ISR Connector
INSTITUTE FOR SOFTWARE RESEARCH / UNIVERSITY OF CALIFORNIA, IRVINE

HOT RESEARCH

The Future of Research in Computer Games and Virtual Worlds at ISR

ISR faculty, research staff, and students are actively involved in advancing the science and technology embodied in computer games and virtual worlds (CGVW). CGVW generally rely on common core software technologies, though the context of their application in entertainment systems versus enterprise platforms for R&D often determines whether they are labeled as a "computer game" or a "virtual world." Thus, we adopt the combined label to focus on what is common in the development, use, and evolution of CG and VW. OK, good. But why do CGVW merit scientific study and technology development? Is such study just a clever way to disguise playful fun as serious work? How is work different than play? If CGVW are software-intensive systems, then what kinds of software engineering research problems are associated with the development of CGVW? What are the grand challenges of research into CGVW, and what kinds of research needs to be engaged over the next 5-10 years to overcome these challenges? These are among the kinds of questions that researchers at ISR are investigating. Further, ISR has continued to be successful in earning external research funding from government research agencies, corporate R&D sponsors, and others to continue to conduct such studies. We are also innovators in discovering and prototyping how CGVW research findings can be translated into new ways and means to design complex software-intensive systems. So what research activities at ISR are investigating CGVW?


Scacchi

First, the largest NSF research project currently at ISR is focused on understanding decentralized virtual activity systems (DVAS) developed or deployed by the project's external research partners. The project examines networked-based multi-user CGVW as a kind of DVAS. DVAS style game play can emerge within a persistent community of users that works hard at interactive, dynamic tasks. Such work may coalesce into sustained patterns where teams, organizational forms, and group leaders emerge and form their own governance structures (e.g, social norms, lines of authority), much like those found in complex enterprise settings. Given such propensities, can CGVW be designed to experimentally enable new kinds of work structures and practices that users find more engaging, which in turn are easier to learn, more satisfying, and potentially more productive and stimulative? Such studies were started at ISR in 2008 with partners such as Northrop-Grumman, and later with the Naval Postgraduate School, San Francisco Symphony, and Discovery Science Center, among others. Early research and prototyping results are beginning to appear as DVAS project research publications, which can be found on the project's website at http://vcp.ics.uci.edu/biblio/28.

Second, Profs. **Walt Scacchi** and **Crista Lopes** helped organize an NSF funded workshop on the future of research in CGVW in Fall 2010 here at UCI. More than 40 academic and industrial researchers from across the U.S. participated in the two-day workshop, including ISR faculty **Bonnie Nardi**, **Robert Nideffer,** and **Jim Whitehead.** All have contributed to the Workshop Report, now nearing completion, that identifies six grand challenge areas for future research, Look for the report as an ISR technical report, to be posted on the ISR publications site later this Summer.

Third, Prof. Jim Whitehead co-chaired the First International Workshop on Games and Software Engineering (GAS) at the recent 2011 International Conference on Software Engineering (ICSE). A lead paper by Whitehead and his Ph.D. student at UC Santa Cruz, Chris Lewis, and another by Scacchi, help to anchor some of the foundational relationships between computer games and software engineering.

RESEARCH BRIEFS

Prof. **André van der Hoek** has been awarded $500,000 from the NSF for "Software Design Sketching", in support of his Calico research project. More information on Calico can be found at http://calico.bhnet.us/.

Prof. **James A. (Jim) Jones** has been awarded $499,600 from the NSF for his project "Promoting Efficient Debugging and High-Quality Software through Contextual Understanding of Faults."

