

HOT RESEARCH

A High-Tech Vision for Software Development: Configuration Management, Software Design, and Beyond

Modern software engineering tools exhibit an interesting paradox that seriously limits their usefulness in practice: while the tools are meant to support the inherently collaborative activity of software development, they more often than not cause individuals and groups to work independently from one another. Configuration management tools (e.g. CVS, Subversion, Clearcase) are a prime example in that individual software developers

make changes to the code in their individual workspaces and only see what the team has done when they check in their changes. Design tools provide another example: a design, produced by an isolated engineer or

design team, is meant to be handed off to others who each independently implement their assigned parts.

On the one hand, independence in software development is beneficial and necessary, as each developer can work efficiently without being disturbed by others. But the paradox leads to subtle but critical isolation side effects that can result in project delays, decreased code quality, increased numbers of bugs, and a multitude of other problems. The infamous Risks Forum contains numerous, sometimes chilling examples (<http://catless.ncl.ac.uk/Risks>).

Using a vision of software development that

RESEARCH BRIEFS

Paul Dourish, Simon Cole and Jennifer Terry have been awarded a \$750,000 National Science Foundation grant to investigate the ways new and emerging technologies such as blogging and text messaging are transforming people's privacy and identity. Dourish, an Associate Professor of Informatics and Associate Director for Research of the Irvine Division of Calit2, is principal investigator. Cole, Assistant Professor of Criminology, Law and Society, and Terry, Associate Professor and Director of Women's Studies, are co-investigators.

Richard N. Taylor, Professor of Informatics, has been awarded \$455,000 in funding from the National Science Foundation to explore software architecture-based approaches for engineering secure decentralized applications with associate professor Paul Dourish. The project will, over a period of three years, focus on developing effective design principles and software architectural styles for incorporating trust management in decentralized applications. The project will also study existing decentralized reputation-based systems and investigate how they can better protect and respond against potential malicious attacks.

More Research Briefs on page 3.

integrates coordination, creative design techniques and seamless development environments, ISR faculty member **André van der Hoek** and a multi-area ISR research team are introducing novel approaches and tools that are squarely aimed at addressing the paradox of collaborative isolation.

The van der Hoek vision combines traditional concepts from the field of configuration management with advanced concepts

from other fields, including awareness (from computer-supported cooperative work—CSCW) and product line architectures (from software architectures). The grand plan in progress (see Figure 1) is to develop a suite

of tools that all leverage the combination of software architecture and versioning to provide integrated support for each stage of the development process, including requirements, design, implementation, system testing, deployment, and run-time. In support of this vision, the team has

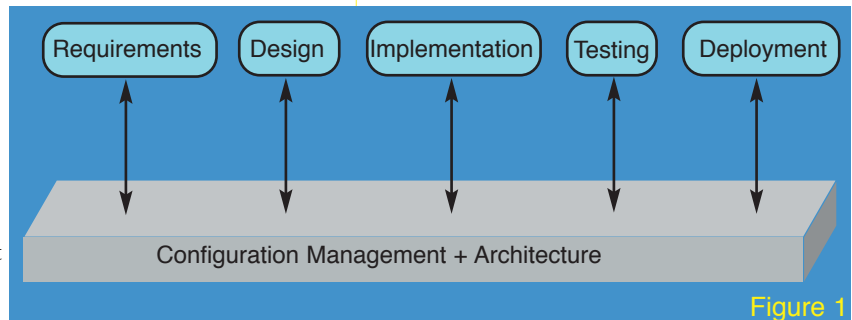


Figure 1

explored a variety of research directions. As one of its primary thrusts, it has introduced and experimented with several architectural design tools, including Ménage, Archipelago, and EASEL. Ménage, an environment for managing evolving product line architectures, is the first architectural design environment that explicitly addresses product lines, that is, architectures capturing sets of closely-related products. Developed with the aid of van der Hoek's graduate students **Ping Chen** and **Chris van der Westhuizen**, Ménage integrally supports the evolution of these product line architectures as well as the propagation of changes from one product to another. Archipelago, the brainchild of grad-

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MESSAGE FROM THE DIRECTOR

This is the first time I've had the privilege of communicating with you as Acting Director of ISR. So part of my job is to help shed some light on current activities and new research initiatives now underway at ISR.



