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FLORIDA INSTITUTE FOR HUMAN & MACHINE COGNITION

Dear Friends of IHMC,

Many of you are aware of IHMC's concept mapping software, CmapTools and its growing importance to the Institute. In past newsletters, we have featured articles on the two key researchers responsible for CmapTools development, IHMC's Joe Novak and Associate Director Alberto Cañas.

In this issue, we discuss IHMC's new partnership with the Government of Panama to integrate CmapTools and an improved computer infrastructure into public schools throughout the country. The work of Dr. Cañas and that of his team, both the programmers working in the lab and those training the teachers in Panama, will surely make a positive impact on education in that country for many years to come. Additionally, we are especially delighted that teachers from our partner institution in Pensacola, Brown Barge Middle School, are part of this project. The Panama project has already received extensive national and international media attention including most major newspapers, television, and National Public Radio. You can read more about this exciting project and meet the Cmap team on page 7 of this newsletter.

Intertwined throughout all aspects of IHMC's research mission is education. While the role of a research institute in education is traditionally construed as training undergraduates and graduate students in scientific research, the dissemination of CmapTools into educational settings throughout the United States and other parts of the world may have a more lasting and broader influence. Currently people in over 150 countries use Cmap-Tools, and there are hundreds of downloads of the software each day from our website <http://cmap.ihmc.us>. Individual schools, school districts, universities, and organizations throughout the world are taking advantage of the unique collaboration and sharing features of the software. We are excited and proud to see how our work with learners ranging from kindergarteners to graduate students to professionals in corporate training will help shape all levels of training and education at home and abroad.

Ken Ford, Director

Biologically Inspired Robotics

> " In nature's infinite
> book of secrecy
> A little I can read. "
>
> —William Shakespeare

Nature is full of wonderful examples of well designed machines. Most humans can walk, run, jump, and manipulate their digits with ease. Cheetahs, the fastest land animal, can run at 70 miles an hour and even climb trees. A duck can swim, paddle on the water, walk, and fly. All of these wonderful skills, plus the ability of animals to locate their

Pisces Test

own fuel, repair themselves after an injury, and replicate themselves far exceed any capabilities of machines heretofore designed and created by scientists and engineers.

Most robots today, such as those in car assembly plants, can't operate independently in a complex environment. The car is brought to a predetermined position, the robot arm moves to a precise location, and then makes a weld or begins spray painting. However, the world outside the factory is much less precise. Understanding the impressive locomotion capabilities of the natural world may be the key to replicating them in the mechanical world.

IHMC researchers Jerry Pratt and Peter Neuhaus look
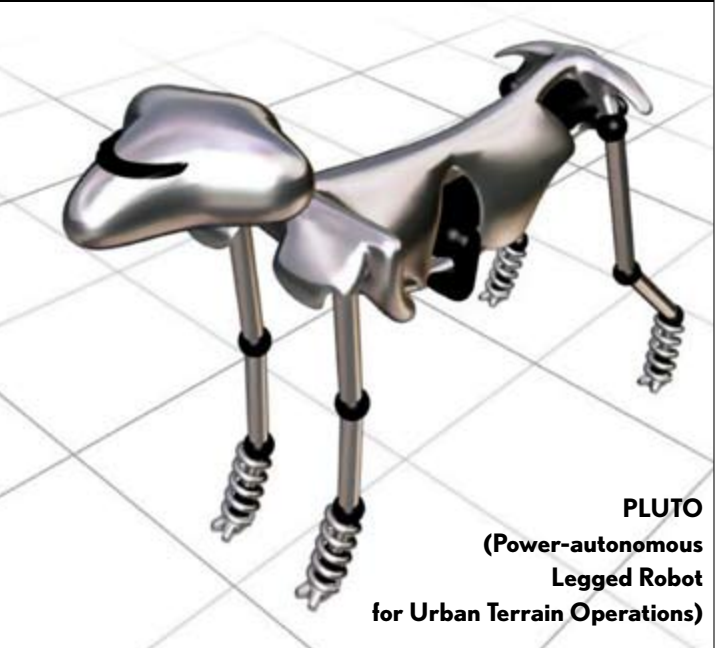
**PLUTO
(Power-autonomous
Legged Robot
for Urban Terrain Operations)**

to nature's secrets in designing robots and mechanical devices to augment human capabilities. By observing and then exploiting some of nature's techniques, machines approaching the versatility of animals can be created.

In his Ph.D. work, Pratt mimicked nature in the design of a bipedal walking robot, Spring Flamingo. By understanding the way walking animals exploit the natural pendulum effect of a swinging leg to reduce the workload, he was able to create a control algorithm allowing the

robot to do likewise. A kneecap provided a natural stop for the swing of the lower leg. A springy ankle, with characteristics similar to a human ankle, naturally transferred the center of pressure forward as the ankle joint rotated. In addition to walking on level ground, the robot could traverse unknown rough terrain without any extra sensors. The robot walked efficiently, tying the fastest walking speed for any bipedal walking robot, only slightly slower than a normal human walking speed. Moreover,

SCIENTIST PROFILES

Jerry Pratt

Hometown: Ashland, WI
Education: B.S. in mechanical engineering, B.S., M.S., and Ph.D. in computer science, Massachusetts Institute of Technology
Joined IHMC: 2002

Jerry started saving for his first computer in second grade. While waiting, he went to the library every day to learn how to program. When he finally got his Commodore 64, he spent much free time programming, including writing a fairly advanced drawing program. After teaching himself programming, he then learned electronics so that he could build his Knock-Out Keyless Doorlock, a lock that unlocks only when a user-programmable sequence of knocks is knocked on the door. The Knock-Out won the $10,000 grand prize at the 1990 Design a Duracell Device Scholarship competition. When he started MIT, though, Jerry almost didn't major in computer science because he thought programming was nerdy.

