IVView

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

INDEPENDENT VERIFICATION AND VALIDATION FACILITY

The *view* from here...

By the time this quarterly reaches you, I will have been enjoying my view of the mountains of West Virginia from our home on Cheat Lake and from my office at NASA IV&V for several weeks. A different vista can bring new perspective—certainly true of one's personal as well as one's professional landscape.

My first weeks at IV&V have been spent getting to know my new colleagues, their professional enthusiasms and expertise. I am, as you would imagine, very impressed by the work being done here and the team that conducts it. You will get an idea of that work—the history, the present, and the future of software assurance efforts—throughout the Services section on pages 3-6.

My first unofficial impression of the IV&V Research team was made back in July at the OSMA Software Assurance Symposium (SAS 06). SAS 06 was a great experience. It afforded me, along with the other nearly 200 attendees, the opportunity to listen and get to know researchers, administrators and project managers from throughout NASA and other national and international agencies, academia and the private sector. You'll find comments from SAS attendees and staff on pages 8-9 to give you a sense of why I was so pleased to participate. You'll also find the Research team that made it all happen featured in *The Cube* on page 15.

I missed IV&V's 2006 "Day in the Park" because of travel commitments. It can probably be proved that I was the only one in the Technology Park who missed this wonderful annual event. The award-winning IV&V Outreach organization is second-to-none, and I am very excited about working with such an outstanding team of staff members and those who volunteer their time to support them. Read about Day in the Park and NASA Day at West Virginia State University on pages 10-12. Well over a thousand students were inspired and educated by our Outreach team at those two events alone.

IV&V has prided itself on building its work on a Foundation of Excellence. In this issue we step away from the bricks and mortar issues for a moment to remind ourselves that our NASA *family culture* also forms our foundation. You will note on page 14 that I have joined a generous and caring organization. The IV&V family knows how to treat the people within it's walls with respect and integrity, but also reaches out often and meaningfully to the people beyond those walls with great interest and empathy.

Before you close the pages of this newsletter, I hope you will turn to page 16 and take a moment to read about and join me in congratulating IV&V Project Manager, Deborah Kromis, whose fine work was acknowledged this year with the Space Flight Awareness Award.

It is always energizing to begin a new assignment. This assignment is one that places me in an enviable position, both geographically and professionally. I look forward to giving you *my view* of the work and the contributions of this team to NASA's mission.

Dr. Butch Caffall
Director, NASA IV&V Facility

Table of Contents

Pillar I: Services
Flash Gordon to Luke Skywalker 3-4
IV&V Tools Lab 4
IV&V of Robotic Systems 5-6

Pillar II: Research
Future IV&V Classroom 7
SAS 06 8-9
Robustness Testing: IV&V R&D 9

Pillar III: Outreach
Electrifying: 2006 Day in the Park 10-11
Upward Bound: NASA at WVSU 12
It'a a Family Matter... 13

Foundation of Excellence
...And a Matter of Families 13
Pencil Us In! / Whose Getting Canned? 14
CFC 2006: Teamwork and Mission Success 14

The Cube
The Home Team: IV&V R&D 15

Our Value-Ables
Kromis Honored With SFA Award 16

Cover:

NASA IV&V thanks Ron Rittenhouse of the Dominion Post for capturing the spirit of Day in the Park by framing this terrific hair-raising experience during the Space Race Exhibit Presentation. *(See story on pages 10-11).*

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Please submit news items and/or photos to Kathleen.M.Millson@nasa.gov; 304-367-8445. Ideas for stories and article submissions are welcome; all submissions are subject to editing. Next Submission Deadline: January 15, 2007

Flash Gordon to Luke Skywalker

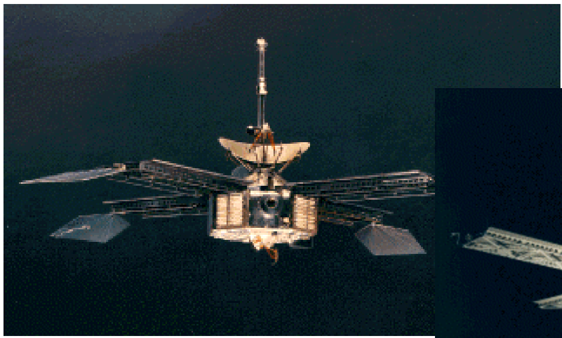
The History of Spacecraft Software in NASA: The Early Years

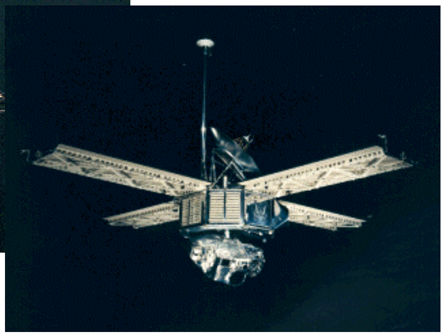
Ken Costello

Often when we go out to speak with project teams or other groups we talk about the software crisis and how so many software projects fail. We discuss the emerging importance of software in space systems as well as how important software is becoming in other systems (even my toaster has software in it now!).

However, we seldom think about how the importance of software grew over time. What was software like during the formative years of the Nation's space program? This article will explore some of the early software and computer development efforts on NASA spacecraft.

Our journey starts in the late 1950's and early 1960's. At that point in time, the focus was more on the computer hardware than on the software. In fact, to a certain extent, the hardware *was* the software. The first robotic missions did not have software as we know it, but rather carried a direct command system or a fixed sequencer (often both for redundancy). For example, some of the first robotic spacecraft sent beyond Earth orbit were the Ranger missions to the moon. These were generally designed to impact the moon but there were cameras on board to record imagery.