Scacchi

This issue of the *ISR Connector* introduces new people and projects at ISR, as well as an exciting new effort emerging in the area of computer game culture and technology. **Celia Pearce** comes to ISR as a senior research associate. Celia's research activities are centered on game culture and technology. This past Fall she led a short-term project focused on the development of mobile games for cell phones using Java through a grant provided by Glu, a leading developer of mobile entertainment products. Celia is also acting as Program Coordinator for the upcoming research summit, *MASSIVE: The Future of Networked Multiplayer Games*. Be sure to register early for the MASSIVE summit, as it is likely to be a sell-out event. A related event on women and game culture and technology is planned for June 2006. For more information about

MASSIVE, see the article on page 8.

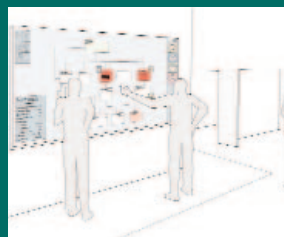
Robert Nideffer who is described in the "Focus on Faculty" on page 3, is also Director of the Game Culture and Technology Laboratory here at UCI. Robert and I are working on a project sponsored by the Discovery Science Center in Santa Ana, CA to develop Web-based science learning games that are part of a large-scale interactive exhibit that employ life-size dinosaur models and embedded digital media to help DSC visitors learn about paleontology and life science. We are also involved in co-chairing the MASSIVE summit. In addition, we are leading a project supported by the UC Humanities Research Institute to develop a Web-based collaboration environment for scholars engaged in studies of game culture and game play experience. **Yuzo Kanomata**, who re-joined ISR as a research programmer/analyst in January 2006, supports them in the development and deployment of this environment.

Finally, it is worth noting that other efforts within game culture and technology research focus at ISR are seeking to build new research partnerships with international collaborators, with leading IT firms both inside and outside of the game industry, and with our traditional research sponsors in government and industry. I am optimistic about these opportunities, so look forward to announcements from ISR in this area.

uate student **Eric Dashofy** (R. Taylor, advisor), generalizes the functionality of *Ménage* with an intuitive and configurable visual design editor for creating and editing xADL 2.0 documents that describe single product as well as product-line architectures. *Archipelago* is complemented by additional tools that integrate verification techniques and design assistance, directly supporting the architect with capabilities that enable rapid development of sophisticated, multi-dimensional software architectures.

EASEL, a project by **Scott Hendrickson** (R. Taylor, advisor), is an early prototype of an architecture design tool that focuses on the creative exploration aspects of architecting. Using change sets from the configuration management field to group related architec-

tural elements and relationships, EASEL allows rapid exploration of alternatives and offers architects a model of interaction similar to Photoshop for graphical design artists.



interactive exploration



alternative comparison



large-scale detailed visualization

Figure 2

"It is time we move away from support for design as a documentation activity performed by the individual to tools that encourage the true exploratory nature of design as a group activity," explains van der Hoek. "ISR's architecture and design technology moves in this direction, and forms the basis for an entirely new view of how developers can and should design in a collaborative manner." A noteworthy characteristic of the technologies is that they are not bound to any particular architectural style or methodology. Hence, they have readily been adapted for use in both commercial and government applications. For example, ISR members recently worked closely with engineers at The Boeing Company using ISR notations and tools to model and analyze the architecture of software-defined radios. These efforts were able to identify areas needing improvement, as well as give Boeing engineers increased visibility into their software.

Tools used in the implementation phase enhance traditional configuration management systems, helping to provide developers with awareness of each others' activities. The result is formal support for consolidating individual changes (provided by CM system functionality) and informal support for self-coordinating changes while they are in progress. Palantir, the project of **Anita Sarma** (van der Hoek, advisor) realizes this new approach, dubbed "continuous coordination", by informing developers – in real time – of relevant ongoing changes in other workspaces. For more information on Palantir, see the "ISR Technologies" article on p. 6.

A new coordination platform, Lighthouse, the project of van der Hoek's students Ping Chen and Chris Van der Westhuizen, explores an alternative approach that is rooted in the concept of emergent design. Chen and Van der Westhuizen "hijack" a second monitor to display the design as it is being implemented in the code by each of the developers. By superimposing the design-in-

progress on top of the original conceptual design, the team has continuous awareness of each other's changes, allowing them to easily coordinate amongst themselves.

Furthermore, this overlay of emerging design on top of conceptual design allows design decay to be constantly monitored.

Effectively, the solution marries configuration management, awareness, and design in a single unified approach.