Jerry eventually chose to major in both mechanical engineering and computer science because he saw a need for an understanding of both, particularly in the design of consumer electronics. He originally wanted to work in automated manufacturing but then found an undergraduate research job in a lab that was applying learning algorithms to robotic helicopters. In searching for a thesis lab in gradu-

ate school, he found an opening in the MIT Leg Laboratory and soon became hooked on legged robots.

In his first meeting with his new advisor, he was introduced to two new ideas, one mechanical and one computational, for improving bipedal walking. These ideas undergirded Jerry's thesis work on the bipedal robot Spring Flamingo and have been used in much of his research.

Jerry's interest in robotics meshes well with IHMC's focus on human centered cognition. Whether on robots or exoskeletons, he sees an advantage in keeping humans "in-the-loop," particularly for cognitive tasks.

Working in a field where he could be anywhere with an internet connection and UPS trucks, Jerry has enjoyed being at IHMC and Pensacola. At IHMC he enjoys not having to deal with tenure politics and other aspects of university life. He loves the hot, humid weather and the Pensacola community. He sees great opportunities to influence the growth of Pensacola in the next few years and is excited about the recent flurry of downtown redevelopment.

Peter Neuhaus

Hometown: New York City, NY
Education: B.S. in mechanical engineering, Massachusetts Institute of Technology; M.S. and Ph.D. in mechanical engineering, University of California-Berkeley
Joined IHMC: 2003

Peter was drawn to mechanical engineering because he enjoys doing hands-on work. When he initially enrolled at MIT, though, he thought he would major in math or physics since he had no idea what engineering was. As a freshman he took an introductory mechanical engineering course that a friend suggested and was hooked. Now, he is enjoying learning more about the computer science side of robotics, particularly because it is not hands-on, things don't break, and you don't have to wait for replacement parts. A mix of the two, mechanical and computational, is ideal for Peter.

One of Peter's biggest accomplishments so far was the robot he built for his Ph.D. thesis. Called the Human Assisted Walking Robot, this bipedal robot was intended for maneuvering heavy loads in isolated areas for extended periods of time. Looking much like a walking wheelbarrow, this robot carried its own power supply, a two-stroke internal combustion engine, and had limited moving parts so that it would operate reliably.

Graduating from Berkeley at the height of the dot-com era, Peter tried his hand in a small company for a couple of years. He is happier now in a more academically challenging environment. He particularly enjoys the free-form environment at IHMC that allows him flexibility. Living in Pensacola also has advantages over Berkeley. A small town with a lack of traffic and parking problems is a welcome change for someone who grew up in Manhattan.

When he is not working on robots, Peter spends his time with his wife, daughter, and new puppy. He always admired how his father put such a priority on spending time with his family when Peter was a child, and Peter hopes to do the same. He and his family particularly enjoy windsurfing at the local beaches.

the incorporation of these natural dynamics lent a natural appearance to the gait.

In collaboration with Ben Krupp of Yobotics, Inc., Pratt is extending some of the lessons learned from the bipedal robot to a new quadrupedal robot. Dubbed Pluto, this quadruped will walk, run, and traverse rough terrain without any vision sensors, operating with self-contained power and computer control systems.

To guide the design and test various control algorithms, Pratt and his team created a physically realistic simulation of the quadruped. The simulation robot can walk, run, and jump while carrying a realistic approximation of the weight of the robot with its power and control systems. Elements of the hardware are currently being evaluated at IHMC in a monopod test platform, and design of the quadruped is underway.

In addition to studying nature to create walking algorithms, Pratt, Neuhaus, and IHMC colleague Brian Bonnlander are exploring ways in which a robot can learn how to walk. The algorithm parameters of many robots, including Spring Flamingo, are tuned by hand, with the researcher adjusting the control

PISCES (Performance Improving Self-Contained Exoskeleton for Underwater Swimming)

parameters through trial and error. This type of search is inefficient and likely doesn't achieve an optimum result. In this project, the scientists will use learning algorithms to define the parameters and adjust the control algorithms in order to improve the performance of a quadrupedal robot that walks over very rough terrain.

One tool, used by humans for thousands of years, is the wheel. Many of our existing machines utilize wheels to allow us to perform exceptional feats, such as achieving speeds far faster than those of a cheetah. When it comes to agility, many of our wheeled and tracked vehicles, particularly those that are unmanned, are not near human capability in certain environments. For example, they have trouble traversing curbs, ledges, stairs, gaps, and rubble that is easily negotiated by a human.

Inspired by the Segway powered scooter, Pratt, Neuhaus, and IHMC colleague Tim Hutcheson are developing the T-Bot to overcome some of the limitations of existing unmanned ground vehicles. The robot is reconfigurable, able to maneuver on two wheels or four. When on two wheels, the robot will be highly maneuverable, and able to navigate narrow passageways while providing an elevated perch for various sensors.

