



FLORIDA INSTITUTE FOR HUMAN & MACHINE COGNITION

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volume 6 issue 2

Featured News

Biologically Inspired Security
for Tactical Environments

3

Happenings

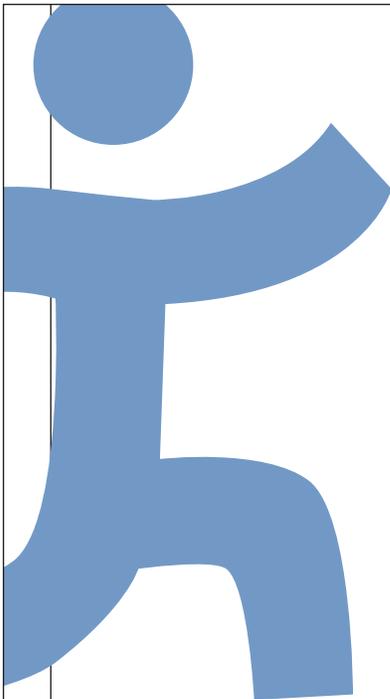
IHMC welcomes three new
board members

6

2 | **Director's Letter**

8 | **Recent Lectures**

11 | **Local News**
IHMC partners with
engineering academy



Dear Friends:

As the holiday season approaches, it is a wonderful time for all of us to pause and reflect on the year that is quickly drawing to an end and to begin to anticipate and plan for the interesting challenges and great opportunities that await IHMC in 2010.

During this year, IHMC has worked diligently to broaden and enhance the exciting research we are pursuing in many areas of science and technology that are critically important to both our national security as well as future technological and economic leadership for our nation. We have continued to expand our collaborations with private sector entities even as we endeavor to broaden our work with our government partners around the country.



This expansion of IHMC's research in robotics, computer and network security, planetary rovers, assistive technologies for wounded service members, software agents, and cockpit displays, to mention only a few research areas, provides solid support for IHMC's growing national and international reputation.

In a different, but equally important vein, we have also increased our mentoring programs for future young scientists and engineers and even added new areas of outreach in the local schools. You will read in this newsletter about some of these programs that we have recently undertaken and meet some promising young researchers.

I am excited to report that the extensive renovation of our Ocala IHMC facility is nearing completion as we finalize this issue, and our next newsletter will highlight this newly renovated "green" building in downtown Ocala. We certainly hope that you will stop in and visit the new IHMC research facility located at 15 SE Osceola Avenue in Ocala's historic downtown.

I am extremely proud of the work we have accomplished this year and look forward with excitement and anticipation to IHMC's continued success in the year ahead. Nancy and I wish all of you a wonderful, relaxing and restful holiday season.

Best Wishes,

Kenneth M. Ford, Director

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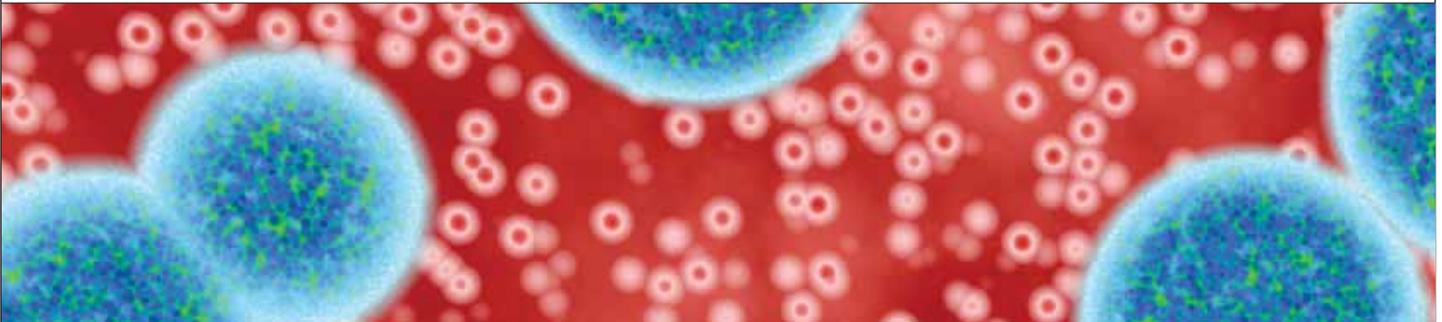
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Biologically Inspired Security for Tactical Environments



Any system, whether natural or man-made, must confront attacks. The survival of biological systems depends on the ability to detect, identify, and respond to external threats and failures. Biological immune systems have evolved into remarkable defense mechanisms, with powerful capabilities such as scalability, adaptation, learning and long-term memory.