To round out the approach, the team is beginning to bridge into testing. **Lihua Xu** (Richardson, advisor) and Scott Hendrickson are exploring the use of EASEL layers as the basis for behavioral testing (see article FW 04, p.1). The team is also currently working on perfecting the Architectural Runtime Configuration Management (ARCM) tool, which extends versioning capabilities to running applications. The development of the tool is being guided by **John Georgas** (R. Taylor, advisor), whose main research focus is self-adaptive software systems. Based on—but fully decoupled from—self-adaptive software systems, ARCM improves the dependability and overall usefulness of the dynamic software systems to which it is applied by maintaining a record of reconfigurations and providing support for architectural recovery operations.

Finally, van der Hoek is working on extending his vision of seamless software engineering by moving the research prototypes to a high-tech environment in which software tools are designed to take explicit advantage of the affordances of modern-day hardware. No longer should software engineers be relegated to using the traditional computer with a single monitor, mouse, and keyboard.

Rather, as illustrated in Figure 2, it should be possible for them to operate in a combined hardware/software environment that is specifically tuned to the tasks at hand.

Design should take place in a war-room supported with software that allows creative exploration; programming in a multi-monitor setting where the secondary and tertiary monitor inform the develop of important events and provide them with the context for the programming; and debugging, perhaps, could take place on a large wall-display through entirely new visualizations of program structure and execution. These kinds of capabilities are looming down the horizon, and ISR is at the forefront of exploring these technologies and demonstrating the real-world benefits that arise from them.

For more information on these and other ISR projects, see:

<http://www.isr.uci.edu/research>

RESEARCH BRIEFS

ISR Acting Director **Walt Scacchi** was featured on the opening segment of *Inside OC with Rick Reiff* on KOCE in December 2005. Scacchi spoke on computer game culture and technology in Orange County, highlighting the UCI Game Lab's work with the Discovery Science Center. The segment premiered on December 11 and was repeated several times that month.

Gloria Mark was recently featured in a *TIME* magazine article titled "Help! I've Lost My Focus" and a *New York Times* article titled "Meet the Life Hackers". The articles focused on her research into strategies used by information workers to manage multiple activities and reveal the roles of technologies on those processes. Mark's graduate student, **Victor González**, who conducted workplace studies to observe and analyze how people, *in situ* and under fast-paced work conditions, experience interruptions and deal with the fragmentation of their activities was also credited in the October 16, 2005 *NY Times* and January 16, 2006 *TIME* articles.

Les Gasser, ISR affiliated faculty member from the University of Illinois at Urbana-Champaign, and **Walt Scacchi**, Acting Director, both gave talks at the Gaming, Learning, and Libraries 2005 conference, held in Chicago in December. Gasser delivered the opening keynote, "New Landscapes for Libraries", and Scacchi gave a one hour invited talk titled "Opportunities for Game Culture and Technology in Public Libraries".

Crista Lopes is the General Chair, as well as Treasurer, for Ubicomp 2006—the Eighth International Conference of Ubiquitous Computing. **Paul Dourish** plays a key role serving a Program Chair. ISR graduate students are also in the organizing committee mix: **Amir Haghighat** (C. Lopes, advisor) is the Student Volunteers Chair and **Amanda Williams** (P. Dourish, advisor) is the Web Master. Ubicomp 2006 will be held in Orange County, California, September 17-21, 2006 and is hosted by the University of California, Irvine. For more information, visit: <http://ubicomp.org/ubicomp2006/>

<http://www.isr.uci.edu/projects/menage/>
<http://www.isr.uci.edu/projects/easel/>
<http://www.ics.uci.edu/~asarma/Palantir/>
<http://www.isr.uci.edu/projects/archstudio/>
<http://www.isr.uci.edu/projects/lighthouse/>
<http://www.ics.uci.edu/~andre>

André van der Hoek can be reached at andre@uci.edu, (949) 824-6326.

FOCUS ON FACULTY

Meet Digital Artist Robert Nideffer

Although **Robert Nideffer** can usually be seen around campus sporting a baseball cap, in his roles at UCI he wears a much more diverse array of hats. Nideffer was the first digital arts faculty in the Studio Art Department of the Claire Trevor School of the Arts, but his background also earned him a joint appointment with the then Department of Information and Computer Science. Most recently he has joined the Arts Computation and Engineering (ACE) graduate program as Co-Director.