To enable this robot to maneuver over obstacles, the design draws on nature. We humans use our arms to allow us to raise our center of mass as we climb obstacles. While the robot does not appear similar to any living creature, two of its wheels are in fact on articulated arms, enabling the robot to climb over obstacles over two feet high.

Four or more legs in the animal kingdom provide stability and increased speed. This robot, too, can travel stably at high speeds when all four wheels are on the ground.

Applications for the T-Bot include military, search and rescue, and transportation security. For example, the use of this robot in searching for bombs or other dangerous devices in parking structures, subway stations, and other transportation infrastructure is being explored.

As with other robots, in developing the T-Bot, Pratt's team began with a concept exploration process utilizing computer simulations. These simulations are physically realistic, even including actual weights and limitations of motors and sensors. The simulations of the T-Bot clearly demonstrated the feasibility of the concept. The next step was the

■ ■ ■ **By observing and then exploiting some of nature's techniques, machines approaching the versatility of animals can be created.** ■ ■ ■

Peter Neuhaus testing PISCES design

construction of a small prototype. This prototype has proven to operate smoothly and with good stability on many different surfaces in all configurations. The next step is the design and construction of the fully articulated robot.

Other projects by this talented team of researchers include power augmentation systems more directly applied to the human being. For example, people have designed boats, even airplanes, to get over their limitations in traversing water. However, sometimes it is necessary for a person to swim long distances, often stealthily, such as during a Navy SEAL mission. Neuhaus, who swam competitively in college, is designing the PISCES exoskeleton, a machine that will augment the swimmer's natural motions. This machine does not kick for the user: Instead, it senses the user's intent and provides a mechanical boost by mirroring the swimming motions of the human.

Another device developed by Pratt, Neuhaus, and IHMC colleague Michael O'Sullivan would assist infantrymen in urban environments to get an improved vantage point. Battles in cities are like more traditional battles in that gaining the higher ground gives advantages. However, the sheer walls of buildings are not easily climbed. To increase the ability of soldiers to scale buildings, the IHMC Powered Climbing Suit will detect the forces applied by the wearer of special gloves. This device will then provide an assistive force through powered cables attached to the wearer's climbing gloves.

In many situations, human capabilities far exceed those that can be created by scientists and engineers. With that in mind, the biologically inspired robotics work of Jerry Pratt, Peter Neuhaus, and their teammates is focused not on replacing the human but rather on augmenting the human's ability to perform their chosen tasks. As they delve deeper into nature's seemingly infinite book of secrets, this team hopes to apply the lessons learned to improving their machines.

Jerry Pratt with MonoPod

HAPPENINGS

■ ■ ■ PANAMA EDUCATION INITIATIVE

IHMC Researchers Enhancing Education in Panama

From left to right: Carmen M. Collado, Executive Director of the Conéctate Project Marta Lewis de Cardoze, Joan Novak, Joseph Novak, President of Panama Martin Torrijos Espino, Alberto J. Cañas, Panama Secretary of Governmental Innovation Gaspar Tarté

The possibilities for education have expanded greatly with the availability of computers and the Internet. However, most schools, not to mention countries, are reluctant to change their system. This is not so for Panama.

President Martin Torrijos Espino took office in September 2004 with a priority of improving education. Gaspar Tarté, currently Secretary for Governmental Innovation, spearheaded the effort and contacted IHMC Associate Director and Institute co-founder Alberto Cañas. Cañas is now working with Tarté and the Minister of Education Juan Bosco Bernal to revolutionize education in Panama. The project, known as Proyecto Conéctate al Conocimiento (Connect to Knowledge), will impact 150 schools in the first year, with the fifth year project goal of introducing concept mapping technology and methodology to 1,000 public elementary schools throughout the country.

IHMC's CmapTools will form the foundation of a new approach to education in Panama, one where students are encouraged to think, reflect and learn how to collaborate and critique. CmapTools software, which empowers users to construct, navigate, share, and criticize knowledge models represented as concept maps, will be integrated into schools of all levels. However, plans go beyond that to a

**Carmen Collado
assists students in Panama**

new school model, one of a constructionist open school.

In addition to training teachers in the use of CmapTools, Cañas and Donna Imatt of Pensacola's Brown Barge Middle School are encouraging teachers to convert to a "streams" format of integrated curriculums. For example, in a stream on architecture, students would study architecture history as well as geometry and the

science of building. The possibility for seeing the relationships between many different topics and ideas through CmapTools meshes well with these integrated curriculums.

Throughout the project, the IHMC team is showing teachers many different approaches they can try in their classrooms, giving them the choice as to how much or how little to incorporate. Empowering teachers in such a way is new in Panama's traditionally top-down education system. Cañas believes, though, that "you won't have creative kids without creative teachers."