The vertebrate immune system has a two-layer defense mechanism. At the lower level, the innate immune system constitutes a first line of defense, immediately after physical barriers such as the skin and the biochemical blockers. The innate immune system is static through the life of the organism, but provides a crucial role not only as a generic defense to common bacterial infections, but also on the triggering and control of the adaptive immune response.

The second layer of defense is provided by the adaptive immune system, which is capable to evolve and specialize for the detection of specific microorganisms. The adaptive system is what allows organisms to develop new defenses to previously unseen attackers, and to maintain a long-term memory of detectors.

Combined, these capabilities provide a powerful and complex defense infrastructure that has allowed the survival and evolution of organisms for millions of years. Despite intense research for several decades, the complex mechanisms for immunological defense are not yet fully understood, but significant progress has been made, and as new models and theories are designed and verified, a growing number of researchers are exploring new concepts and analogies applicable to other domains, and to new computational paradigms.

At IHMC, Marco Carvalho and his research group and collaborators are looking to biological systems for models on how to help computer systems defend against attacks. They are investigating how large-scale cyber infrastructures and tactical computational systems can be designed to incorporate similar self-regulated and adaptive capabilities, using concepts borrowed from the innate and adaptive defense mechanisms of biological systems.

Typical computer systems, such as a personal computer, rely primarily on a self/non-self test for protection, and can be compared to the innate immune system. All incoming data, whether from a webpage or email, is scanned for suspect code. Anything unexpected is quarantined and presented to the human user for approval or rejection.

The computer systems of the future, however, cannot rely on such intensive security screening. In addition, they must be highly adaptable, responding to a variety of changing conditions. These systems, called ad hoc networks, consist of mobile nodes working together to create connectivity.

■ ■ ■ **At IHMC, Marco Carvalho and his research group are looking to biological systems for models on how to help computer systems defend against attacks.** ■ ■ ■

The amount of data traveling in these systems precludes the use of humans to monitor suspect data. These systems could range from office systems to disaster relief or military operations, anywhere that multiple computers must work together on a common mission.

This type of network has characteristics that make it vulnerable to attack. For example, there is not a fixed, centralized support infrastructure that provides information on the reliability of the nodes in the system. In addition, the nodes vary in their nature. They could range from unmanned aerial vehicles to ground sensors to hand held devices each with mission related programs and unrelated programs, such as email systems or flight systems. The complexity of the system makes security challenging.

The computers in such a system must share information in an attempt to accomplish the mission, relying on the strengths and data of each. For example, a soldier on the ground may have the ability, through a handheld computer, to request a UAV to take aerial photos of a certain area. Another soldier may later download those photos. However, an enemy may attempt to hack into those signals, corrupting the data as it is transmitted. Computers in this ad-hoc network must be open to much non-self data which may or may not be trustworthy. In this scenario, a traditional protection scheme would be too computationally intensive.

Departing from conventional biologically inspired strategies for network security, Carvalho proposes the design of new distributed systems capable of identifying the set of critical operations or the main mission being carried by the system. In the proposed approach, the computational and communication infrastructures provide the resources that are used to support one or more critical tasks that must be monitored and protected.

Dr. Carvalho's approach leverages and builds upon previous research efforts in artificial immune systems, autonomic systems, danger theory and cognitive resource management to create an adaptive infrastructure that monitors and manages resources to

■ ■ ■ The prioritization of goals allows for defense strategies that are generally unavailable in conventional network security. Attacks that directly affect the performance of the mission are a first priority. ■ ■ ■

SCIENTIST PROFILE



MARCO CARVALHO

Education: B.S. and M.S. in mechanical engineering, Federal University of Brasilia, Brazil; M.S. in computer science, University of West Florida; Ph.D. in computer science, Tulane University.