Above: Mariner 4 Right: Mariner 6

These missions carried both a direct command system and a sequencer as a back-up. The direct command system worked much as the name implies. Since the time lag on a mission to the Moon is rather short, the system worked via a voice/manual command system and provided almost real-time control over the spacecraft. Based on returning telemetry, new instructions were formatted at NASA's Jet propulsion Laboratory (JPL) and then given to the appropriate Deep Space Network station via telephone. At the station, an operator would use a thumb-wheel to enter octal codes into a panel called the "Read-Write-Verify Console," and once verified, send them to the spacecraft. Of interest, even though this was a totally manual process with a verification step, a guidance error on Ranger III caused the spacecraft to miss the moon by 23,000 miles. In addition to the guidance error, a documentation discrepancy between the command set developed during ground testing of the spacecraft and the flight command set resulted in Ranger III being pointed the wrong way and returning only images of open space.

As noted previously, Ranger III also carried a back-up computer known as the "Central Computer and Sequencer." This system was simply a set of timed commands that were associated with a timer in the computer. The system was activated prior to lift-off and would begin counting time. If the uplink radio channel failed, the mission events would be activated by the time-tagged commands when the timer reached the activation time. This would provide some assurance of the mission succeeding, but that assurance was based on the assumption that the mission performed optimally. As an example, the timer would turn the cameras on at a set time even if the spacecraft was not pointing at the correct target.

At the same time that the Ranger missions were being flown, JPL was working on the Mariner series. This set of missions was traveling beyond the moon to Venus and Mars. The greater distances involved did not allow for real-time control as with the Ranger missions, however, the direct commanding capability was retained to allow for adjustments when needed. For example, if the star tracker locked onto an incorrect target, the ground station could send a command to re-initiate the target search.

The Central Computer and Sequencer was flown on three Mariner missions from 1962 through 1967. There was only one computer on each mission due to weight constraints (the machine weighed 11.5 pounds); fortunately, the direct command capability provided a reasonable level of redundancy. The 1969 Mariner mission to Mars called for a larger spacecraft and more ambitious objectives than in the past: *two* picture-taking flybys of Mars. With this mission, creation of more flexibility in the spacecraft was desired so that if something interesting was seen during the first pass, adjustments could be made to the second pass to focus on that interesting item. One more benefit of this flexibility would be to lessen the direct command sessions with the spacecraft. At that time the command rate was one—yes, one—bit per second and a direct command session lasted upwards of 8 hours. This was expensive in terms of personnel time as well as Deep Space Network time. So JPL decided to try and change the "computer" that they had been using into more of a real computer rather than a timer.

Flash Gordon to Luke Skywalker (continued)

The new computer, still called the Central Computer and Sequencer, was designed by JPL and built by Motorola. At 26 pounds, the weight was more than double the original machine flown on the previous Mariner missions. The primary difference between this computer and the others is that this version had a 128 word memory that could be altered in flight. While this new computer provided greater flexibility, the mission still carried one of the older models on-board as a redundancy/back-up. During critical operations, both computers would run in parallel with any disagreement between the two causing an abort of the operation. The back-up sequencer existed in case of a loss of commanding from the ground. Then the mission would proceed as planned under the control of the sequencer. In fact the sequencer itself checked every 66 2/3 hours to see if the communications were still working (fault protection).

The new computer design was the result of studies done in 1964-1965 for a Mars orbiter called "Voyager" and a Mariner mission to Mars in 1966 that did not happen. Even though the computer was not designed specifically for the Mariner 1969 mission, the memory size was considered quite adequate. However, the mission itself was undergoing growth pains that quickly made the 128 words of memory a limiting factor. At this point in NASA's history, each mission whether it was a success or a failure was huge learning experience. Technology was changing rapidly and the understanding of what could be accomplished with a spacecraft headed to another planet was growing exponentially. For the 1969 Mariner mission, the engineers at JPL had taken ideas from other missions including three-axis stabilization, new algorithms for antenna pointing and an improved telemetry system that increased the transmission rate. All of these ideas placed a greater demand upon the computer. Thus, while the initial plan was to only use 20 words in the 128 word memory, it was quickly discovered that the total memory requirements were much greater than 128 words.

In order to overcome this memory limitation, some creative programming techniques were used. Luckily, the design of the computer, by making use of software, allowed for the reprogramming of the 128 words of memory during flight. As the mission progressed the old 128 words of memory were replaced with a new set of commands for the upcoming phases of the mission. This was perhaps the first application of swapping out old commands for new commands.

Even though this computer system was chosen to enhance the flexibility and autonomy of the spacecraft, Mariner VI and its sister mission Mariner VII were two of the most commanded missions to date with Mariner VI receiving 946 radio commands and Mariner VII 957. Either of those numbers exceeds the total number of commands sent to all three of the previous successful Mariner missions combined.

Although this computer had a segment of memory that could be updated with commands, it should be noted that this "computer" was not making any of its own computations. To a certain extent this machine was not much more than a glorified sequencer, even though it proved very useful up through the Mariner X mission. This was the beginning of the realization that more than just a computer sequencer was needed.

Beyond these missions, the importance of software started to grow even more as the sequencers were replaced with computers that provided more memory for more software. The computers started doing their own calculations to include such things as monitoring their own health and safety and issuing commands based on those computations. Some of this type of work was already occurring on the computer developed for the Gemini program. The discussion of that system will be in a future article.

IV&V Tools Lab

Anna Sherer and Pavan Rajagopal

October marks the 8th month of the five year NASA IV&V Tools Lab Contract, currently awarded to Geo Control Systems (GCS) of Houston, Texas. During the past few months the NASA IV&V Tools Lab has been working to improve Tool support and enhance Tool utilization.