For his Ph.D. in sociology, he produced the first interactive CD-ROM-based thesis in

that discipline, and looked at the rhetoric and representation of the first Persian Gulf War, which has often been called the first "Nintendo" war, highlighting the fact that the warfare process itself was mediated for its participants through high-tech weaponry and video-game aesthetics. Following his Ph.D. and building upon his interest in art and technology, Nideffer earned an MFA at UC Santa Barbara. His MFA thesis project was

titled *The Fine Art of Appropriation*, a reflexive online artist's book exploring, while it demonstrated, what would now be trendily referred to as 'remix culture.' In the mid-1990's, he also art directed and production managed *Life in the Universe*, an interactive CD-ROM project with theoretical physicist and cosmologist Stephen Hawking. This work led to his hiring by the Computer Science Department at UC Santa Barbara to create and direct a User Interface Design and Implementation team for the *Alexandria Digital Library*, one of the first-round feder-



ISR STUDENT NEWS BRIEFS

Justin R. Erenkrantz (R. Taylor, advisor) has been elected to the board of the Apache Software Foundation (ASF). He has also been selected as Treasurer for ASF. Erenkrantz is interning at Google during the first quarter of 2006. He will work with a team of open-source developers on projects benefit-



ing the Subversion CMS and other open-source projects. Erenkrantz is also the webmaster for ICSE 2006.

As part of UCI's collaboration with the EU PRIME project (<http://www.prime-project.eu.org/>), **Sameer Patil** (A. Kobsa, advisor) spent three months at Karlstads University in Karlstad, Sweden. Patil was involved in usability evaluation of an early prototype designed by the PRIME



project for helping individuals manage their privacy and identity in online transactions. Patil also presented "Uncovering Privacy Attitudes and Practices in Instant Messaging" (Group 2005, Sanibel Island,

FL), "THAT's What I Was Looking For': Comparing User-Rated Relevance with Search Engine Rankings" (Interact 2005, Rome, Italy), and "Balancing Awareness and Privacy in Loosely-coupled Collaboration" (Doctoral Consortium at ECSCW 2005, Paris, France).

Girish Suryanarayana's paper "An Architectural Approach for Decentralized Trust Management" appeared in the IEEE Internet Computing special issue on Ad Hoc and P2P Security, Vol. 9, No. 6, pp. 16-23, November/December 2005. The paper was co-authored by fellow graduate student **Justin R. Erenkrantz** and their advisor **Richard N. Taylor**.

For more information on students: <http://www.isr.uci.edu/people.html>

ISR Technical Reports Available Online

ISR technical reports present information resulting from student and faculty research carried out under the auspices of the Institute. They showcase early results not available in print elsewhere. ISR technical reports are available in PDF on the ISR website. Recent reports include:

"TREF: A Threat-centric Comparison Framework for Decentralized Reputation Models" Girish Suryanarayana, Richard N. Taylor, UCI-ISR-06-2, January 2006

"Using Visualizations to Analyze Workspace Activity and Discern Software Project Evolution" Roger Ripley, Anita Sarma, André van der Hoek, UCI-ISR-06-1, January 2006

All ISR technical reports are available at:

<http://www.isr.uci.edu/tech-reports.html>

ally funded digital library projects.

Since joining UC Irvine in 1998, Nideffer has continued to produce digital art works. In 2003 his online art game *Proxy* was featured in the Whitney Biennial of American Art, one of the premier contemporary art exhibitions in the world. Nideffer has spearheaded the integration of digital games into both the curriculum and research agenda on campus. In addition to building the digital arts lab program at UCI, in 2000 he proposed the first academic program in gaming within the context of North American research universities. He also founded the Game Culture and Technology lab within the School of the Arts. Since then, literally dozens of such programs and several labs have sprung up nationwide, yet academia still lags far behind pop culture in this regard. In February 2006, the Concentration in Game Culture and Technology was approved as a multi-school program offered between ICS and SOTA. His Game Studies course has been a perennial favorite in the Studio Arts curriculum, integrating cultural studies, design and implementation. In 2001, he co-curated *Shift+Ctrl* with Antoinette LaFarge at the Beall Center for Art and Technology, located in the UC Irvine Arts Plaza. *Shift+Ctrl* was one of the first major exhibitions in the U.S. devoted to games and game art, and was followed up by 2004's *ALT+CTRL*, a juried independent game festival, also at the Beall Center, and co-curated by Nideffer, LaFarge and **Celia**

Pearce, a researcher at ISR.

Nideffer was also instrumental in crafting the games emphasis for the Media Arts research component of Calit2, whose new building now sits nestled between the UClub, the Engineering Gateway, and the Donald Bren School of Information and Computer Sciences. Due to Nideffer's contribution, Calit2 includes games in its mission, acknowledging their vital role as both an engine for technological innovation and a cultural force. Along with ISR's acting Director **Walt Scacchi** and Pearce, he also formalized the Game Culture and Technology Lab within the context of the School of the Arts, Calit2 and ISR.