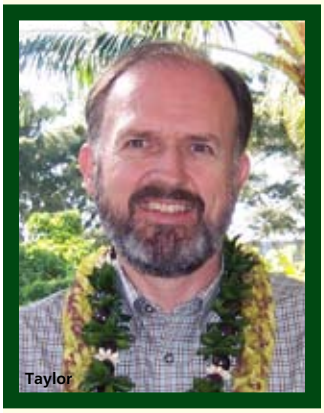
Prof. **Paul Dourish** and cultural anthropologist Genvieve Bell of Intel have authored the book "Divining a Digital Future: Mess and Mythology in Ubiquitous Computing" which addresses not only the technical importance of ubiquitous computing, but cultural, social, political, and economic aspects as well.

More Research Briefs on page 5 and 7.

IN THIS ISSUE:

MESSAGE FROM THE DIRECTOR

Early in June I had the privilege of giving a talk at the Boeing site in Huntington Beach, as part of their Distinguished Researcher and Scholar Seminar series. I always appreciate the opportunity of speaking at industry events, for it gives me an occasion to learn more about the challenges and issues facing high-tech companies and consequently hone the direction of my research. In trying to decide what my seminar would be about, I decided to leverage a surprise I'd had earlier in the year. In February I needed to be away from campus, and hence my classes, due to some conference-related travel. For my graduate class on software architecture, I decided to ask Dr. **Eric Dashofy** (an ISR alum now at The Aerospace Corporation) to guest lecture. I figured the class was in good hands and that the lecture wouldn't be too much work for Eric since he is one of my co-authors (along with USC Professor and ISR faculty asssociate **Nenad Medvidovic**), on our textbook, "Software Architecture: Foundations, Theory, and Practice." When I returned from the conference I heard that the class had gone very well and the students were excited by Eric's talk. But then I saw the title for his lecture: "Software Architecture is Bogus!" Uh-oh.


Taylor

As it turned out, Eric had taken a brilliant pedagogical line: argue the exact opposite of what the students expected (and what I expected!), and make them figure out where the truth lies. Eric's points were solidly grounded in the everyday practice of software engineering. He discussed, for instance, the nastinesses associated with building modern web-based applications, the degree to which choice and use of implementation frameworks dominates most application architectures, and how such frameworks even inhibit reuse – the very opposite effect from what they are supposed to do.

Given the enthusiastic discussion — both when Eric was lecturing in class and later when I returned to campus — I figured we could employ this idea in a dynamic back-and-forth style in the talk at Boeing. Hence the result: Eric and I both spoke in the seminar, with the session titled:

"Software Architecture is Bogus"
"Is Not!"
"Is So!!"

Speaking (arguing?) alternately, we covered a variety of architecture-related issues. It seemed that adopting a confrontational style in analyzing technical perspectives or opinions can serve to really highlight the key issues, identify ways in which a good idea can become subverted or rendered impotent, and clarify what the essentials really are.

The central point in our talk is that for system design conceptual integrity is paramount. Not a surprising conclusion, by any means, but conceptual integrity – how to achieve it, how to assess it, how to maintain it – becomes a fine touchstone to apply to any putative process, notation, language, or technology. Many software engineering techniques start off focused on or supporting conceptual integrity, but then seem to lose their way over time, as they take on other goals and start serving other masters. Others technologies, however, do keep the eyes on the prize, and are the valued tools in system development. I hope that my work is always "kept honest" by being challenged from many perspectives, and I hope that you will try this strategy with your personal favorite ideas and technologies.

In other news, you may recall that I focused in an earlier issue of the **ISR *Connector*** on the degree of involvement ISR staff, students, and faculty had with the 2011 International Conference on Software Engineering, which was held in Honolulu this past May. I am happy to report that the meeting with its 1070 attendees, was a technical, social, and financial success, a trifecta that was our goal. A critical element in the meeting's success was the tireless contributions of ISR's Technical Relations Director **Debra Brodbeck**. So one last time, "Mahalo, Debi!"

Best wishes for a great summer!

ISR Director **Richard N. Taylor** can be reached at taylor@uci.edu.