Hometown: Rio de Janeiro, Brazil

Joined IHMC: 2000

Originally from Brazil, Marco first moved to Pensacola to start a software development company and an Internet service provider. He ultimately left the business world to join academia and started working at IHMC in 2000. He is IHMC's first scientist in Ocala.

Marco has always had a passion for science. While attending the Brazilian Naval College he was involved in science groups working on custom-built remote control airplanes and model rockets. His undergraduate and graduate studies in engineering were primarily in applied computational thermodynamics and dynamic systems, a background that would prove valuable later in his Computer Science related work on distributed systems and autonomy security.

The interdisciplinary nature of his research is what he finds the most fascinating part of his work. Having the opportunity to discovery and learn new things every day and to apply different concepts and theories across different fields is a privilege. If he could, he would readily go back to school for further study, perhaps in philosophy or mathematics.

With his diverse interests, the multidisciplinary nature of IHMC is a natural fit for Marco. He enjoys the opportunity to work with leading figures in such a large range of fields. Working in Ocala is providing him the opportunity to strengthen collaborative relationships with researchers at nearby universities. He is a faculty member of the Center for Applied Optimization at the University of Florida and also holds a graduate faculty position at the Florida Institute of Technology. He currently works from home, eagerly awaiting the renovations of IHMC's new building in downtown Ocala.

Marco enjoys running and long hikes; he also likes to travel with his wife and two young daughters. He frequently visits with numerous collaborators in central Florida and returns monthly to Pensacola to work with colleagues.



Dr. Marco Carvalho (IHMC) and Dr. Richard Ford (FIT) collaborate on BITS I

ensure the survivability of the mission as a primary goal and the secondary protection of the infrastructure. This prioritization of goals allows for defense strategies that are generally unavailable in conventional network security. Attacks that directly affect the performance of the mission are a first priority. Upon sensing such an attack, the system reallocates mission-critical tasks and resources to isolate the affected area and mitigate its effects. Low impact attacks are tolerated and monitored to better identify attack patterns and better devise a more permanent defense.

Information learned from local attacks against one of the network nodes or services is not only used to improve the defense mechanisms of that specific node but in addition efficient targeted dissemination mechanisms (based on affinity measures between systems and applications) accelerate the propagation of “antibodies,” prioritizing delivery to similar systems, which are likely to be vulnerable to the same, recently identified attack. The mission is well-served since resources can be allocated based not only on cost and health information but also on the estimated vulnerability and risks that each node or service may bring to the mission.

Together these capabilities underlie BITS I (the Biologically-Inspired Tactical Security Infrastructure). BITS I is part of a research effort sponsored by the Army Research Laboratory, to create a cognitive three-tier defense infrastructure integrated with a dynamic resource allocation infrastructure for mission survivability.

This research effort is being developed in collaboration with the Florida Institute of Technology and the Harris Center for Information Assurance. Through this collaboration, FIT and IHMC are developing new concepts and creating novel infrastructures for the defense of our tactical military systems and critical infrastructures.

The system stability and security provided by the BITS I system can improve many other infrastructures. Carvalho is exploring how to generalize these ideas for use in a variety of other domains, such as the development of cross-layer communication middleware for opportunistic resource management in tactical networks, adaptive in-stream data processing frameworks, stochastic routing and adaptive transport protocols, self-protecting Information Management Systems, and adaptive defense infrastructures for distributed control and SCADA (Supervisory Control and Data Acquisition) Systems.

By imitating biological elements and the way they respond to damage, Carvalho and his team are helping to create new defense infrastructures that will enable better security, survivability and the optimization of distributed computer systems. This security will allow the creation of networks that focus more on achieving the mission than the survival of individual components, leading to graceful degradation under attack or resource contentions and ultimately to greater mission success.

HAPPENINGS

■ ■ ■ IHMC BOARD MEMBERS

IHMC Welcomes Three New Board Members

In June of 2009, IHMC added three distinguished individuals to its Board of Directors.