The Tools Lab recently distributed a survey to assess the utilization of COTS (Commercial Off The Shelf) tools. The survey will provide some of the information necessary to help make decisions about allocating scarce dollars to ensure both Contractors and Government personnel have the best tools at their fingertips. Work is currently underway to revamp the Tools Lab Website. The site will allow both on and off site personnel to submit Tool Account requests quickly and more accurately. Once complete, the new and improved Tools Lab website will also provide information on available tools as well as instructions, training documentation, and help files.

Tools Lab staff are continually researching new tools to assist personnel involved in the practice of Independent Verification and Validation. The Tools Lab recently sponsored a visit from Scientific Toolworks Incorporated (STI). Ken Nelson, the president of STI, gave a presentation on the functionality of the UNDERSTAND Source Code Navigator and also discussed non-standard analyses that can be performed by using the UNDERSTAND Application Program Interface (API). The newest tool being offered through the Tools Lab is Enterprise Architect. Enterprise Architect is a comprehensive UML analysis and design tool, covering software development from requirements gathering, through to the analysis stages, design models, testing and maintenance.

5 IV&V of Robotic Systems in Space Exploration Missions

Charles R Price

Both robotic and human missions in space have accrued impressive achievements in our first fifty years in space, primarily on separate missions, and also as some joint human and robotic activities. As we venture further into the human and machine exploration of the solar system to achieve the goals that have been set, new challenges will necessarily have to be met that include performing Independent Validation and Verification (IV&V) of these emerging human and robotic systems.

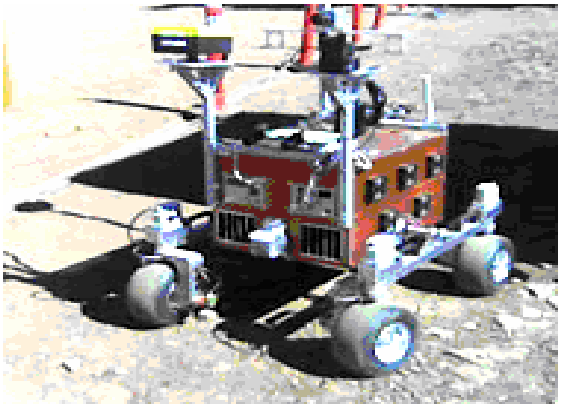
Robots as Precursors of Humans

Robotic missions preceding the arrival of humans to earth orbit, the lunar surface, and the surface of Mars have been mounted for decades, with successes far outweighing the failures. Design and operational achievements to date include cramming the hardware and software into increasingly smaller packaging while increasing the functionality and reliability of the orbiters, landers, and rovers. The extended operation of the Mars Rovers, Spirit and Opportunity has far exceeded all expectations and is a testament to the design, integration, and testing – including IV&V – of these visionary robot systems. Their operations within the constraints of communications windows, communication time lags, temperature extremes, and uncertainties of the surface environments have overcome crises and continue to this day. Current plans include uplinking limited autonomy to these worthy robotic explorers to perform image selection onboard to reduce the number of images sent to earth.

These robots have obtained impressive science data of Mars and also engineering data sufficient to establish that such robots can operate on those Martian “terrains”. The heavier systems of the human exploration of the human presence will require engineering field data beyond what has been obtained and will create challenges in how that data will be obtained and how the systems that obtain it will be validated and verified. Moreover, future robots will be called upon to construct the labs and habitats of the humans that follow them. Construction functions such as site preparation, deployment, assembling, outfitting, energizing, and maintenance are essential to establishing outposts on Mars for extended human operations. Robots working collectively to perform tasks that cannot be achieved by a single robot will be required. Validation and verification of how these robots perform these tasks together and how they are controlled are challenges that will soon be upon us.

Robots Working Jointly with Humans

To date, the joint operational activities of humans and robots in space have been in the domain of the large crane like electro-mechanisms of the Shuttle Remote Manipulator System and the ISS Remote Manipulator System. These giant equivalents of earth bound “back-hoes” have repositioned masses exceeding hundreds of thousands of pounds through complex kinematics and dynamics in the construction of the ISS. These operations are “free motion” beginning with the manipulator’s end effector rigidizing onto



K-10 Inspection Robot

ATHLETE with Crew Compartment

Centaur handling science sample box

NASA centers participating in the Coordinated Field Demonstration included ARC, JPL, JSC, and LaRC. Details of the Coordinated Field Demonstration can be accessed at http://robonaut.jsc.nasa.gov/desert06.htm the grapple fixture of the module (to be moved) and concludes with the module's attachment fixtures positioned within the grasp of the proper receiving mechanisms on the ISS.

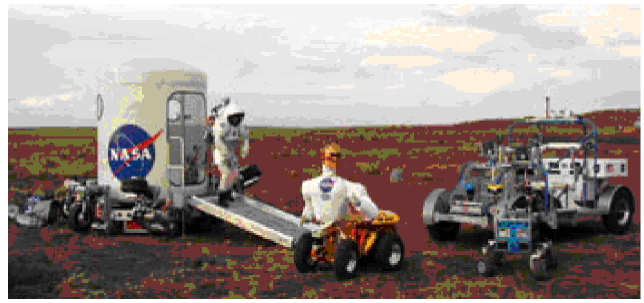
Space suited astronauts on the ends of these manipulators performing EVA operations are a sight that thrill us all. Commands to the remote manipulators are by an IVA astronaut using hand controllers through a computer system that converts the hand controller signals into commands to the manipulator joint motors. Each space construction and EVA procedure has been developed using kinematic analyses to determine what paths the manipulators can traverse during the particular operation, then tested in real time simulators, and then rigorously taught to the mission astronauts. Any deviation from the prepared scripts must be in the form of a "contingency operation" which is a documented alternative procedure with a rigorous development history.