Nideffer's work integrates research and practice, and his current focus is on 'heterogeneous' gaming experiences that take place over diverse platforms on a single network. His newest art project, *unexceptional.net*, integrates location-aware mobile phones, a 3D game client on a desktop PC, a Blog, and a voice-driven telephony system, maintaining a persistent character through a series of levels towards spiritual enlightenment. He is also working closely with Scacchi on *DinoQuest* for the Discovery Science Center in Santa Ana. *DinoQuest* is an online gaming environment for children that ties to the upcoming dinosaur exhibition within the center's Santa Ana exhibition space. He and Scacchi are also establishing an international research partnership in advanced game culture and technology with the Center for Digital Industry Promotion (DIP) in Daegu, Korea.

In April, Nideffer, Scacchi and Pearce are co-chairing *MASSIVE: Research Summit on the Future of Networked Multiplayer Games*,

DID YOU KNOW?

Did you know that UCI's Game Culture and Technology Lab was founded by **Robert Nideffer**, **Walt Scacchi**, and **Celia Pearce**?

which counts several ISR faculty among its speakers. *MASSIVE* is co-sponsored by ISR and Calit2, and is supported by a UC Discovery Grant, UCI Research and Graduate studies, and others. (See related story p. 8)

Overall, game culture and technology and its multidisciplinary focus on computer-supported cooperative play, immersive interactive experience, interaction visualization, networked-based systems design, and online/virtual ethnography is expected to become another of ISR's areas of expertise and center for world-class research.

For more information:

<http://proxy.arts.uci.edu/~nideffer/>
<http://proxy.arts.uci.edu/gamelab/>
<http://www.ace.uci.edu/>
<http://www.calit2.net/>

Robert Nideffer can be reached at nideffer@uci.edu, (949) 824-4218.

FOCUS ON STUDENTS Internship Synergy at Wonderware

Most ISR students forge relationships with companies while pursuing their UCI graduate studies. The strongest of those relationships usually starts with a summer internship and develops into ongoing rich interactions of mutual benefit. What are the ingredients of a perfect match between company and graduate student, and how are such relationships forged?

This past summer, **Hazeline Asuncion** (R. Taylor, advisor) and Wonderware Corporation of Lake Forest made such a match.



Asuncion

Wonderware, an operating unit of Invensys' (UK) Production Management division, is the world's leading supplier of industrial automation and information software that allows manufacturers to manage

their factory operations. Asuncion's internship, which builds on her relationships with Unisys and First American (see Fall/Winter 2004 *ISR Connector*), addresses the long-standing Wonderware challenge of require-

ments traceability. In exploring possible research areas in traceability, her summer internship project with Wonderware Systems Architect Jim McIntyre and Domain Architect for Visualization Frédéric François helped her identify the key research issues of requirements tracing and process workflow. A member of ISR's software architecture research group, Asuncion is pursuing research in traceability, which is identifying relationships between various forms of data and its application in various domains, including software development.

Said François, "The company benefited greatly from both my interns this summer, with Hazel's project having far-reaching effects for the whole lifecycle of our software development and profound consequences for our operations." Asuncion has continued to work with the company to prepare the fruits of her project for a crucial upcoming corporate operations audit.

All ISR graduate students are encouraged to seek positive interactions with companies through conferences, networking opportunities, personal introductions by faculty advisors and staff, research projects, meetings, and presentations. The goals of these interactions include a better understanding of real world applications and needs, a furthering of the students' graduate research program, and financial support for the students' studies and research activities.

Companies seek out students for their expertise and consultancy, for internships and employment, and as speakers and assistants in conferences. Corporate goals include solutions for their challenges, introduction to new ideas and technologies, inexpensive labor, and testing students for potential as future employees.

Good matches are often forged by an intermediary, such as ISR's Technical Relations Director, the student's faculty advisor, a company scientist, a member of the company's recruitment team, or the company's designated university liaison. The close relationship of intermediaries between academia and industry clearly favors good internship matches.

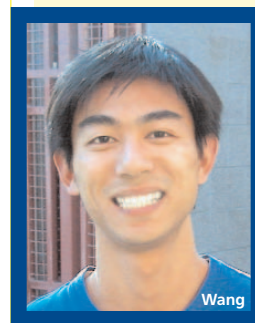
Wonderware fosters beneficial internship relationships in part through a program that provides seed funding for novel R&D projects. As part of Wonderware's maverick and fun-at-work culture, this program made Asuncion's project possible. Flexible hours, nightly work-sponsored dinners, and onsite playing areas (a sand volleyball court, a bas-

ISR STUDENT NEWS BRIEFS

Chris Jensen (W. Scacchi and A. van der Hoek, advisors) spent Summer 2005 at Google participating in the "Summer of Code", where over 400 students were paired with 40 open source projects. The goal was to introduce students to the world of open source software development.