Ron Ewers

Ronald L. Ewers is the President of Ewers Consulting and a part owner of Encore-Classics Fire, building fire apparatus; Oxy Life, an Ocala oxygen supply company; and Fire Programs, a fire reporting software company. He served as a Jet Engine Mechanic in the US Air Force. After tours of duty in 35 countries, Mr. Ewers returned to civilian life and became Vice President of Engineering for Game Time Inc, a commercial playground equipment manufacture company. Mr. Ewers served as Vice President of Operations and later President of Emergency One, a national company which designs, manufactures and markets rescue vehicles. Later he founded and served as President of Class 1, a company developing innovative technology applications for emergency vehicles with production facilities in Ocala Florida. Active in community endeavors, Mr. Ewers serves on the Board of the Ocala/Marion County Economic Development Council, SunTrust, the Boys & Girls Club, Hale Academy, and



Ron Ewers

he is currently the Co-Chair of the Central Florida Community College Promise for the Future fund drive and Co-Chair of the United Tocqueville Society Fund Raiser.

Hector A. "Tico" Perez

Tico Perez is the founder of Edge Public Affairs, LLC, a government relations consulting firm; Mas Communications, LLC, an Hispanic media relations firm; and Tico Perez Solutions, LLC, a business development consulting firm. Previously he was a partner of the national law firm Baker and Hostetler where he practiced business law, specializing in mergers and acquisitions. Mr. Perez serves as a member of the Board of Governors of the State University System of Florida where he is the chairman of the Budget Committee and Vice Chairman of the Facilities Committee. Mr. Perez is a member of the National Executive Board of the Boy Scouts of America and serves as the National Commissioner of the Boy Scouts of America. He is active in the central Florida



Hector "Tico" Perez

community, serving as the Past President of the Orlando Utilities Commission, Past President of the Greater Orlando Chamber of Commerce, Past President of United Arts of Central Florida, Past Chairman of the Orange County Arts and Cultural Affairs Commission, Past President of the University of Central Florida Alumni Association and is also Past President of the Southern Region for the Boy Scouts of America. He is a political analyst for the local NBC affiliate, WESH Channel 2, is a weekly political commentator on the nationally syndicated Daily Buzz and hosts his own political talk radio show, Talkin' with Tico, on Cox radio's newstalk AM 580 WDBO. Additionally, Mr. Perez has a regular weekly television program in Spanish on the local Telemundo affiliate in Central Florida entitled TeleNoticiasExtra.

Gordon Sprague

Gordon J. Sprague is currently the owner and operator of a working Vermont dairy farm and an Antique Auto Private Collection Museum in Gulf



Gordon Sprague

Breeze, Florida. After serving in the Air Force and obtaining his degrees, Mr. Sprague worked in Parks and Recreation serving as Tallahassee's Director of Citywide Athletics, West Palm Beach Director of Recreation, Jacksonville Division Chief of Recreation and Parks, and then Executive Director of the City of Memphis Park Commission. Mr. Sprague then served as the Assistant to the President for Fogelman Properties and as a Mutual Fund Money Manager for AIM in Houston where he marketed investment products to financial advisors, served as National Sales Manager of a new division of AIM, and as Advisor to Global companies in Canada, Australia, Japan, Hong Kong, Singapore, Taiwan and New Zealand. Mr. Sprague has served on the FSU Foundation Board and Seminole Booster Board. He currently serves on the Board of the Pensacola Beach Elementary Charter School, the FSU National Alumni Association, Meridian Health Care, and the WSRE Public Television Board where he also serves as Finance Chair.

HAPPENINGS

NEWS OF IHMC



IHMC receives a \$150,000 grant from Florida's Great Northwest for the development of an innovative training program

IHMC Receives Workforce Training Grant

Florida's Great Northwest, an employment and training organization, awarded IHMC a matching grant to support efforts to boost young scientists' research careers. The grant will support graduate students and post-doctoral scholars to work on federal research projects. The goal of the grants is to grow technology talent, encourage innovation, and foster sustainable economic growth in the Pensacola area.

"The Florida Institute for Human and Machine Cognition's continued success as a habitat for innovation depends upon our ability to recruit and grow the very best technology talent. We are delighted to receive the support of Florida's Great

Northwest in order to recruit outstanding new trainees who will work with our scientists, learn the competitive research enterprise and become contributing members of our regional technical community," said Dr. Ken Ford, IHMC's chief executive officer.