What Is Coming

Only recently has the operation of a remote manipulator from the ground (to the ISS) been demonstrated. No operations to date include "constrained motion" where the manipulator is used to "force" an object against a resistive surface or receptacle. Nor has autonomous control been used for any operation other than very simple "canned" trajectories of a few feet of motion such as raising a manipulator from a stored position to a deployed position. Real time planning has never been an option. Safety concerns both for the astronauts and for the spacecraft have largely impeded the acceptance of these more sophisticated capabilities. As a consequence, the required work has been accomplished without these functionalities at a cost of substantial labor on the ground with a sizeable labor force.

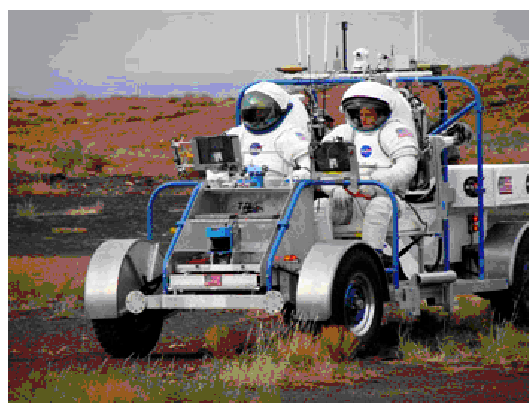
Ground control, force control, and autonomous control for manipulators of various sizes are functionalities that will be needed for Exploration missions. Other functionalities include robots with dexterity systems capable of operating the same EVA tools used by the suited astronauts. Robots and humans working to accomplish jointly more than they can do separately will also be needed. Local mission management of real time planning, contingency responses, and judgment calls will be as necessary for the robots as for the humans. Nearly all of these capabilities have been demonstrated in the NASA labs and some have been tested in earth analog field trials. All will form significant challenges to IV&V in the near future.

A recent example of Mars surface exploration robots and EVA subjects being tested together in an earth analog environment is the NASA Coordinated Field Demonstration at Meteor Crater, Arizona, in September 2006



CFD Participants: ATHLETE/Crew Compartment, suited EVA crew, Centaur, SCOUT, and K-10

This demonstration included two suited EVA test engineers, three robots, and SCOUT – a car sized rover that can be both driven or remotely controlled. The robots were ATHLETE – a hexapod, all terrain walking robot (with a wheel on each leg) that supported a crew compartment; Centaur – a highly dexterous anthropomorphic robot (Robonaut) on a four wheel platform, and K-10 – a four wheeled inspection robot.



EVA test engineers driving SCOUT

21st Century IV&V Training and Education Workshop

Christina Moats

IV&V is rapidly growing in importance and complexity as modern software systems become increasingly critical to global human endeavors. In particular, software is more and more becoming an inescapable ingredient within safety critical systems such as those found within aerospace and within the economically critical systems of global industries. If this is to continue, there will be an increasing need for well educated and highly trained IV&V personal. Are current education and training programs able to meet the expected needs for 21st century IV&V?

To answer that question, the 21st Century IV&V Training and Education Workshop was held on April 20, 2006 in Hawaii. It was jointly sponsored by the National Aeronautics Space Administration (NASA), Japanese Aeronautics Exploration Agency (JAXA), Japan Manned Space Systems Corporation (JAMSS), and the University of Hawaii in conjunction with the 19th Conference on Software Engineering Education and Training (CSEET).

The workshop sought to establish and clarify issues regarding the development of effective IV&V education and training programs to secure a sensible supply of IV&V personnel. Position paper topics covered a broad range of interests including: Training of IV&V Personal; IV&V Certification and Licensing; University Programs that Include IV&V; Latest Techniques and Methods for Performing IV&V and Their Educational Demands; and, Assessment and Evaluation of IV&V Practice. Participants worked to identify and create consensus about (a) the most critical issues in IV&V education and training; (b) programs, research, or actions that are needed to address those critical issues; and, (c) the prioritization of opportunities for collaboration with industry, government, and academia.

In order to increase opportunities for success, three specific conclusions were reached as necessary first steps:

- Continue to encourage and support educational improvements in software engineering, systems engineering, and software development.
- Conduct a gap-analysis between Computer Science and Software Engineering course material IV&V Processes. As a result of the gap analysis prepare some training material for use in an undergraduate software engineering course that explains what IV&V, V&V, and assurance are and then modify a graduate-level software engineering program to include: Systems Engineering, Requirements Engineering, Architecture and Design, Language Theory and Implementation, Testing of Systems, Verification and Validation, and Project Management
- Use Barry Boehm's software class as an experiment for rolling out the IV&V training (in Barry's class, a small number of students act as the "IV&V" analysts on their peer's software development projects after receiving one lecture on IV&V). At the current time, distant students perform a quality check and/or testing on their fellow students work – in the class they call this effort IV&V. We proposed teaching a section on IV&V for Barry in his class, at a minimum, so that the "IV&V" analysts have better information, tools, and processes to perform their designated roles.

Haruka Nakao (JAMSS) and Marcus Fisher (NASA IV&V Research Lead) discuss the JAXA, JAMSS, and UHawaii research that assesses risk reduction vs. costs based upon the different methods used to prioritize IV&V tasks.

At the conclusion of a workshop marked by meaningful contributions from all participants, it was agreed that the issue of IV&V training and education would be incorporated into the international IV&V Working Group (IVVWG) activities comprised of JAXA, NASA, and the European Space Agency's (ESA) IV&V organizations.