CmapTools are only a small part of the IT innovation planned. A communications network is being designed and implemented that considers the whole school system as a single organization. Schools will have their own CmapServer and will be linked with regional CmapServers. Students will be able to create portable environments so that, when they log on to any computer within the entire

HAPPENINGS

■ ■ ■ AFFILIATION AGREEMENT SIGNED WITH FLORIDA INSTITUTE OF TECHNOLOGY
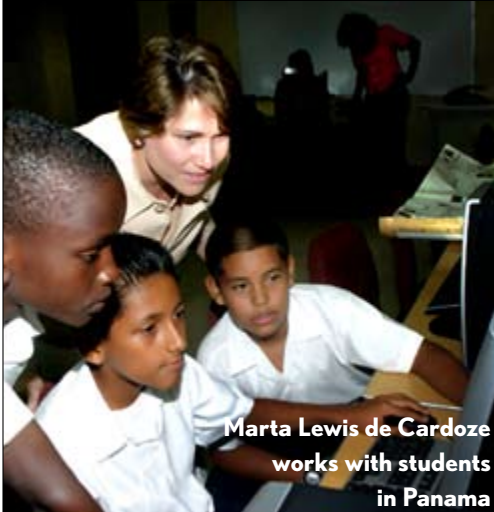
Marta Lewis de Cardoze works with students in Panama

school system, it will be customized to their liking. Email addresses and user names will be standardized and portable so a student transferring schools will be able to keep their original environment. The environments will be kid-friendly and education oriented, unlike than the more common "Office" systems.

The first computers available for this program are those used in the recent national election, but soon more will be acquired. While the goal is to have computers in every classroom, currently most are being put in new Innovation Classrooms—Many classrooms don't have enough outlets or air conditioning, with some even just open to the outside.

Cañas, Imatt, and IHMC's Rodrigo Carvajal, together with consultants German Escorcia, Carmen Collado and Eleonora Badilla, participated in the workshops to train the trainers for 4th, 5th, and 6th-grade teachers. Several hundred teachers have been trained already. This training is more than just teaching them how to use the CmapTools program—A large percentage of the teachers have

never seen a mouse before.

Training is also not the typical lessons in how to use a computer or how to open files and programs. Instead, teachers immediately begin to construct representations of their understandings using concept maps. By making the training relevant to their work, the team hopes to accelerate the understanding and facilitate rapid incorporation into the classroom.

"The response to the initial training sessions has been tremendous," noted Marta Lewis de Cardoze, executive director of the project. "Teachers at all grade levels are eager to be included as are school

principals and parents." Principals are being trained now with a particular focus on using streams, and Saturday workshops for parents are underway.

This innovative approach to education and technology is certain to transform education in Panama. Soon Panama may be a role model for other nations seeking to improve their educational systems and their economy.

IHMC begins partnership with FIT

IHMC has entered into a memorandum of understanding with the Florida Institute of Technology. The MOU will facilitate joint research efforts and other collaborative activities between the two entities. The university and IHMC have already begun discussions regarding the use and development of technology in

several new and ongoing science and engineering projects. These include machine vision, human factors, neural networks, robotics, swarm computing, and optical signal processing.

"IHMC is one of the nation's premier research institutes and works in the fascinating field of human and machine cognition. We are extremely excited about contributing to their work in leveraging human cognitive and perceptual capabilities and we welcome their support in pursuing our educational goals," said FIT President Anthony Catanese.

FIT is the only independent technological university in the Southeast and grants degrees through the doctorate. Over 3,000 students study science, engineering, business, psychology, and other fields on the main campus in Melbourne, FL.

Seated left to right: Florida Tech President Anthony J. Catanese and IHMC CEO Ken Ford. Standing left to right: Florida Tech's Carey Gleason, Director of Community/Government Relations; Dr. T. Dwayne McCay, Provost and Chief Academic Officer; Dr. Mike Karim, Dean of the College of Aeronautics; Dr. Fred Ham, Harris Professor of Electrical Engineering; Dr. Terry Oswalt, Associate Provost for Research; IHMC Deputy Director Tim Wright.

PEOPLE IN THE NEWS

■ ■ ■ NEWS AT IHMC

Robert Galvin receives the 25th annual Vannevar Bush Award from IHMC's Ken Ford

Ford Presents Vannevar Bush Award

On May 25, 2005, at the National Science Board Dinner, Dr. Ken Ford had the distinguished honor of presenting the 2005 Vannevar Bush Award to Mr. Robert W. Galvin, Chairman and CEO (Retired), Motorola, Inc. Each year, the National Science Board bestows this award in recognition of its name-

sake, Vannevar Bush, the founder of the National Science Foundation. This award is provided annually to an individual who has displayed exceptional qualities essential to a democratic society, such as unselfish devotion to public service, and lead-

ership and creativity in advancing science and technology for use by all.

Robert Galvin, a gifted leader, was responsible for leading Motorola into a global position and had a profound influence on the public and private sectors worldwide. For over 50 years at Motorola, Galvin led the company through innovations in television receivers, mobile communication, transistors, cellular technology, and computer chip design. Celebrated for his vision, Galvin guided Motorola's transformation from a consumer electronics company in 1959 to a global leader in high technology in 1990, when he retired as Chief Executive.

Robert Galvin is also well known for his public service having served on countless government advisory committees and boards that have issued important and timely studies on the future of science and technology in the United States. In particular, Galvin is remembered for having chaired the Task Force on Alterna-

tive Futures for the Department of Energy National Laboratories, which is commonly referred to as the Galvin Commission.

Congratulations to Robert Galvin, the 25th recipient of the Vannevar Bush Award.

Wright appointed to Commission on the Future of Space

Florida's Governor Jeb Bush recently appointed IHMC Deputy Director Tim Wright to the newly created Commission of the Future of Space and Aeronautics in Florida. The commission is tasked by the Governor to examine Florida's existing space and space-related programs and make recommendations that will enable the State to not only maintain its leadership position as the "Gateway to Space" but also to expand that leadership role in ways that will broaden and deepen the positive economic impact of space business for Florida's citizens.