Judy Chen (P. Dourish, advisor) and **Emily Oh Navarro** (A. van der Hoek, advisor) interned at Google in summer 2005. Chen served as a Usability Analyst and Navarro worked on Google Ads.

Yang Wang (A. Kobsa, advisor) interned at zLab of CommerceNet in summer



Wang

2005. Wang spent his time working on a web-based, decentralized, personalization engine with built-in privacy protection mechanism based on bloom filters. ISR alumnus **Rohit Khare** (Ph.D. 2003; R. Taylor, advisor), is Director of

CommerceNet Labs.

Scott Hendrickson (R. Taylor, advisor) spent last summer interning at The Aerospace Corporation working on REACT (Real-time Embedded Architecture-Centric Testbed), an aspect-oriented, architecture-centric testbed capable of analyzing and modeling architecture designs prior to code development. He continues to work on REACT with Phil Schmidt and Sergio Alvarado at The Aerospace Corp.

Eugen Nistor (A. van der Hoek, advisor) spent the summer at IBM Research in



Nistor

Hawthorne, NY evaluating the use of advanced software engineering concepts in scientific programming. He examined how multi-dimensional separation of concerns and aspect-oriented programming can be applied to programs using

MPI (Message Passing Interface). Part of the work, with Harold Ossher, Bill Chung, Stan Sutton and others, resulted in an Eclipse CME tool contribution.

ketball court, and a putting green) add to the positive work environment to make interns like Asuncion feel at home at Wonderware.

An internship is the ideal vehicle to meet multiple goals for both companies and students, but not often is the relationship a perfect match, as in Asuncion's case. From the academic view, an optimum internship furthers the student's dissertation research in real and measurable ways, including providing for publishable results. Not only does the internship support the student's academic financial obligations for at least the term of the interactions, but it also broadens the student's understanding of real-world applications of her research and graduate studies. The perfect intern for the company is one that exceeds job and project expectations, provides excellent value, fits the corporate culture well, is available for ongoing work beyond the internship period, and has real interest in becoming an employee.

Asuncion's ongoing work at Wonderware continues the project begun this summer. According to McIntyre, "The main goal of the project is to lower the cost of requirements traceability by eliminating double entry and manual checking of consistency between high level design documents. Not only does Asuncion's project achieve this goal, but it also facilitates project cost analysis and supports scope management."

In addition to requirements tracing, tracking software development tasks to enhance coordination between members in a development team is vital to timely delivery of products, especially in an organization where projects run in parallel. François remarked, "There will be great interest in the workflow oriented intranet site we designed based on our functions as architects, project managers, lead developers / testers, and other programmers."

Wonderware and ISR are continuing to build on their relationship, with plans for ongoing joint presentations and next-phase collaborative projects. The team is exploring opportunities for a new project examining traceability issues in the manufacturing domain. Asuncion has been asked to present her work next Spring at a meeting of the ACM Orange County Computer Human Interaction Special Interest Group (OCCHI).

Asuncion can be reached at hasuncio@ics.uci.edu.

For more information:
<http://www.isr.uci.edu/~hasuncio/>

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Affiliate—Grad Student	\$60,000	Graduate Student fellowship.
Partner	\$100,000 or more	Large-scale research project.

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brodbeck@uci.edu
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Debra A. Brodbeck
Technical Relations Director
brodbeck@ics.uci.edu, (949) 824-2260

FOCUS ON ISR TECHNOLOGIES

Reaching for Software Development without Conflicts

Writing software is hard! Software programs are complex, intangible, and changeable. They generally are created by a team of interdependent developers who have different

perspectives, technical skills, and communication powers. Add work conditions with intense time pressures, changing requirements, and frequent team reorganizations, and you have a recipe for errors. Coordination and communication mechanisms can bring much-needed structure to this chaotic environment by enabling different developers and teams to be in-sync with each other.