Discussions continued at the international IVVWG Technical Interchange Meeting in July 2006, where the group agreed to host an IV&V workshop at INCOSE 2007 to actually provide tutorials/lectures on IV&V topics and techniques. The IVVWG is working to generate and organize the material needed for INCOSE. JAXA initiated a relationship with NARA University in Japan and has arranged for each IVVWG organization to present an IV&V tutorial/lecture to the graduate students in November 2006.

Shigeo Yoshikawa (JAMSS), Haruka Nakao (JAMSS) and Masa Katahira

Ashlee Holbrook, (UKentucky), Alex Dekhtyar UKentucky), Jane Hayes (UKentucky), Dan Port (UHawaii), and Senthil Sundaram

"The Software Assurance Symposium (SAS) for 2006 was highly successful for one main reason this year. Our folks were very determined and had a clear vision of the need for research to advance the state of technologies that will help realize the landing on the Moon, Mars, and beyond. The team work that was displayed among everyone responsible for SAS were the exact character traits sought after throughout NASA. When Bryan O'Connor spoke about applied research, integrating the results of research back into the missions, and optimizing the dollars spent on performing research it strengthened our cause and motivated us even more in making research an integral part in getting back to the Moon. I honestly can not say enough good things or show enough appreciation to our team for their excellent work. All I can say to Lisa, Wes, Tim, Frank, Kat, Kristine, Dave, Susan, Jess, Jake, Justin, Tobias, Dave, Lee, Sunny, Kayla, Adly, and Dale is "outstanding job and thank you". Now having said that, there are many more opportunities awaiting us." *Marcus S. Fisher, IV&V Research and Development Lead*

"The NASA IV&V facility in WV and the annual SAS opportunity for collaborative technical exchange is a precious resource to the entire NASA community. Coupling this superb annual effort with a companion session at selective NASA community sites will give our nation's space exploration efforts the assurance of having the software and hardware systems that will prevail in the most unusual circumstances with successful results." *Dudley Killam, JPL*

"As an SMA Director, I have attended the annual SAS to keep current on NASA Software Assurance challenges. This year's event followed the established tradition of continual improvement, proving great technical variety and Q&A opportunity in the break cuts. You have definitely raised the bar and I look forward to the 2007 SAS." *William Wessel, GRC*

"The SAS was great. It was well organized. The food was delicious and the entertainment was wonderful. Of course, the material presented was very good and informative. The interns were wonderful by helping the process of signing in very efficient and pleasant. When I remembered that I needed to access a PC to check my email, they made sure that there was a PC available for me to use." *Ken Chen, JSC*

"During one week of our summer internships, we provided support for the Software Assurance Symposium. We were responsible for helping ensure the symposium went as scheduled. We worked together to prepare, set up, and assist with many of the symposium's events.

During the Software Assurance Symposium, we had the opportunity to meet and talk with engineers from the Japanese Space Agency, Portuguese Space Agency, JPL, Goddard Space Flight Center, and Langley Research Center.

Two interns worked with a Critical Software employee from the Portuguese Space Agency and received training on their tool, Xception.

SAS was one of the most enjoyable highlights of our internships, because it gave us the opportunity to work hands-on with other interns and faculty. SAS presentations had never been recorded before. Making that happen was an enriching endeavor.

The symposium gave us the opportunity to learn about the various NASA IV&V projects, meet some of the top researchers in our fields of study, and gain an understanding of their research projects and even their careers." *SAS 06 Intern Team, NASA IV&V*

Left: Snark and his very own passport. Below: Snark is seen below with his new traveling companions and SAS colleagues Yuko Miyamoto and Haruka Nakao of the Japanese Aerospace Exploration Agency

SAS and International Relations: The Aardvark's Excellent Adventure Snark, the SAS mascot, continues to do his part to further our working relationships with our international partners. As part of an exchange program, Snark accompanied IV&V's guests from the Japanese Aerospace Exploration Agency on their return to Japan.

Robustness Testing: NASA IV&V R&D

Wes Deadrick

The NASA IV&V Facility R&D Program is engaged in a collaboration with a Portugal based company, Critical Software SA, to develop tools and techniques for performing robustness testing on Commercial Off-The-Shelf (COTS) software applications. The primary focus of this effort has been on the robustness testing of a type of COTS software know as Real-Time Operating Systems (RTOS) which are used heavily in mission critical embedded systems.

The premise of robustness testing is to introduce faults in the Application Programming Interface (API) of the application under evaluation in order to identify input parameters that may cause erroneous response (failures). The introduced faults alter the input parameters turning them into exceptional values that may cause application failure. The tests can be performed in either a manual or automatic fashion and the final result is a set of inputs parameters, both expected and unexpected, that cause application failures or reveal weak (i.e., non robust) aspects of the application under evaluation.

The approach presently under evaluation by the IV&V Facility employs a methodology that allows for the automatic generation of test cases for a given application, or in this case RTOS. To perform the automatic fault injection the analysts must identify the API calls to be tested, the parameters of the call, and the types of the parameters. Once this is complete test values are generated based on the types of the parameters selected. Since it is unfeasible to test all legal values, historically troublesome values are initially targeted.

Research to date has included the robustness testing of the Real-Time Executive for Multiprocessor Systems (RTEMS) operating system. RTEMS is an open source real-time operating system commonly used in embedded systems and found on several NASA missions. Preliminary results have identified a number of RTEMS directives that may be candidates for concern when used on mission critical systems. It is important to note that these functions do not always fail under execution, only in the presents of certain input parameters. Results such as these provide the IV&V Facility with a means for assuring that NASA flight software using COTS software, such as RTEMS, does not execute in a fashion that could result in a failure in the operating system.

The R&D Program has a team of 3 students leading the IV&V Facility involvement in the research. The team consists of Justin Morris (WVU), Tobias Brozenick (WVU), and Jacob Brozenick (FSU). Research has been being performed in-house at the IV&V Facility since June 2006 and is expected to continue through 2007 and include the evaluation of other RTOS, including VxWorks, as well as other COTS applications.