IHMC anticipates training as many as 25 scientists and engineers. It is expected that many will remain in the region and become researchers in the regional technical community and, eventually, technology leaders. These researchers will bolster IHMC's existing efforts to mentor and support upcoming leaders in scientific research.

■ ■ ■ The Florida Institute for Human and Machine Cognition's continued success as a habitat for innovation depends upon our ability to recruit and grow the very best technology talent. ■ ■ ■

IHMC interns

Giacomo Benincasa

Giacomo just received his M.Eng. in Computer Engineering from the University of Modena and Reggio Emilia, Italy. He has returned to IHMC to work with Niranjnan Suri on a dissemination service for tactical network environments.

Divya Garg

Divya is a Ph.D. student at the University of Florida, where she recently received her M.S. in mechanical engineering. Her B.S. in mechanical engineering is from Malaviya National Institute of Technology, Jaipur, India. Her Ph.D. research focuses on optimal control problems. She is working with Jerry Pratt and Peter Neuhaus on humanoid robotics.

Laurent Moulouquet

Laurent is an engineering student in cognitive science at the Institut de Cognitique, Bordeaux, France, where he also received his M.S. in the field. At IHMC, he is working with Guy Boy, David Lecoutre and Anil Raj on the brain port and with Niranjnan Suri on an adaptive information dissemination system.

Hossein Tamaddoni

Hossein is a Ph.D. student at Virginia Tech, focusing on dynamics and control of vehicles. He received a B.S. and M.S. in Mechanical Engineering from Sharif University of Technology, Iran. He is working with Jerry Pratt and Peter Neuhaus on bipedal push recovery.



Giacomo Benincasa



Divya Garg



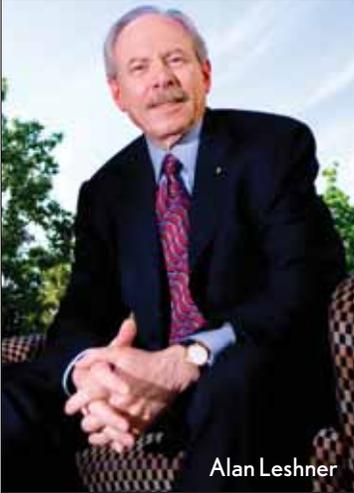
Laurent Moulouquet



Hossein Tamaddoni

RECENT LECTURES

■■■ IHMC'S EVENING LECTURE SERIES



Alan Leshner

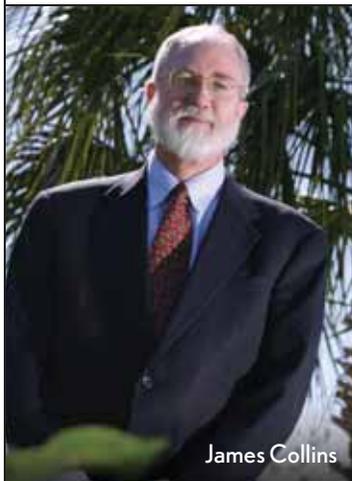
Alan Leshner examines relationship between science and society

While people consistently believe that the benefits of science outweigh its costs, the relationship between science and society fluctuates, particularly over certain issues. During his lecture "The Evolving Societal Context for Science," Alan Leshner highlighted several challenging issues that have generated and will continue to generate substantial tension.

He claims that most of the tension on these issues, such as stem cell research and global climate change, is due not so much to the science but rather the political and social implications of the science. He argued that science and society need to engage in further

dialogues to guide both sides in moving forward in order to resolve some of the ongoing conflict.

Leshner is the Chief Executive Officer of the American Association for the Advancement of Science (AAAS) and Executive Publisher of the journal *Science*. He is the former Director of the National Institute on Drug Abuse and also was the Deputy Director and Acting Director of the National Institute of Mental Health. Additionally, he has held a variety of senior positions at the National Science Foundation.