Scacchi's paper, for instance, examines the activity of "game modding" (modifying existing games to create new versions or variants to enable alternative play experiences) embodies many key practices in software extension, end-user software engineering, and open source software development that have appeared in the SE research community. Game modders apparently find developing game mods is a fun way to engineer complex software systems. Perhaps there are lessons here for how to make SE projects more fun and hence more productive. Scacchi's GAS 2011 paper and other CGVW papers from ISR can be found at http://www.isr.uci.edu/research-games.html.

Last, as suggested earlier, a number of new CGVW research studies are underway at ISR. Prof. Crista Lopes has become a lead developer of the OpenSim VW platform environment. OpenSim is an open source software server that works like its very popular, proprietary, closed source software counterpoint, Second Life™. But as open source software, functional software capabilities "under the hood" can be accessed, extended, refactored and redistributed to support experimental studies in ways not allowed with Second Life™. Lopes now produces the current releases of the OpenSim software distributions, which are freely available for download, installation, and experimentation on Windows, Mac, or Linux-based systems at http://opensimulator.org/wiki/Download.

Scacchi, along with ISR research programmers **Craig Brown** and **Kari Nies,** have in turn taken OpenSim to prototype new kinds of application systems. For instance, they have modeled and simulated a new kind of command and control (C2) system based on DVAS principles. The resulting prototype system is called DECENT. The DECENT study started with seed funding to Lopes, Prof. **Gloria Mark**, and Scacchi in 2009-2010 from a partnership with Northrop Grumman Intelligence Systems Division. Since 2010, Scacchi's team has been supported by the leading C2 research center in the U.S., the Center for the Edge at the Naval Postgraduate School. A screenshot from the DECENT VW is shown below (Figure 1). The design and modeling of the DECENT CGVW mirrors physical command and control centers, including large wall-sized data and video stream displays that can be seen by all DECENT users, while virtual desktop PCs provide (semi-)private views only to users whose in-world avatars are nearby. However, studies at ISR focus on decentralized play of seven card poker games as a metaphor for team-based problem-solving activities that involve the initial/incremental allocation of resources at risk, situation assessment, and tactical resource allocation trade-offs, all of which are a serious part of mission planning and scheduling in a C2 environment, much like they are the fun and playful part of a poker game.

Overall, CGVW continues to emerge as a new part of the research focus and expertise at ISR, and we welcome the opportunity to conduct innovative studies with new research partners in industry, government, or academia. Are you ready to play with us?

For more on Scacchi's research, see:

http://www.isr.uci.edu/~wscacchi

Scacchi can be reached at: wscacchi@ics.uci.edu.

Figure 1: Screenshot from DECENT project virtual world.


Medvidovic

Achieving Security on the Cloud through Nature-Inspired Computing

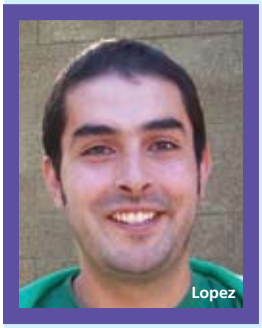
During the past decade, USC Professor and ISR Faculty Associate, **Nenad Medvidovic** has been looking at the role software engineering plays—and should play—in the emerging, related fields of grid computing and, more recently, cloud computing. Medvidovic's recent collaborative work with Yuriy Brun, his former Ph.D. student and currently an NSF CRA Postdoctoral Computing Innovation Fellow at the University of Washington, has focused on providing security and privacy guarantees to users of inherently insecure clouds. In this effort, which grew out of a collaborative research project with Director **Richard N. Taylor** at UC Irvine, funded by the National Science Foundation, Medvidovic and Brun have leveraged nature-inspired computing models to provide the types of guarantees that are unattainable via traditional computing approaches.