Electrifying: 2006 Day in the Park

Jess White

Remember those days in middle school when you knew that for this one day you would not be crammed in a classroom—when a long bus trip could be found so exciting and full of possibility. The operative word: *field trip*. We share in the excitement of that experience each year when we leave our offices and cubes and man the tents, auditorium or bus drop off to greet 900 seventh graders as they pour out of those big yellow school busses to participate in the annual Day in the Park. As the convoy of bright yellow school busses crested the hill on NASA Boulevard this September, the sun came out from behind the clouds. The students, teachers, parents, volunteers, and exhibitors all reflected that "out-of-the-classroom feeling" as the busses discharged their noisy and curious passengers.

First off the busses, 300 seventh graders from Marion County. They trouped into the WV High Tech Foundation Building to begin their day with Dr Charles Camarda, who served as Mission Specialist on STS 114 Return to Flight in 2005. Dr. Camarda's presentation held the attention of the crowd by describing the training and teamwork required for a journey to the International Space Station on board the Shuttle. His remarks

were peppered with introductions by way of photographs of his teammates and descriptions of their contributions to the workings of that historic flight. He painted very vivid pictures of the work that was conducted, the competence and courage of those who planned and manned the mission and the awe that they each felt at the opportunity to participate with one another in such an endeavor. It was especially inspiring to the young girls in the audience to hear this highly respected astronaut speak of his admiration for the mission's commander Eileen Collins. The audience of young people, ever mindful that the flight preceding ended in tragedy, were riveted by Dr. Camarda's description of the fifteen minutes of being surrounded by a fireball that marks the return through the earth's atmosphere. Again and again, throughout the morning, the busses unloaded new groups of students who would sit at his feet to hear his stories of STS 114.

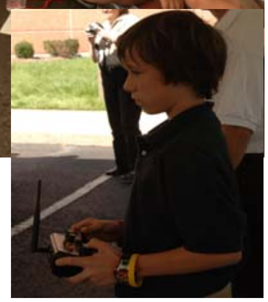
Thirty minutes after those first busses arrived, Monongalia and Tucker County School busses rounded the curve at the bottom of NASA Boulevard and unloaded another group of exuberant field trippers who began their Day in the Park experience at the Space Race Exhibit. The students from this group filed into the tent and took their seats with the clamor that you would expect from 300 7th graders. Over their heads could be seen a man in a white lab coat, pacing madly and fidgeting with some scientific looking apparatus, seemingly unaware of his chaotic companions making themselves at home in his tented laboratory. The chatter was allowed to rise to deafening levels.

Just when it seemed that the students were going to be left to their own devices, completely ignored by the "mad scientist" at the front of the tent, an echoing BOOM filled the air under and around the tent, followed by the kind of loud, high pitched screams that only seventh graders can emit. From that moment the "Mad Scientist" had their attention.

The "Mad Scientist's" name is Ralph White and he is the Coordinator of Planetarium and Astronomy at SciWorks of Winston Salem, North Carolina. Ralph's presentation covered everything from why we use certain types of fuel for rockets to the effects of space travel on the human body. He brought students forward to participate in his experiments, and delighted them when he singled out some teachers for hair-raising demonstrations as well. He taught, amused, engaged and inspired the students with his great scientific expertise and some very crazy antics. This was one science class that every student was sorry to see come to a close…but it did, of course, just as it had begun, with a very loud bang.

Next off the bus, Harrison County. Their first stop of the day was a forensics presentation performed by members of the Fairmont Police Department and the Morgantown Police Department. The students were shown the tools of the trade and the education requirements needed to become a forensics investigator. They were an impressively knowledgeable crowd. A generation growing up on the likes of such TV programs as CSI was well prepared to see the value of the work of the officers who brought forward an incredible array of technology designed to catch the bad guys.

The last presentation that these 900 7th graders experienced, as they made their way in groups of 300 at a time through the event tents was a demonstration of a BomBots. BomBots are specifically designed to mitigate improvised explosive devices (IEDs). The BomBots presentation was delivered by Innovative Response Technologies, Inc. (West Virginia High Technology Consortium Foundation, Azimuth, and Nomadio). Members of this team explained the importance of the BomBots program in the War on Terror. The presentation also explained some civilian applications for the BomBot. Each crowd of students watched as a few of their lucky peers were allowed to operate a BomBot, sending it traveling by remote control through the aisles and alley ways formed by their seated classmates. I have to admit to my own moment of envy watching the selected students enjoy playing with—or rather—operating the BomBots.



Along the way, the students stopped by the food tent, manned by volunteers from offices throughout the Technology Park. The volunteers took their assignment to feed 900 hungry young people as quickly and as efficiently as is humanly possible very seriously.

Many schools made long tiresome journeys on busses to come out to participate in Day in the Park and I like to think that their trip was well worth it. They were out of the classroom and on one of those coveted *Field Trips* we all remember from our own middle school days. They met an Astronaut who was among the team that manned STS 114, local Crime Scene Investigators whose skills rival those of TV's finest forensic programs, inventors of such simple but amazingly effective tools as Bombots designed to save the lives of our troops stationed in Iraq and Afghanistan, and don't forget, they got to spend time with a very "mad" scientist. If you ask me, there is no better day than a Day In The Park.

I thank all of the volunteers from throughout the Technology Park who joined me as I watched them piling back on their busses. We waved them off for the return trip to their classrooms. Hopefully, they were newly inspired but tired enough to make the ride back to their schools a little less raucous for their teachers and their drivers. It is our hope that at least a bit of the chatter on the return trip was less about the usual gossip that is part of the life of every seventh grader and more about the life that could be their's if they pursue some of the interests that the Day's experiences might have inspired. As for all of us at NASA and the WV High Technology Consortium Foundation, this was a high-voltage experience that we will have to work very hard to top in 2007.

