysis programs use this signature in the correction procedure.

The WICS development schedule indicates that it will be available for routine test corrections within about one year. The next hurdles for WICS are to provide corrections for the F-18 test in June of this year and then for the high lift semi-span, High Wing Transport tests late this year.❖



Converging Approaches Study — CVSRF 747-400 Simulator

by Barry Sullivan

In January, the Federal Aviation Administration (FAA) conducted a test on the CVSRF's 747-400 Simulator aimed at increasing airport capacities by developing a standard for air-carrier airplanes equipped with state-of-the-art Flight Management Systems (FMS). This test also provided for simultaneous Instrument Landing System (ILS) approaches and missed approaches, to be conducted to a primary traffic flow runway and to a converging runway by aircraft utilizing a modern FMS. Over the past few years the FAA, with participation from the airlines, aircraft manufacturers and oversight agencies, has been investigating flight track data obtained as a result of using high-end FMS equipped air carrier aircraft simulators when operating with FMS Lateral Navigation (LNAV). To further enhance data previously obtained, additional testing was necessary to properly assess the safety aspects of the converging missed approach conducted during FMS LNAV tracking, as well as evaluating flight crew human factors issues. This study was conducted by the FAA's System Capacity Office in Washington D.C., in cooperation with the Standards Development Branch at the FAA Aeronautical Center in Oklahoma City.

This study was the latest in a series of studies designed to examine the use of a revised missed approach procedure for FMS equipped aircraft. The goals of this study were to determine aircraft geographic position relative to the runway threshold position during missed approach procedures, to evaluate aircraft state versus geographic position during the missed approach maneuvers, and to determine if there are any human performance issues associated with flying these specialized procedures. This study examined the use of a 96 degree lateral course offset from the localizer using Chicago O'Hare's runway 4R and the aircraft's FMS for positive guidance during the converging missed approach operation. To support the converging missed approach, a customized FMS database was provided by Honeywell through the FAA, in order for the participating pilots to fly the given procedure. Line qualified 747-400 flight crews participated in this study. Overall, 8 days of data runs were completed, totaling 128 runs.❖

RAH-66 Commanche Simulation

(Continued from page 2)

System (AFCS). The final step was to validate the model with a pilot-in-the-loop fixed-base simulation this February in a development lab in the VMS complex.

The Comanche math model was entirely implemented by SimLab engineers. The flying portion of the model validation was accomplished by test pilots flying specific tasks as defined in the "Handling Qualities Requirements for Military Rotorcraft (ADS-33)" document, and other aggressive maneuvers designed to exercise the entire flight envelope of the helicopter. Four NASA pilots and one SYRE pilot flew over 250 data runs, as well as numerous additional runs to flush out and correct any discrepancies in the model. The U.S. Army and Sikorsky personnel working on the project considered the simulation to be successful and were very satisfied with the accurate implementation of the real-time Comanche model.

AFDD now has a fully validated, pilot-in-the-loop, Comanche model ready for simulations at the SimLab facility. The model has also been transferred to an AFDD workstation where they plan to run in-house, engineer-in-the-loop, real-time simulations.❖

Continuous Improvement

Quality Records for ISO Compliance

by Sally Brew

AO, as a division within Code A, was part of a recent gap assessment conducted throughout the center. As expected, the auditors asked employees for the records that affect quality. To be prepared for AO's future registration, employees need to be aware that the ISO standard dictates that certain records shall be maintained which means an auditor will be looking for specific records. Examples of some of the records specifically called out for in the standard include the following:

- Minutes of the monthly AO Management Review meetings
- Customer agreements
- Minutes of all formal design reviews.
- Records of design-verification measures.
- A list of approved subcontractors kept by the business offices of AO and of the AO support service contractors responsible for purchasing products.
- Records of any customer-supplied product (such as a model) that is lost, damaged, or unsuitable for use.
- Records showing that received products have been inspected and tested and whether the

Tilt Rotor Aeroacoustic Model Research Program

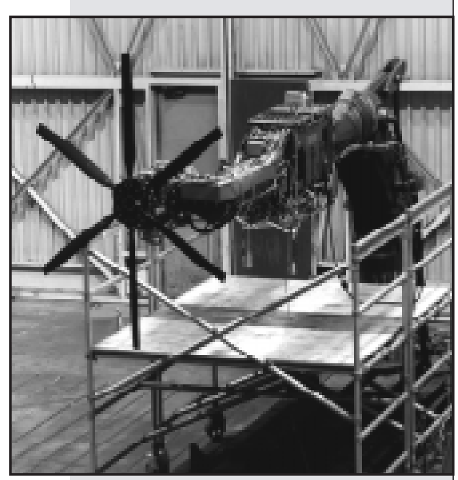
(Continued from page 1)

the development of two hardware-compatible test rigs: an isolated rotor test stand, and a full-span model (dual rotors with a complete V22 airframe representation). These two test stands were inclusively called the Tilt Rotor Aeroacoustic Model (TRAM). The Isolated Rotor is not a stand-alone unit, but is instead intended to be comprised chiefly of major subassemblies of the Full-Span configuration.