Members of the Commission, chaired by Lieutenant Governor Toni Jennings, are leaders with significant experience and insight into space-related fields including aerospace, space vehicle launch, manufacturing, research and development of supporting technologies, work force preparation, defense issues, communications, and finance.

Florida has been a critical component of the national space effort for more than 50 years. However, changes to the civilian space industry and new visions for NASA could
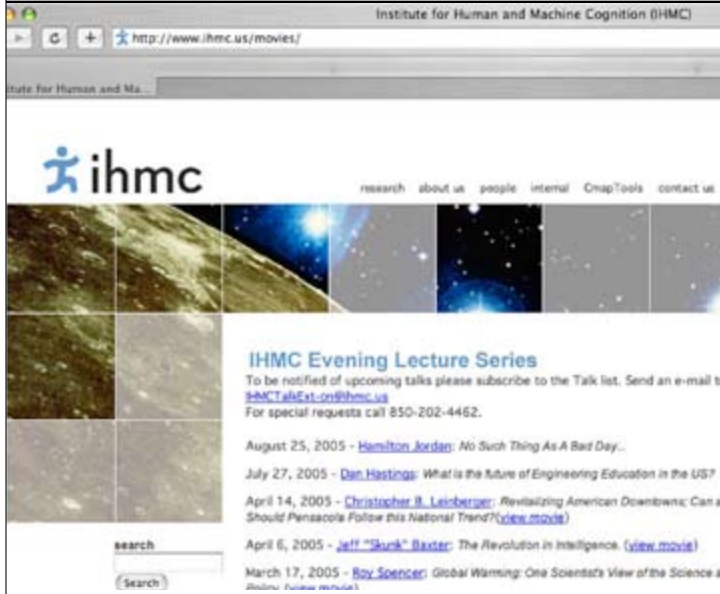

Tim Wright

erode Florida's leadership in the field. Consequently, the Commission will examine all aspects of the future of the space business with an eye toward the future environment that will result from these new visions and opportunities. To that end, the members will look at everything from the effectiveness of Florida's secondary and post-secondary education to the policies and regulations of all levels of government...and everything in between. The report to Governor Bush is due January 31, 2006.

RECENT LECTURES

■ ■ ■ IHMC's Evening Lecture Series

Visit http://www.ihmc.us/movies/ to view lecture series online

IHMC lecture series available online

IHMC's website is fast becoming a resource for information on urban planning, politics, and science. Many of the lectures hosted by IHMC, going back to the October 2001 lecture by Robert Davis, town founder of Seaside and a foremost authority on New Urbanism, are available to view in streaming video. Other notable past lectures include General Charles Horner, former Commander In Chief North American Aerospace Defense Command and the United States Space Command and Commander of Air Force Space Command; Dr. Rita Colwell, then-director of the National Science Foundation; Dr. Richard Florida, author of *The Rise of the Creative Class*; and Mr. Malcolm Gladwell, staff writer for The New Yorker magazine and author of *The Tipping Point* and

Blink. Visit http://www.ihmc. us/movies/ to view these and other interesting lectures.

Roy Spencer presents arguments over global warming

The debate over global warming is based on some scientific principles upon which most scientists agree. The discrepancies come from differences in models for predicting the impact of

carbon dioxide, according to Dr. Roy Spencer, a principal research scientist for the University of Alabama in Huntsville. In his lecture "Global Warming: One Scientist's View of the Science and Policy," on March 17, Spencer described different methods of predicting global warming.

The theory behind the correlation of rising carbon dioxide levels and global warming is based on the greenhouse effect. Carbon dioxide is one of many greenhouse gases in our atmosphere, Spencer explained. Our dependence on fossil fuels since the industrial revolution has led to a gradual increase in atmospheric carbon dioxide. Water vapor is the most prevalent greenhouse gas, however. Most of the warming that climate models predict is related to increasing water vapor due to the slight warming tendency from extra carbon dioxide.

Spencer's concern is that we still don't understand well how water vapor works. Changes in atmospheric water aren't just due to how fast water evaporates from the surface. Rather there is, a balance between the source, evaporation, and the sink, precipitation. In addition, the

microphysics of rain clouds and how they reduce water vapor in atmosphere, is poorly defined. The complexity of these systems leads climate modelers to make simplifying assumptions that may bias models toward indicating global warming.

Without a firm understanding of exactly what excess carbon dioxide will do, it is hard to justify the expensive steps to reduce emissions, argued Spencer. The alternatives to burning fossil fuels, such as wind, solar, or nuclear power, face hurdles such as low efficiency, costing more for the same energy production. Finding a balance between the unknown effects of carbon dioxide and the costs for reducing carbon dioxide emissions, Spencer stressed, is necessary in the global warming debate.

Chris Leinberger details steps toward a revitalized downtown

About one-third of U.S. metropolitan households want to live in a pedestrian-oriented, urban community. However, only 5% of the current housing stock meets that requirement, noted Mr. Chris Leinberger, a land use strategist, developer, and author, in his lecture "Revitalizing American Downtowns; Can and Should Pensacola Follow this National Trend?" on April 14. In 1990, only four cities' downtowns could

Roy Spencer debates global warming

RECENT LECTURES

■ ■ ■ IHMC's Evening Lecture Series

■ ■ ■ Creative use of space provides the density critical for a vibrant urban core. ■ ■ ■

be described as vibrant. Since then, more than 50 percent of American downtowns are "on their way to being financially viable and sustainable." Now it seems that a downtown would have to work hard to avoid revitalization.