Upward Bound: NASA IV&V at West Virginia State University

The NASA Student Outreach team made the journey to Institute, West Virginia, on July 12th and 13th to participate in West Virginia State University's NASA Science Fair Extravaganza.

The NASA team led activities designed to engage and inspire 400 Upward Bound students. The Upward Bound Program is designed to develop the skills and motivation necessary to complete a program of secondary education and to enter and succeed in a program of postsecondary education. Activities included morning sessions of "Launching Rockets from Spinning Planets" which engages students in some of the basic principles of launching rockets from Earth and provides an understanding of the complexities behind planning launch windows. A "Tour of our Milky Way Galaxy" took the Upward Bound students from the outer reaches of our Milky Way Galaxy to our Solar System. The "tour" took them to our Sun and then through the planets with some interesting stops at the ISS, Hubble, and our MER missions along the way. In the afternoon our team also served as coordinators and judges of what has become the traditional Bottle Rocket competition. Once again, the Upward Bound students surpassed the usual engineering designs with rockets that were also works of art.

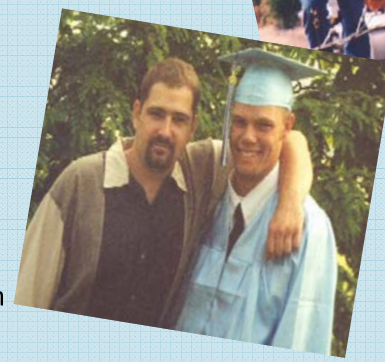
NASA congratulates West Virginia State University on another successful Upward Bound experience for so many deserving students from throughout the State.

Shirley Simmons, the Executive Assistant to the Director of IV&V, is pictured here as a member of the 1967 Upward Bound class at Salem College. Shirley, who has built a successful civil service career, remembers her three years as a West Virginia Upward Bound student as a highly motivating experience. Her advice to today's Upward Bound program participants? " Take every advantage offered. Upward Bound can do so much more than ensure that you have a great summer it can also help to ensure that you have a great future."

It's a family matter...

Jess White

My father is one of those guys whose mannerisms reflect all that you would expect from a man who put 40 years of manual labor on his back, specifically transmission and distribution power line work. I suppose hanging from a steel tower around 40000 volts of electricity would make anyone strong and stoic of mind and emotion. It was rare to see my father laugh, but to see him with tears of laughter rolling down his cheeks, now that was a scene that could only be inspired by my infamous brother, Ralph. Yes, you guessed it, Ralph, the Mad Scientist. My family calls him Jody and I'm still searching for an answer for how Jody became Ralph to his colleagues, but who am I to question it—after all, who would question such a scientist, and remember, he *is* mad.



It is hard to explain Jody, a.k.a Ralph, but I normally do so by saying, "I wish I had one teaspoon of his brains and a drop of his quirky charisma." Ralph is the Coordinator of Planetarium and Astronomy at SciWorks in North Carolina. During this year's planning phase of Day in the Park, I proposed inviting Ralph to be a presenter. I was fully aware of his professional capabilities and I realized that there could be no one more able to create excitement about science for a teaming crowd of seventh graders because he has been passionate about science since he was a young boy. We used to play chess (he played at it, I worked at it), and he would inundate me with countless quirky science facts during the game. He would go on and on about the vastness of space and how black holes are truly beautiful. I understand now, that along with trying to impress me with his vast knowledge of all things galactic, he was also doing a very good job of distracting me to the point of defeat. I have long since stopped trying to beat him at chess, but I remain in awe of his great enthusiasm and skill when it comes to inspiring the next generation of scientists, mathematicians and engineers. My brother Jody..er..Ralph is a scientist who knows that it is not only gratifying to inspire young people to be just as "mad" as he about science, it is imperative. I am proud to be his brother and proud to be considered by him as a colleague in the *inspiring the next generation business* since becoming Student Outreach Manager for NASA's IV&V Facility. We know our strong, stoic Dad is proud that his sons have found work that is just as exciting as hanging around 40000 volts of electricity. No matter the job, it's great to get a big kick out of what you do every day for a living, isn't it?

...and a matter of families

The Facility Picnic was a great success this year. More food than anyone could or should eat and a great time arranged for kids and grownups alike. We owe a debt of thanks to a number of our NASA IV&V Family members for making the day so memorable. Folks like Deborah Radabaugh, L-3 Titan, and Dave Dial, WVU, who led the effort to make the arrangements for all of us...the where, the when and the what-are-we-gonna-eat. A special thanks to Kaci Reynolds, NASA, who helped everyone find the picnic site by making sure the Deputy Director, Bill Jackson, (top right photo), or rather a billboard size photo of him was pointing the way all along the route. Kaci and her "busy-ness partner", daughter Taylor (bottom right photo) managed a tie-dye t-shirt tent so that everyone could leave the picnic with a great memento of the day.

NASA IV&V Family Picnic

Looking for Help? Pencil Us In!

Melissa Northey This year's Back to School Supply Giveaway Program at Scott's Run Settlement House was able to fully equip a total of 552 students. Although the specific number of students that the Facility equipped is not available, it is safe to say that nearly 10% came from our donations. Thank you for remembering that "brand new pencil box" feeling and giving, as always, so very generously.

Whose Getting Canned?

Melissa Northey Word has it that hungry local families are getting canned— that is if we all give of our own well-stocked pantries. Get ready for the upcoming holiday charity events...including the non-perishable food drive for the Salvation Army Food Pantries!