James Collins

James Collins envisions the future of biology

In the twentieth century, science was pursued as single

disciplines, such as biology, chemistry, and physics. Now though, as James Collins explained during his lecture "One Biology, One Science: A Vision for the 21st Century," we must have a transdisciplinary approach. The Earth's climate and related life support systems are changing today in ways and at rates that are markedly different from those experienced in recorded human history. To provide the knowledge needed to adapt to these changes, scientists must work across traditional disciplinary boundaries to recognize a range of triggers that could cause environmental degradation, economic hardship, or pandemic disease. New generations of scientists must be able to communicate science to other scientists and the general public so they can understand the role of science in understanding life and adapting to the changing world.

Collins is the Assistant Director for Biological Sciences at the National Science Foundation (NSF). He is also currently Virginia M. Ullman Professor of Natural History and the Environment in the School of Life Sciences at Arizona State University (ASU). He previously served as director of the Population Biology and Physiological Ecology program at NSF.



Eileen Collins

Eileen Collins explores lessons from space travel

Many of the lessons learned from the Space Shuttle Columbia disaster and the subsequent investigation can be applied in a variety of settings. Eileen Collins outlined these lessons and also described her experiences on the space shuttle during her lecture "Leadership: Lessons Learned from the Space Shuttle Era." NASA employees in general have a great knowledge of their jobs, work well together, and have high integrity. However, they miss opportunities to improve through their organizational culture with strong everyday assumptions that do not get questioned. Collins believes that NASA and other people and organizations could benefit from a change to valuing and practicing listening, humility, and creativity.

Collins is a former NASA Astronaut and retired Air

RECENT LECTURES

■■■ IHMC'S EVENING LECTURE SERIES

Force Colonel and is currently Chairman of the Space Operations Committee of the NASA Advisory Council. A veteran of four space flights, Collins' career at NASA has been punctuated by firsts. She was the first woman selected as a pilot astronaut, the first woman to serve as a shuttle pilot and the first woman to command a U.S. spacecraft.



Charles Carlson

Carlson advises on financial strategies

The stock market and economy are a large concern presently. As Charles Carlson explained during his lecture "The Smart Investor's Survival Guide," knowledge of how we got to where we are is important, but, ultimately, we must be forward looking. In order to fix the underlying problems in the current

economy, we must understand the root causes, such as the housing bubble. To know if the problems have been fixed, we can look at how the market is performing compared to past performance. However, things are at extremes right now, so many of the tools that economists use do not provide good guidance. So what is an investor to do? Do what you are always supposed to do: balance your portfolio according to your risk tolerance and determine, based on fundamentals, if a stock is worth its current price. Carlson is Chief Executive Officer of Horizon Publishing, one of the oldest investment newsletter publishers in the country, and Horizon Investment Services, a money management firm. He has published a number of books on investing.

Stoddart mixes art with science

Interlocking is present in art, architecture, toys, fashion, and chemistry. Sir James Fraser Stoddart detailed his exploration of interlocking rings in art history and chemistry during his lecture "Mingling Art with Science." In particular he described Borromean rings and the Solomon link, both their presence in art and culture



Sir James Fraser Stoddart

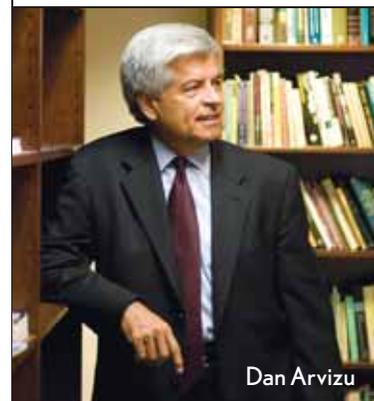
as well as his laboratory's efforts to synthesize these two complex molecules.

He is noted as a leader in the consistent use of molecular cartoons for illustrating the synthetic methods of his research. Further research will focus on using these rings as catalysts as well as potential for drug delivery. Sir James Fraser Stoddart is a Scottish chemist who is currently the Board of Trustees Professor of Chemistry at Northwestern University. He works in the area of supramolecular chemistry and nanotechnology. His efforts have been recognized by numerous awards including the 2007 King Faisal International Prize in Science.