Palantir is a novel ISR technology that provides a coordination and communication solution at the implementation stage of the software development lifecycle. (See p. 1 article for an overview of ISR's lifecycle solutions.) Similar to its namesake, the Lord of the Rings' crystal ball, Palantir foretells of potential conflicts—in the developing software kingdom. Most conflicts in software development are due to tension between individual work and the need for integration of individual changes into the final system. Most software companies depend heavily on configuration management (CM) systems for their coordination needs. However, these systems cannot guarantee a conflict free environment. Conflicts can arise either because of overlapping changes to the same artifact in multiple workspaces (direct conflicts) or because changes in an artifact in one workspace negatively affect changes made to another artifact in another workspace (indirect conflicts). Pessimistic CM systems coordinate access to artifacts by locking an artifact under modification. Optimistic CM systems allow parallel modification of artifacts, but require changes to be resolved through successive versions in the repository, providing automated merging and differencing tools to resolve direct conflicts.

The drawback with the pessimistic approach is that sequential development, a forced by the locks, proves to be costly in terms of project delays. The optimistic approach, on the other hand, allows direct conflicts to occur and its automated differencing and merging tools fail when these changes overlap. In such situations, conflict resolution requires manual effort and translates to lost development time. Furthermore, neither the optimistic nor the pessimistic approach can detect or resolve indirect conflicts. Because of this, indirect conflicts are usually not detected until the integration phase, deployment phase, or worse, not detected until a disastrous failure of the systems. Conflicts and their resolution, thus, continue to pose a serious software development problem.

ISR's **André van der Hoek** and graduate student **Anita Sarma** believe that most conflicts in software development are hard to resolve because of their late detection. Their workspace awareness tool Palantír gives developers the power to

proactively avoid conflicts earlier in the development cycle. Developers are continuously informed with up-to-date information regarding relevant changes that are ongoing in parallel workspaces. This

allows developers to proactively take action to reduce the number and magnitude of conflicts, and thereby reduce development cost and effort.

Palantír not only shows which artifacts are changing, but also the change severity ("how much has changed") and impact ("how much does that change influence the artifacts in my workspace"). This information empowers developers to distinguish parallel changes upon which they should act from those that are harmless. For instance, a set of changes could have a severity of 30% (e.g., the developer changed 30 out of a 100 lines of code), but the change impact could be 0%, since the developer did not change the interface of the module implemented by the code. Alternatively, it is possible to have a severity of 10% (e.g., the developer only changed 10 out of a 100 lines of code), but the change impact could be 80% since the developer changed 8 of the 10 public functions.

Palantír has stand-alone integrations with RCS, CVS, and Subversion, and additional

The Engineering of Palantír

Palantír was architected to ensure smooth and easy coordination of distributed software development projects by incorporating the following characteristics of well-designed tools.

Non-obtrusiveness: Palantír relies on workspace wrappers that have the sole purpose of emitting events regarding development activities and otherwise are invisible to the user. Hence, developers can maintain established interactions with their particular CM system. A set of visualizations, each with varying degree of detail and obtrusiveness, is provided from which the user can choose per their preferences. Palantír only provides awareness information and does not in any way dictate when or which actions users need to take.

Compatibility: Not all CM systems have the same policies and each system may support different sets of actions. To enable compatibility, Palantír events represent the particular states in which an artifact can exist in a workspace, rather than capturing CM-specific actions (e.g., check-in, check-out, synchronize).

Scalability: Informing developers of all activities in all workspaces tends to overwhelm users and is in fact unnecessary. Such large amounts of information are distracting and often lead to users disregarding the information presented by the tool (or worse, discontinue using the tool itself). Bearing this in mind, Palantír only informs developers of relevant activities taking place in other workspaces. Relevant activities are defined as all activities pertaining to the artifacts in the local workspace, as performed in parallel by other developers in their remote workspaces. In addition to showing only relevant activities, Palantír provides filtering and sorting techniques to allow developers to further tailor the visualizations to fit their preferences (see "Configurability").

Flexibility: Different CM systems and users require or prefer different levels of awareness. By separating the internal data management from data extraction and information visualization, Palantír offers a flexible architecture in which different visualizations and conflict indicators can be used.

Configurability: Palantír can be easily configured to adapt to individual developer's needs. The tool supports filters for monitoring a desired subset of activities only. Palantír also allows developers to go back in time and play back past events.

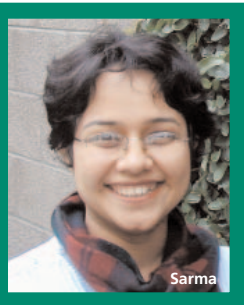
Connectivity: CM systems are multi-synchronous and require developers to be online only when they need to interact with the repository. Palantír notifies users of their offline status, and distinguishes which workspaces are offline at any given time. The tool stores all local activities that occur while a developer is offline and posts this information when the user returns.

integrations are planned. The tool is also available for download as an Eclipse plug-in. Palantír provides a set of four visualizations (the Eclipse package viewer, the fully graphical visualization, the tree view, and the scrolling marquee), each with varying degrees of detail and obtrusiveness that show parallel activities, severity of changes, and impact of changes.