Leinberger outlined 12 steps to successful revitalization of downtowns based on his hands-on experience consulting on dozens of urban areas across the United States and Europe. Six steps focus on building infrastructure. This infrastructure is not just roads and power lines but also includes improvements to land use codes and the creation of public/private partnerships and non profits focused on downtown improvement. The remaining steps focus on the types of developments needed.

Throughout the talk Leinberger highlighted the steps taken in Albuquerque, NM, where he

currently lives, to revitalize their downtown. Creative use of space, such as a stadium seating movie theater nestled into the center of a block, surrounded by restaurants, provides the density of attractions critical for a vibrant urban core.

In most cities, however, leaders need to be cautious about the gentrification of downtown. He outlined several ways to prevent downtown residents from being priced out of their neighborhoods. In Albuquerque, they are trying "value latching," which reserves a portion of the property tax growth for affordable housing and business space.

Pensacola has many elements essential for revitalization, Leinberger noted. As long as we maintain our track, focusing on areas in which we are lacking, our downtown will again become a magnet for growth.

Chris Leinberger

Jeff "Skunk" Baxter explains role in security analysis

Jeff "Skunk" Baxter

In order for the United States to fight wars of the future, including terrorism, they must learn how to combat nontraditional enemies. Mr. Jeff "Skunk" Baxter is well-known as a rock and roll guitarist, most notably as a member of Steely Dan and the Doobie Brothers. What is not well-known, however, is Baxter's career as a consultant for the military and intelligence agencies.

Baxter described his experiences in this area during his lecture "The Revolution in Intelligence" on April 6. Improving our country's security requires hard changes, asking people not to put their lives on the line but to put their jobs on the line. Military and intelligence personnel need to be taught how to improvise and take appropriate risks. "Collecting and analyzing intelligence in the same old way is not working," noted Baxter. You draw the same conclusions, turning in on yourself. Instead, improvisation requires people to take a chance, push the envelope, explore new possibilities, and, most important, be willing to fail. The military and intelligence communities need to move from the symphony, with the conductor who determines how the music sounds, to the jazz quintet, with five experts supporting each other within a given structure.

Baxter prides himself on bringing a fresh approach to intelligence

work. An aging hippie, he points out, is not who people expect to interact with. For instance, during a war simulation, his task was to beat the U.S. Navy. With limited military capabilities, he simply took available photos of personnel and altered them so they looked like they had been disfigured by chemical weaponry. Then he forwarded the pictures to their wives. This action caused at least one U.S. colonel to be thrown out of the game because he "was no longer capable of making decisions rationally." The U.S. finally withdrew after the opposing team destroyed the oil supply to Japan who threatened to sell their U.S. Treasury notes if the U.S. didn't withdraw.

Baxter pointed out that these actions, and others like them, are not part of the traditional military planning but should be incorporated into their thinking in the new military age.

RECENT LECTURES

■ ■ ■ **IHMC's Afternoon Lecture Series**

Psychologist and computer scientist discuss causal learning

Understanding causal systems is a significant aspect of learning in almost all disciplines of science, engineering, and technology. However, understanding causal systems is difficult, and often leads to misconceptions because many aspects of such systems are dynamic, invisible, and interdependent. Dr. Hari Narayanan, Associate Professor in the Department of Computer Science and Software Engineering (CSSE) at Auburn University, and Dr. Cindy Hmelo-Silver, Assistant Professor in the Department of Educational Psychology at Rutgers University, presented their work in bringing a cross-disciplinary approach to research on learning causality. In their lecture "Causal Learning about Complex Systems: Multiple Perspectives" on

March 1, they reported the current results of their efforts to develop a prospective synthesis of the state-of-research on complex causal learning across disciplines and identify gaps in the knowledge base that past research has built up.

Glymour presents approach to causation determination

In many circumstances and fields, such as gene regulation, an understanding of the causal relationships between multiple variables is critical. In his lecture "N-1 Experiments Suffice to Determine the Causal Relations Among N Variables" on March 3, IHMC's Clark Glymour explained the theory behind his approach to finding relationships between variables. The typical methodology, with randomization and control of variables, gets very complicated very fast. Glymour

explained how this alternate approach can lead to fewer experiments. In particular, he noted that if you can randomize more variables, ideally half of them at once, you can determine causality in a relatively small number of experiments.

Mathematician details model for cancer prediction

The diagnosis of breast cancer is based on the observation of a number of features in an x-ray. Dr. Subhash Bagui, Professor in the Department of Mathematics and Statistics at the University of West Florida, presented a novel classification scheme for multivariate data in his lecture "Breast Cancer Detection Using Rank Nearest Neighbor Classification Rules" on March 25. He compared this new generalization of the rank nearest neighbor (RNN)

classification rule on two databases against the conventional k-NN classification rule. Bagui showed that the rule performed comparably to the conventional rule and resulted in much less computational complexity.