CFC 2006: Teamwork & Mission Success

As we go to press we are kicking off the 2006 CFC Drive. Traditionally IV&V is one of the most giving organizations within NASA, with individual contributions rivaling that of all other codes. However, when it comes to putting forward a winning golf team for the tournament our contribution to the sport of golf has been less than remarkable. This year, four NASA IV&V Project Managers made it their mission to represent us to the *campaign* and to the *sport* . And represent us they did! They not only won the tournament but contributed all their winnngs back to the CFC General Fund for local charities. In their generosity and in their game score they reflected the CFC 2006 slogan:

Tom Maccaulay, Steve Pukansky, Robbie Robinson, Ken Vorndran

Every One of Us Can Be the Miracle!

The Home Team: IV&V Research and Development

The IV&V Research and Development Team is made up of three native West Virginians—Marcus Fisher, Wes Deadrick, Lisa Montgomery—who are enthusiastically and effectively meeting the challenge inherent in building a top notch research program for NASA. Of course, if you ask any one of them, they will tell you that challenge is just another word for opportunity.

Wes Deadrick, Marcus Fisher, Lisa Montgomery

Marcus Fisher took on the role of Research and Development Lead in January 2006. Like many West Virginians, Marcus is an avid out-doors man, and once thought he had found his dream job working for the West Virginia Fish and Wildlife Services creating detailed models of wildlife populations and hi-tech ways to track those populations. While earning a second Bachelor's degree, Marcus attended a presentation given by a West Virginia University faculty member who worked for NASA. The presentation focused on the International Space Station and more than captured his imagination, it caused him to embark on an entirely new career. Marcus has been at IV&V since 1998 and has worked on many projects. His fine work on one of those projects earned him NASA's Space Flight Awareness Award. Which project? You guessed it—the International Space Station.

Wes Deadrick joined the IV&V Facility as a Co-op student in 2002, and has been contributing his expertise and enthusiasm to an amazing array of assignments. By virtue of his early start as a Co-op, he is the longest serving member of the Research Team.

Lisa Montgomery entered the NASA Facility as a contractor with degrees in history, education, and computer science. It wasn't long before she joined the civil service to work directly for NASA. Lisa works to bring a balance between the technical work and the communication of that work to create new collaborative opportunities.

As West Virginians, Marcus, Wes and Lisa share not only an alma mater, WVU, but also similarities that enable them to form a cohesive team. One of the surprising things that they share is that not one of them ever dreamed that they could ever work for NASA. Mindful of their great fortune to contribute to NASA's mission from their own "neighborhood" they share a commitment give back to the community each in their own way. For several years Marcus has lead a drive to buy school supplies for young West Virginia students; Lisa is involved with a volunteer group raising money for Special Olympics; and Wes is always supportive of IV&V's outreach activities.

All of the members of IV&V's highly successful Research and Development team are determined to bring West Virginia high school and college students into their program as interns whenever possible. This year seven interns have worked for NASA under their mentorship. Now those interns will have the same terrific feeling that Marcus and Wes and Lisa know so well when someone says to them, "Wow, you work for NASA?"

David Tate, Justin Morris, Lee Zaniewski, Jacob Brozenick, Tobias Brozenick, Kayla Medina, Dale Everett

Our Value-Ables

Safety, Respect, Teamwork, Balance, Excellence, Innovation, Integrity

Deborah Kromis honored with NASA's *SFA* Award

Deborah Kromis is the Project Manager for the delivery of Independent Verification and Validation (IV&V) services to the International Space Station Program. She is responsible for leading more than 30 contractor FTEs in performing IV&V analyses on safety and mission critical ISS software as well as managing the associated cost and schedule. She reports IV&V readiness status at Agency and programmatic forums such as the Safety and Mission Success Reviews prior to each mission. Deborah also serves as IV&V Services Project Manager for the Lunar Reconnaissance Orbiter project and as NASA POC for the research initiative "Software Interface Validation".

Deborah's years of work on ISS, level of technical expertise, and initiative enabled her to clearly communicate the need for and benefit of safety-related analysis that had never been performed on ISS. Though the ISS Program agreed with her recommendation, they indicated that the Program did not have the necessary skill base to perform the work. Deborah proposed that IV&V contractors under her direction develop a prototype process, methodology, and tool for the Program. This resulted in the **Hazard Trace Task**:

- Trace between ISS hazard reports whose causes are related to software and the relevant software requirements of the ISS software.
- Develop a data base that shall contain trace analysis information and has capabilities to maintain the relationships among hazard reports, hazard causes and SRS requirements.

Deborah presented her idea and strong supporting rationale to IV&V management. Her plan to perform hazard tracing for ISS was approved, with support and a contribution of funds from ISS.

Deborah performed hands-on analysis as well as overseeing contractor analysts. The data-

base and input/reporting tool that have been developed for this task will allow review of the data/traces/analyses as part of the risk assessment for software changes.

For example, if there is a proposal to change a portion of software, the traces in the trace tool can be used to determine if the software has a role in control or mitigation of any hazards. Determination of the risk introduced not just into the software, but into the entire ISS system, by that particular software change can be explicitly reviewed and appropriate risk assessments can be made. In addition, the analysis techniques and the database/tool can serve as a model for future similar efforts. A side benefit of the Hazard Trace task has been the identification of potential errors in both hazard reports and software requirements.

The ISS software community and the ISS S&MA community have made very positive comments about this effort. They are excited by the prospect of the many ways in which the analyses and the tool can be used to protect the safety of the crew.

"By virtue of your selection, you can take pride in knowing that your contributions play a very important role in the program. I congratulate you and look forward to your continued excellent support of the Space Shuttle/Payloads program."

Edward J. Weiler, Director