A checkout test of the TRAM isolated rotor test stand is currently being conducted in the National Full-Scale Aerodynamics Complex N246 Model Preparation building. The checkout testing includes the acquisition of hover data — including rotor dynamic pressure data — for a 1/4-scale set of V-22 rotor blades. A considerable amount of infrastructure build-up — including armor plate shielding and control room installation — was required in N246 to enable TRAM functional testing.

The full-span version of the TRAM test stand is also being concurrently developed. Fabrication of full-span model development is underway with the bulk of the hardware being delivered in a partially assembled state in June 1997. A new generation rotor control console for the isolated rotor test and the full-span model is also in development; delivery of the console is scheduled for the end of this month.

The baseline, 1/4-scale TRAM rotors are based on V-22 Osprey tiltrotor aircraft. The TRAM test stand will also, however, be an advanced technology demonstrator platform for the Short Haul Civil Tiltrotor (SH(CT)) program, a sub-element of the Advanced Subsonic Transport (AST) initiative. Both Boeing and Sikorsky have been contracted by the NASA SH(CT) program to develop interface hardware to test a new generation of small-scale, advanced proprotors on the TRAM test stand. The Boeing and Sikorsky proprotors are planned to be tested on the full-span TRAM test stand in the NFAC 40- by 80-Foot Wind Tunnel. The full-span TRAM proprotor testing is currently planned for FY 98-00.❖



TRAM model being prepped for checkout test in N246.

product has passed or failed.

- Calibration records for inspection, measuring and test equipment
- A record of products accepted with a nonconformity and the repairs done to the product.
- Results of investigations of nonconformities, such as Test Discrepancy Reports (TDR's).
- Results of internal audits conducted in AO.
- Training records for each employee whose work affects the quality of AO's product, data, to ensure personnel are qualified to perform their assigned tasks.

In reality, many records are maintained in AO either in a Test Book, a library, a box, a file, or a drawer. The challenge within each branch now is to determine what *are* quality records within their organization, *where* the records can be found, and *how long* the records should be maintained. Records do not have to be kept in one central repository in AO, but may be kept within the organization's office responsible for the record. Each branch now has the responsibility to develop a list of quality records and ensure such records are maintained.

One help in this task is for every employee to review the AO Quality Manual which states what records must be kept. Any employee can access the AO Quality Manual by the following steps:

(1) Go to Chooser and select the Appleshare Icon and the Apple Talk Zone, AO4/N227.
(2) Select the file server N227. Click OK
(3) Select "guest" on the next screen. Click OK.
(4) Select "group" on the next screen.
(5) Under group, select ISO Implementation. The updated manual is there.

During the next few months, the ISO effort in AO is not only to update all the documentation related to ISO compliance, but also to ensure appropriate records are maintained and readily retrievable. The benefit of maintaining quality records is that records provide a major source of data needed to efficiently plan, budget, and manage functional organizations. All AO employees are a part of this effort. For all of AO, ISO compliance provides an excellent opportunity to improve our record keeping procedures of data needed to run our division efficiently.❖

Aeroacoustic Project Update

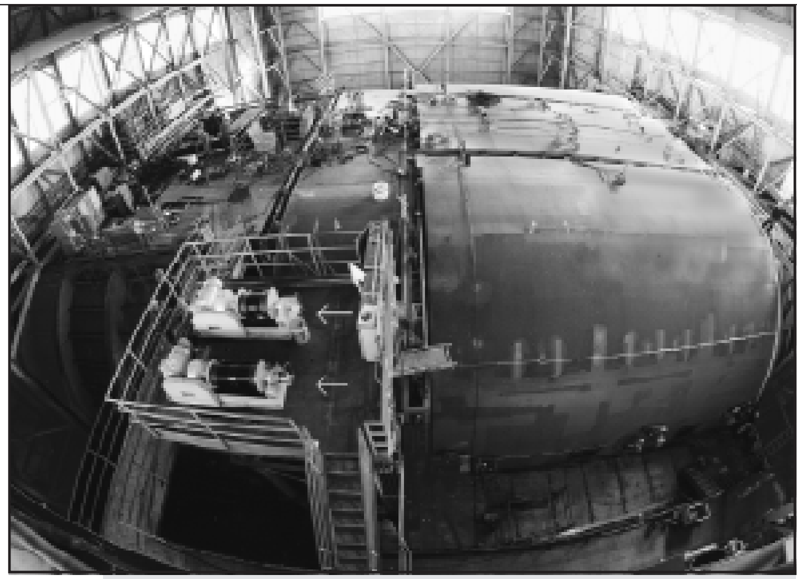
by Joe Sacco and Sharon Marcacci

Progress continues on the 40 x 80 and 80 x 120 wind tunnel modifications, with a significant amount of work nearing completion. The project is divided into the three major work packages, outlined below:

- The IFC (Induction Frequency Changer) Overhaul
  - Motor Generator Set Refurbishment
  - Installation of Interpole Shunting System

- The Control System Automation
  - Variable Pitch Mechanism (VPM) Control System
  - 80 x 120 Model Support Control System
  - 40 x 80 Model Support Control System
  - Facility Annunciator System

- The 40 x 80 Test Section Modifications
  - New Test Section Pressure Shell
  - Acoustic Liner Material
  - Flow Liner Panels
  - Model Utility Systems



New Aeroacoustic test section pressure shell (arrows point to new personnel door ramp hydraulic system.)

Operational checkout and functional subsystems testing must be complete in each area before Integrated System Testing (IST) can begin. The target date for the 80 x 120 wind tunnel circuit IST is late September, with the 40 x 80 circuit IST to begin late '97.

The goal of the IFC changes is to refurbish and improve efficiency of the main drive system at lower fan rotation speeds. Load testing of the drive motor generator set was temporarily stopped due to uncertainties regarding the availability of power. Testing is expected to resume this month to coincide with the completion of the Lube Lift Skid, a newly designed lubrication system being installed and tested by Code AO.

The goal of the Control System Automation effort is to upgrade the control systems for the model support systems and main fan drive blade pitch control. Verification of wiring connections for the Variable Pitch Mechanism (VPM), which controls the blade angle of individual fans, is expected to start soon. Wiring checkout for the 80 x 120 model support system continues, as well as for the annunciator system. The latter monitors the wind tunnel systems, notifying tunnel operators of any facility problems.

Inside the new test section looking south (with a fisheye lens.) Shows wedges installed between ring girders 12 and 13, upper flat section.

The third major objective of the Aeroacoustic Project is to remove and replace the existing test section with a new anechoic (no echo) test section. Installation of the acoustic wedges and panels, designed to absorb sounds generated in the test section, is well underway and should be completed mid-June.

The latest updates on this project can be accessed at website *http://ccf.arc.nasa.gov/wind_tunnel/homepage.html.* ❖

CH-53 Accident

(continued from page 1)

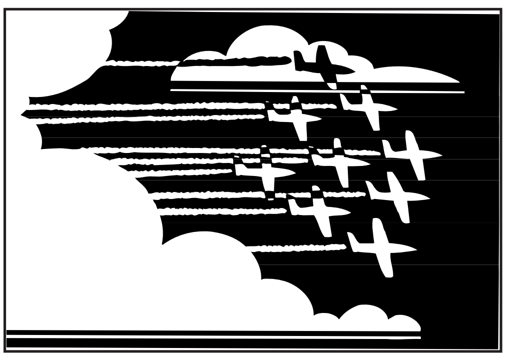
2) To create a video showing the collision of the helicopters from a wide variety of viewpoints and angles.

3) To recreate the final thirty seconds of flight of one of the helicopters, from the collision until the tail section broke off and the helicopter spun to the ground.

This was a very rapid response effort: the request for help was received on the 26th of February, the accident investigation team members arrived on 10 March and they left with their video tapes on 13 March.

After an existing math model of the CH-53 helicopter was brought up, verification of the model and integration with the existing cab in the VMS was completed during the week of 3 March. The capability of driving and viewing two separate CH-53D graphical images was also verified. When the accident investigation team members arrived, they had some eyewitness testimony and a radar map of the positions of the two helicopters. The radar map contained eleven points for one helicopter and sixteen points for the other during the final ninety seconds of flight. These points were time tagged, but did not include altitude data. Since this map was two dimensional and the time of each point was not correlated, the investigation team members wished to get a graphical viewing of the events leading to the collision.

The map was placed on a digitizing tablet and the position of all the points was recorded into a file. This file was reformatted to be read real-time into the drives for the two helicopters. After fine tuning the trajectories to make the helicopters fly reasonably, instead of the jerkiness apparent with so few data points, runs were collected onto video. Recorded onto the video were sixty different angles of the collision, including each of the pilots views, “chase plane” viewpoints of the incident, a view from the eyewitness perspective, and straight overhead views. The investigation team members left 13 March with the data and videos desired as well as a better understanding of the collision.❖



Ames Aero Days!!!