Arvizu describes energy future

Our energy future is enormously challenging, according to Dr. Dan Arvizu, the Director of the U.S. Department of Energy's National Renewable Energy

Laboratory. Improving our energy future is essential for three important, different factors: national security, economic productivity, and environmental protection. The challenges are not really technical but rather the amount of commitment we want to make to improve our energy future.

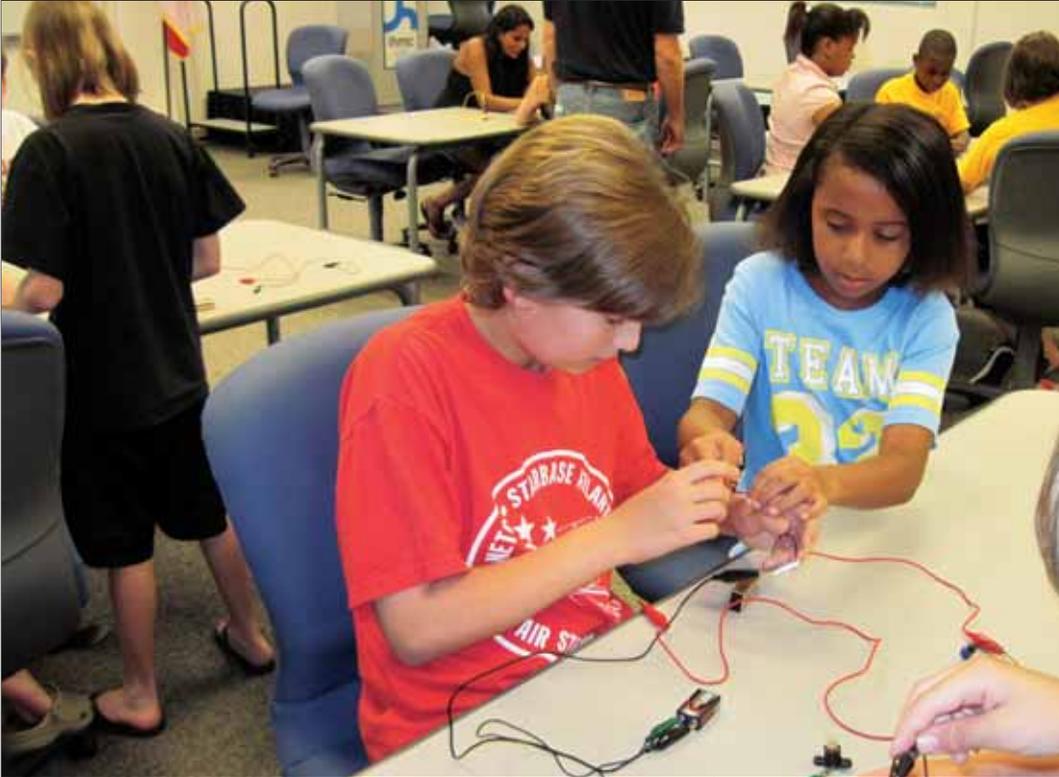


Dan Arvizu

Over the next 20 years, a significant amount of investment will be made in energy infrastructure, and the country has a choice in how we want to spend that money, whether for new energy efficient technologies or shoring up our current energy systems. NREL is the Department of Energy's primary laboratory for energy efficiency and renewable energy research and development. In addition to his role at NREL, Dr. Arvizu also is a Senior Vice President with MRI, headquartered in Kansas City, Missouri.

LOCAL NEWS

NEWS OF THE IHMC COMMUNITY



including physics, chemistry, biology, and earth science, and last for approximately one hour. Volunteers are provided detailed background information but are given wide latitude in leading their activities. Many go above and beyond the suggested activities, bringing in activities and ideas of their own. Volunteers range across fields, including many non-scientists, demonstrating to students that science is relevant in different areas.

Resources incorporate components that are designed to spark students' curiosity and interests in science. Elements included in activity script suggestions include poetry, history, and math. By approaching science from multiple angles, we aim to make it of broader interest to all of the students.

Last year approximately 80% of 5th grade teachers in Escambia and Santa Rosa counties were partnered with volunteers, and 100% of the teachers in the Title 1 schools had volunteers.

Nearly all of the schools in the two districts include participating in the program as an integral part of their school improvement plan, confirming the perceived value of the informative *I LOVE Science* program.