Systems Engineer describes airspace system

The National Airspace System is distributed among many organizations and individuals due to its cognitive complexity. In his lecture "Distributed Work in the National Airspace System" on April 13, Dr. Phillip Smith, Co-Director of the Institute for Ergonomics and a Professor with the Industrial and Systems Engineering program, Biomedical Engineering, and the Advanced Computing Center for Arts and Design at Ohio State University, discussed the design of this distributed system. He described the

Hari Narayanan

Cindy Hmelo-Silver

Clark Glymour

Subhash Bagui

RECENT LECTURES

■ ■ ■ IHMC's Afternoon Lecture Series

potential for design-induced error resulting from the use of graphical flight planning systems by airline dispatchers and the need for better feedback and sharing of knowledge among FAA traffic flow managers and airline dispatchers. Different architectures for distributing work have evolved and performed in support of different functions within the NAS. Smith detailed the application of relevant cognitive systems engineering concepts to these distributed work architectures.

Glymour researches communication data to identify chain of command structures

The command and control structure of a group is critical to knowing who the key players are and predicting actions. In many cases, such as terrorist groups, however, the structure is unknown. IHMC's Clark Glymour presented

an approach to determining such a structure in his lecture "Discovering Command & Control Structures from Almost Nothing" on May 9. Using a set of communications that contain a time stamp and identifiable actors, the algorithm he presented identifies both chain of command and the reporting chain. By applying this algorithm to a complex hypothetical set of data, Glymour found more than half of the commanders and a third of the others involved. Further refinements, such as analysis of the topics of the communications, should yield improved results.

Hayes outlines new common sense approach

The idea of putting "common sense" knowledge into a program was one of the earliest goals of AI. Progress so far has been rather disappointing, however, especially when compared with progress

in other AI topics, such as machine vision or expert systems. IHMC's Pat Hayes described the history of incorporating "logical common sense" and offered ideas on new approaches to the problem during his lecture "Uncommon Sense" on June 7. He suggested that an intelligent machine should not view its environment as a collection of state transitions. Instead, the machine should conceptualize the environment in terms of a large collection of possible scenarios from which plausible explanations can be formed. These explanations would be created by a process more like assembly than formal inference. The focus is less on solving goals and more on analyzing barriers to causal influence; Such barriers simplify computation by assuming that the effects of actions are limited. Logical reasoning is then seen as a last resort when these normal processes fail,

rather than as the basic engine of thought.

Jung describes agent learning and autonomy

In teaching and learning new tasks, humans use pre-existing knowledge, perception, and intuition to understand complex and often ambiguous commands. It is hard for us to detail fully all of the steps, and the constraints and goals of each. IHMC's Hyuckchul Jung is combining demonstration and discussion to teach agents tasks, providing multiple inputs for agent comprehension and simplifying the teaching by the user. In his lecture "Making Agents Learn Tasks and Controlling their Autonomy" on June 29, he demonstrated how the PLOW (Procedural Learning On the Web) system can be taught a task, such as finding information on the internet by watching user demonstrations, receiving instructions, and reasoning about the relationships. In addition, he discussed his work relating to dynamic control of agent autonomy.

Phillip Smith

Pat Hayes

Hyuckchul Jung

GRANTS

From May to July 2005, IHMC was awarded over $1.9 million for research

■ ■ ■ NEW GRANTS AWARDED TO IHMC FROM MAY 2005 THROUGH JULY 2005

Team-Centered Virtual Interactive Presence for Adaptive Autonomy

Dr. Jeff Bradshaw
Amount: $607,502
Granting Agency: NASA

Future space missions will require local crews, remote humans, and robots to work together as a team. Under this grant, IHMC researchers will work with collaborators on Team VIP technology that will improve communication between these entities, providing flexibility and quicker turnaround in responding to unforeseen problems in maintenance of lunar facilities. IHMC's KAoS system will be integrated into the system to provide adjustable autonomy features. In addition, initial models for teamwork and adjustable autonomy will demonstrate the concepts in a spatial setting.

Apex and Autonomous Agents Architectures

Dr. Michael Freed
Amount: $355,349
Granting Agency: NASA

Apex, created by Dr. Michael Freed, is an autonomy architecture specialized for unmanned aerial vehicles. Dr. Freed will work closely with NASA Ames researchers in the development of autonomous systems using Apex. Continued development of Apex is critical to meeting the objectives of several NASA programs including the Exploration Systems Mission focus. In addition, Dr. Freed will advise the leader of the Human-Centered Computing element of the Exploration Systems Mission Directorate and other

NASA officials in the area of cognitive modeling.

JBI Dynamic Administration & System Policy

Dr. Jeff Bradshaw
Amount: $275,000
Granting Agency: Air Force Research Laboratory

The Joint Battlespace Infosphere (JBI) Information Management Reference Implementation is evolving from a centralized server-based architecture to a distributed dynamic system. As this evolution proceeds, the Reference Implementation (RI) will require powerful, extensible, and general-purpose mechanisms to allow administrators to control the configuration, operation, and security of the individual components and services that comprise the evolving architecture. IHMC researchers will work with ISX Corporation scientists and the AFRL to produce J-DASP, a JBI policy capability, by designing a combination of RI interfaces and KAoS services that will interact via well-defined, high-level software interfaces. The design of these pluggable interfaces will potentially allow for alternate implementations of the components of the system.