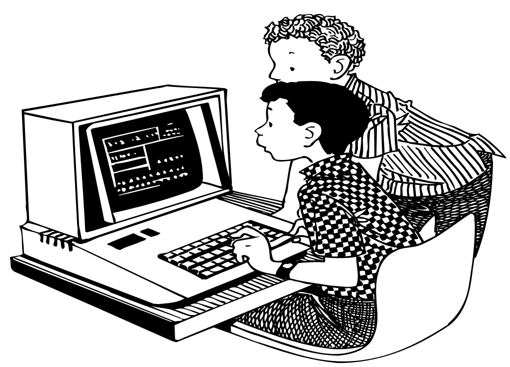
What: An opportunity to explore, play with, and provide feedback on the educational CD-ROM ‘Exploring Aeronautics’ produced right here at Ames!! There will be a brief (10 minute max) introduction to the CD and the review process, then all the time you want to explore the CD within the session time! (Feedback forms can be filled out ‘as you go’ or at session end.)

Who: Adults and kids grades 4-6 (includes children entering 4th in fall of ‘97 and those leaving 6th this June.) (Note: at least one adult in a group must be an employee of Ames or an Ames Contractor; kids are optional, adults are not.)

Where: Teacher Training Facility - Building N226

When: Friday, June 20 and Saturday, June 21
There will be 4 sessions offered -
you only need to attend one session!

Friday AM	**9:00 - 11:30**
Friday PM	**1:00 - 3:30**
Saturday AM	**9:00 - 11:30**
Saturday PM	**1:00 - 3:30**



How: Please fill out the registration form. Registration forms are available in AOGROUPS on the A04/N227 Server. (If you need real paper call (4-3867) or e-mail lalderete.)
Return Registration Form either by e-mail (lalderete) or fax (4-3869).
Please submit a form even if you have already indicated you are interested in attending!

Contractor Team of the Month for December

The Johnson Space Center researchers made a late request to study the feasibility of landing the Space Shuttle directly at Palmdale Airfield for retrofitting, thus saving the money it would take to ship the Shuttle from Edwards to Palmdale. The researchers promised to provide maps and photographs necessary to build up the airfield, but the data was late and inadequate for the purpose of building a new airfield.

On their own initiative, the Syre Database Development Group of **Dave Carothers**, **Gloria Lane** and **Cary Wales** obtained maps and photos from contacts at Boeing North American (formally Rockwell Intl) and had the airfield ready for the Shuttle researchers when the Shuttle Simulation began early in January. It would have been impossible to integrate a new airfield into the massive Shuttle Visual Environment in such a short time without the extraordinary knowledge, skills and commitment of this group. Their extra efforts contributed significantly to many successful simulations with very satisfied customers. Through the years, they have logged many hours outside the normal work schedule to get the customer's last minute needs satisfied.

Dave Carothers, Gloria Lane and Cary Wales

Contractor Employee of the Month for December

Jim McGinnis

During the 40x80x120 RCM study, **Jim McGinnis** on his own initiative worked meritoriously on streamlining the RCM (Reliability Centered Maintenance) analysis database (RCM-RIGHT). The RCM analysis is a detailed process of analyzing and improving the maintenance program of a facility system, by understanding specific functions of components in the system. Due to the nature of this detailed work, this process can be lengthy. Jim saw the potential of improving this RCM-RIGHT software. He worked with the other RCM team members to incorporate their needs, and then modified the software. The final results of Jim's efforts have contributed substantially by increasing the efficiency of the RCM analysis process. A typical RCM study, on average, now takes two to three months to complete, compared to five to six months previously. A major part of this improvement can be attributed directly to Jim McGinnis's efforts. As a result, both the 40x80 and the 12-ft Wind Tunnel RCM teams were able to complete one additional system analysis for each facility during the FY96 RCM program. Jim went beyond his expected performance requirements by using a high degree of talent to provide significant process improvements and cost reductions in the RCM process.

Civil Service Employee Of The Month for January

Doug Greaves (photo not available) received this award for his solution to a SimLab interface problem. The CT5A 'out the window' visual system had an old PDP-11 front end computer, which was mid-1970's computer system technology. The software on it could not be modified in a simple way to add ethernet network capability, required to be compatible with the upgraded simulation network. Doug Greaves' idea was to use a low cost state-of-the-art VME computer system to solve this problem. Using VxWorks operating system (which was already available at SimLab) he assembled a system which would provide the required interface between the new host computer and the CT5A visual system. This solution was effective, inexpensive, and provided improved capability by performing extrapolation tasks in the faster VME portion of the pipeline. He designed, built and tested the unit during off-hours due to lack of access to host equipment during the normal workday. This unit removes the need to keep an aging interface system operational. It also removes the need to keep an extra VAX computer in the loop between the host and the CT5A visual system.❖

AO CONNECTIONS
helping you get to know AO!

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