Science Saturdays kicks off Fall Season

IHMC has announced its new Fall schedule for *Science Saturdays*. IHMC's popular *Science Saturdays* is entering its 7th year with sessions on electronics, flight, and balloon cars. In addition, members of the American Chemical Society Pensacola Section will again hold their National Chemistry Week activities for a Saturday activity.

Science Saturdays is a hands on science program for kids in grades 3, 4, and 5. Activities are led by IHMC researchers and allow children to explore

the excitement of scientific discovery. They are held one Saturday a month during the school year, with overflow sessions on the following Saturdays in most months.

Last year we began offering overflow sessions to accommodate the growing demand for this program and will continue this year.

During the 2008-2009 school year we saw a large increase in participation of approximately 50%, with over 400 attendees, many attending more than one session. IHMC anticipates an additional increase this spring as the popularity and publicity about of *Science Saturdays*, continues to increase.

I LOVE Science recruits volunteers for new school year

I LOVE Science is again partnering volunteers with teachers to improve science education. Volunteers lead activities in 5th grade classrooms throughout Escambia and Santa Rosa counties. This year is the 4th year, and we again have volunteers working with almost all of the 5th grade teachers. We always welcome new volunteers throughout the school year.

I LOVE Science activities are aligned with the curriculum,

LOCAL NEWS

NEWS OF THE IHMC COMMUNITY

IHMC Partners with Engineering Academy

IHMC is expanding its outreach efforts into high schools with a new partnership with Okaloosa County Schools.

This year, IHMC began a partnership with the CHOICE Engineering Academy at Choctawhatchee High School to bring research to their students through project-based science activities.

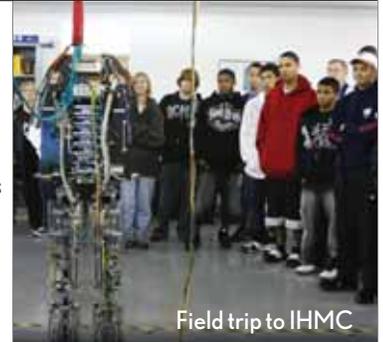
The CHOICE program is an initiative piloted in Okaloosa

County to provide students with industry certification, college credit courses, and work experiences through the choice of a particular field of study.

Programs include allied health, automotive maintenance, aviation and aerospace, construction technology, engineering, hospitality, and information technology. CHOICE Institutes emphasize partnerships among secondary schools, postsecondary institutions, workforce boards, and businesses and industries with course offerings and training linked to regional

business demands.

In conjunction with the engineering academy faculty, IHMC will provide students with three technology problems to be tackled during the school year. Areas will include medical robotics, enhanced operator performance, and unmanned vehicles. IHMC staff will assist the students in creating engineering solutions to specific detailed tasks within these areas. IHMC scientists will create the activities with consideration of real-world applications and relevant research challenges.



Field trip to IHMC

IHMC is eager to see students engaging with real, current challenges in engineering. With the expertise they will develop in high school, they will become uniquely positioned for work experiences before their first college engineering courses.



IHMC Goes Green

IHMC has started a community garden. With the assistance of a master gardener, IHMC staff began their first season of gardening during the spring. Staff are welcome to cultivate their own plots or can harvest the produce from the community plots.

This community garden is a resource for IHMC employees to have fresh grown vegetables as well as an opportunity to learn more about gardening.

The gardens take advantage of the multiple growing seasons. During Summer, crops included okra, zucchini, squash, peppers, tomatoes,

arugula, eggplant, and beans, as well as a variety of herbs.

In Fall, the summer plants are replaced with winter produce, such as beets, broccoli, carrots, and lettuce.

IHMC employees are always welcome to make suggestions for produce they would like to have included in the garden.



Pratt Elected to City Council

Megan Pratt, a staff member at IHMC, has been elected to the Pensacola City Council. She will serve a two year term as one of the two at-large councilmembers, representing citizens throughout the City of Pensacola.

Pratt leads IHMC's educational outreach programs, including *Science Saturdays*, *I LOVE Science*, and *Voluntology*. In addition, she writes for the newsletters and annual reports.



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