In addition to providing support for early conflict detection, mainly geared towards individual developers, Palantír provides the Workspace Activity Viewer (WAV), which allows one to visualize and explore workspace activities and their evolution on a project-wide basis. The project of **Roger Ripley** (van der Hoek, advisor), WAV is a three dimensional (3D) visualization tool that builds on the underlying infrastructure of

Palantír and its events. The 3D visualization gives an overview of all workspaces at the same time, either from the perspective of a developer or an artifact, while placing the most important and relevant data at the forefront of the visualization. Developers find this approach helpful to contextualize their activities with concurrent project work, while managers gain a comprehensive view of all project activities, so task assignments can be adjusted and problematic situations rapidly identified. In addition to showing a snapshot of a project, WAV supports a movie-like capability to replay past events, which can be used for analysis of project dynamics and other forensics.

Palantír has been successfully tested "in retro" on the archives of five open source and one commercial project. The project is now



ISR EVENT SCHEDULE

Mark your calendars now!

February 24, 2006

Distinguished Speaker: Victor Basili

Computer Science Department, University of Maryland and Fraunhofer Center - Maryland
The Role of Empirical Study in Software Engineering

March 17, 2006

Distinguished Speaker: Laurie Williams

Computer Science Department, North Carolina State University
Industrial Case Studies of Extreme Programming Teams

April 20, 2006

MASSIVE: Research Summit on the Future of Networked Multiplayer Games

<http://www.isr.uci.edu/events/massive/>

MASSIVE is held in conjunction with the AeA-OCTANe@UCI meeting on "Corporate Opportunities for Multi-Player Games" and the Les Gasser ISR Distinguished Speaker meeting, both on April 21.

April 21, 2006

Distinguished Speaker: Les Gasser

Graduate School of Library and Information Science and Computer Science Department, University of Illinois at Urbana-Champaign
Ecologies of Games: Organizing Information and Activity in Synthetic Worlds

April 28, 2006

Distinguished Speaker: Chris DiBona

Google, Inc.
Open Source, GPL v3, and the Summer of Code at Google

June 2, 2006

2006 ISR Research Forum

1:30-7:30 p.m., McDonnell Douglas Auditorium
Evening reception with posters and demos at the University Club.
<http://www.isr.uci.edu/events/Research-Forum-2006/>

Graduate Student Research Symposium: For Students By Students

9:00-1:00 p.m., CS 432
This special event, organized by ISR graduate students, features refereed short paper presentations. It precedes the main ISR Research Forum program.
<http://www.isr.uci.edu/events/GSRs-2006/>

For more information:

<http://www.isr.uci.edu/events.html>

looking for an active field site to test the work in real-time.

For more information visit:

<http://www.isr.uci.edu/~asarma/Palantir>

or contact: asarma@ics.uci.edu,
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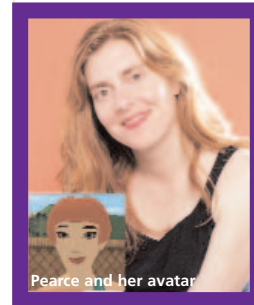
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Join us for MASSIVE: Research Summit on the Future of Networked Multiplayer Games

ISR and Calit2 are pleased to co-sponsor the Research Summit on the Future of



Networked Multiplayer Games, to be held April 20, 2006 in the new Calit2 building at UC Irvine. The summit is produced by ISR researcher **Celia Pearce** and co-chaired by ISR Profs. **Walt Scacchi** and **Robert Nideffer**.

A broad range of speakers from industry and academia will address:

- Networked Play Cultures/Player Perspectives
- Out of the Box: Heterogeneous Networks
- Industry/Academia Collaboration
- Strategic Design
- Production Models and Infrastructures

The over-arching aim is to engage in academia-industry dialogs and craft research agendas around the future of networked computer games and their impact on the Internet and society. This event will engage both speakers and attendees in an interdisciplinary dialog on the creative, social, technical, and business challenges posed by the "next generation" of online, networked games.

The day will end with a reception featuring demonstrations.

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For more information, contact:

Debra A. Brodbeck
Technical Relations Director
brodbeck@uci.edu, (949) 824-2260

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