BrainPort Underwater Sensory Substitution System

Dr. Anil Raj
Amount: $149,846
Granting Agency: DARPA

On land, humans have good spatial awareness provided by our visual, auditory, and vestibular systems. Underwater, however, these senses suffer. Hearing is rendered useless, visibility is considerably reduced, and our sense of position is ruined by the motion of the water around us. Under this grant, IHMC researchers will work with staff at WICAB to develop a sensory substitution system to be contained in a diver's rebreather apparatus. This system will display sensory information from inertial navigation systems, sonar, and other systems on the diver's tongue. Software will allow adjustable output during use, providing flexibility in types of sensor data, signal gain, and zoom.

Robots for Transportation Security

Dr. Jeff Bradshaw &
Dr. Jerry Pratt
Amount: $147,502
Granting Agency: Federal Transportation Authority

Robots have the potential to play an important role in the security of multimodal transportation systems. Possible uses include remote vehicle inspection, perimeter security, search and rescue, and bomb disablement. IHMC researchers will examine the use of different robots in these activities. In addition, they will explore the use of adjustable autonomy to provide flexible interaction between the robot and operator.

Fire Risk Prediction in Intelligent Archives

Dr. David Danks
Amount: $98,938
Granting Agency: NASA

Wildfire is a relatively rare phenomenon that is quite difficult to predict and understand. Previous work at IHMC showed improvements in prediction of wildfires. However, the successes were limited by the amount of relevant available data. This grant will enable IHMC researchers to develop and extend our knowledge discovery/data min-

GRANTS

■ ■ ■   NEW GRANTS AWARDED TO IHMC FROM MAY 2005 THROUGH JULY 2005

ing (KDD) efforts by utilizing the Intelligent Archive (IA) framework being developed at George Mason University (GMU).

Workshop on Knowledge Representation for the Novel Intelligence from Massive Data (NIMD) Program

Dr. Pat Hayes
Amount: $92,000
Granting Agency: MITRE

In order for knowledge to be disseminated, a useful, common form of knowledge representation must be created. This grant will fund the organization, conduct, and reporting of an information technology workshop that will address the interoperability of knowledge representation technology and the practical representation of knowledge that is relevant to intelligence analysis tasks. Workshop participants will review existing knowledge interchange standards, extend the recommended standards as needed, and develop technology for translating knowledge from one standard to another. The workshop team will adapt, integrate, and extend existing technologies. The results will include designs of representations, automated reasoning methods for knowledge expressed in the representations, prototype implementations of the designs and methods, and use case demonstrations.

Embedded Real-Time Advisory System for Crew-Automation Reliability Software and Testing Support

Dr. Anil Raj,
Amount $86,000
Granting Agency: NASA Ames

The NASA Ames Research Center needs software development and human subject testing to support and evaluate the Embedded Real-Time Advisory System for Crew-Automation Reliability (ERTAS). Project goals in Phase I are to assess the requirements for ERTAS technology for current and future mission plans,

ground- or space-based teleoperation of robots and rovers, docking operations, and performance or monitoring of complex scientific experiments. The Florida Institute for Human and Machine Cognition is providing expertise to support ERTAS development in the areas of heterogeneous software agent integration architectures and human subject performance evaluation. In addition, IHMC will integrate techniques for real-time detection of cognitive state changes.

Cmap Tools Team from left to right: Top Row: Michael O'Sullivan, Niranjan Suri, Roger Carff, Alberto Cañas. 2nd Row: Larry Bunch, James Vallese, Rodrigo Carvajal, Adrian Granados, Marco Carvalho. Front Row: Greg Hill, James Lott, Marco Arguedas, Mario Arroyo

develop a simulation test-bed for the technology, and perform experiments that demonstrate the potential for substantial improvements in crew-automation reliability. Phase II goals are to harden and space-qualify ER-TAS system hardware and software, incorporate the most advanced sensor technology that is commercially available, and validate the ERTAS system in high-fidelity simulations of training exercises for complex tasks requiring reliable crew-automation performance. Candidate tasks include extra-vehicular activities (EVA) for in-space assembly and maintenance,

Courses for the Intelligence Community

Dr. Clark Glymour
Amount: $84,050
Granting Agency: DoD

Our partners in the Department of Defense recognize that educating the United States intelligence professionals is a vital part of maintaining our top-of-the-line ability in the field. Dr. Clark Glymour and Dr. David Danks will prepare and teach two courses specifically tailored to the needs of the students. The first class is an in-

tensive 3 day course called "Thinking Things Through." The second class – "Causality" – will be taught over a full week. Students will learn how IHMC's researchers are expanding academic knowledge in areas related to their profession.

KAoS Policy in the Joint Battlespace Infosphere

Dr. Jeff Bradshaw
Amount: $48,000
Granting Agency: Air Force Research Laboratory

The dramatic increase in the amount of information available to military commanders in recent years has not necessarily led to improved situational awareness or better decision making. The Joint Battlespace Infosphere (JBI) aims to improve information management and exchange. IHMC's KAoS policy management tools are well suited to managing and disseminating information. Under this grant, IHMC researchers will assist in integrating KAoS into the JBI.

Concept Map Workshops for Teaching Basic Algebra

Dr. Alberto Cañas
Amount: $12,000
Granting Agency: State of Florida

IHMC's CmapTools are uniquely suited for improving education at all levels. This grant will fund the training of teachers and University of North Florida faculty in the use of CmapTools. Subsequently IHMC facilitators will attend and offer support at a workshop that will include facilitation sessions in which teachers will create Concept Maps/Knowledge Models pertaining to basic algebra.