The recent emergence of cloud computing is forcing the nature of computation to evolve. For example, users no longer run computations on private machines or machines of which they even have physical awareness. The same evolution has taken place for data storage: many users no longer keep data, such as email, on their machines, but rather allow "the cloud" to maintain and safeguard that data. This transformation has allowed ubiquitous access to computation and data with higher availability and reliability than possible with personal machines and local servers. It has also allowed us, in principle, to dispense with certain (at times, severe) limitations of traditional computing, due

ISR STUDENT NEWSBRIEFS

Nithya Sambasivan (B. Nardi, advisor) has been awarded the Google Anita Borg scholarship for the 2011-12 year, the UCI Graduate Dean's Dissertation award, and a Microsoft Research Travel scholarship for 2011.

Nick Mangano (A. van der Hoek advisor) presented two papers at ICSE 2011 in May: "Blending Freeform and Managed Information in Tables (NIER Track)", co-authored by Harold Ossher, Ian Simmonds, Matthew Callery, Michael Desmond, and Sophia Krasikov of IBM T.J. Watson Research Center; and "A Demonstration of a Distributed Software Design Sketching Tool", a demo paper co-authored by Ph.D. students **Mitch Dempsey** and **Nicolas Lopez**, and Prof. **van der Hoek**. Mangano also served as an ICSE 2011 Student Volunteer.



Nicolas Lopez, (A. van der Hoek, advisor) presented his paper "The Code Orb - Supporting Contextualized Coding via At-a-Glance Views (NIER) Track" at ICSE 2011 in May. The paper was co-authored by Prof. **André van der Hoek.** Lopez also served as a session chair for the ICSE Software Engineering in Practice (SIEP) Track.

to the possibility of distributing highly demanding tasks onto many nodes. As a result, however, this transformation has created new security and privacy challenges.

The rapid evolution of how systems execute and how data is handled has, in fact, affected the meanings of the terms security and privacy, when referring to software systems. Security of a computation used to mean "the computer running the computation should be protected from malicious compromise," and privacy of data used to imply "unauthorized entities could not gain access to the data." Today, however, with computations on private data running on remote, unknown, potentially untrusted machines, security should mean "no computer, including the one(s) running the computation, may undetectably compromise it" and privacy should imply "no entity, including the one(s) executing the computation, should gain access to the data." Cloud computing has not yet embraced these new definitions, largely due to the intellectual hurdles and costs of developing systems that conform to these high standards.

Enter sTile, Medvidovic and Brun's approach for secure and trustworthy distribution of computation on the cloud. sTile leverages an existing theoretical model of molecular assembly to construct and deploy onto the cloud large, distributed systems that solve complex computational problems while providing security and privacy guarantees. Specifically, as long as no adversary controls more than ½ of the network used by sTile for solving a problem, sTile guarantees that, with exponentially high (in size of the input) probability, no adversary can learn the data used in the computation. As a simple example, let us assume that an sTile computation is deployed on TeraGrid, which comprises around one million computers, and that an adversary has compromised about 12,000 computers (about 1/8 of TeraGrid); in that case, sTile guarantees that the adversary's chance of "cracking" the sTile computation is 1 in 10 billion.

sTile solves a problem by:

1. mapping it to the tile model of molecular assembly, where a problem is decom-

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:

"Mapping Software Architecture Styles and Collaboration Patterns for Engineering Adaptive Mixed Systems"
Christoph Dorn, Richard N. Taylor
UCI-ISR-11-4, June 2011

"The Future of Research and Challenges in Computer Games and Virtual World Environments"
Walt Scacchi, Magda El Zarki, and others
UCI-ISR-11-3, June 2011

"Architecture-Centric Traceability for Stakeholders: Technical Foundations"
Hazeline U. Asuncion, Richard N. Taylor
UCI-ISR-11-2, May 2011

"Details on Extending the Meta-Design Theory: Results from Participant Observation of Active Contributors in Virtual Worlds"
Benjamin Koehne, David Redmiles, Gerhard Fischer
UCI-ISR-11-1, March 2011

All ISR technical reports are available at:

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

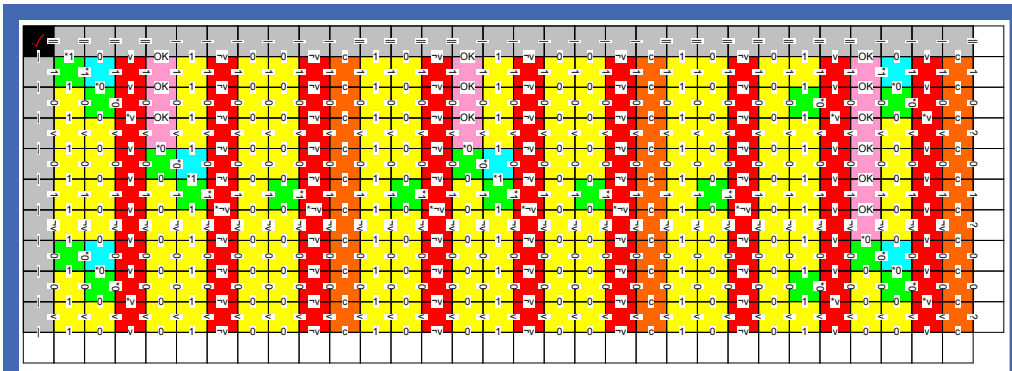


Figure 2: sTile crystal that solves a 3-SAT problem

posed into an arrangement of computing "tiles",

2. engaging a large number of computers in a cloud to each participate in solving a tiny piece of the problem, i.e., to embody a small number of tiles, and

3. virtually composing large numbers of tiles (each of which is executing on a separate physical computer) to arrive at a solution for the problem.

The underlying tile assembly model has tiles, or squares, that stick or do not stick together based on various interfaces on their four sides. Each tile has an interface on its top, right, bottom, and left side (and a "strength" parameter we will elide for simplicity). The four interfaces, elements of a finite alphabet, define the type of the tile. The placement of a set of tiles on a 2-D grid is called a crystal; a tile may attach in empty positions on the crystal if the appropriate interfaces match. Starting from a seed crystal, which is provided by sTile, tiles may attach to form new crystals. Sometimes, several tiles may satisfy the conditions necessary to attach at a position, in which case the attachment is nondeterministic; this property helps to explore the large space of possibilities for solving a complex problem. Therefore, if there exists a way to encode inputs to a computing problem as crystals, sTile will enable attachment of appropriate tiles to produce crystals that encode the output. Figure 2 above shows one such crystal that solves a 3-SAT problem.

RESEARCH BRIEFS

The paper "Extending Design Environments to Software Architecture Design" from KBSE'96, authored by alumni Dr. **Jason Robbins** of Google and Dr. **David Hilbert** of FX Pal, and their advisor Prof. **David Redmiles,** received the Most Influential Paper Award selected from the 1994, 1995 and 1996 ASE/KBSE conferences.

Prof. **James A Jones** has been awarded $58,000 from Google for his research on "Bug Comprehension Techniques to Assist Software Debugging."

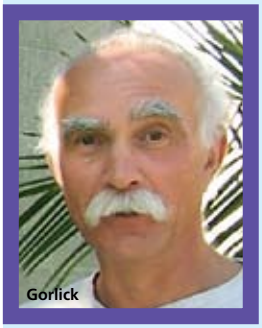
Prof. **Gloria Mark** has received a $50,000 grant from NSF for her research project "RAPID: Citizen Use of Social Media in the Egyptian Uprising."

Profs. **Alfred Kobsa** and **Walt Scacchi**, with ICS Professor Yunan Chen and Professors Jill Berg and Jung-Ah Lee from the UCI Nursing Program, received two seed grants for their proposed research on "Personalized Games for Children with Asthma": the first, a UCI ICS/HSSoE/CalIT2 Large-Scale Interdisciplinary Research Ignition Initiative Award in the amount of $36,000; and the second, a UCI Senate Multi Investigator Faculty Research Grant in the amount of $7000.

Project Scientist **Ban Al-Ani** will present her paper "An Understanding of the Role of Trust in Knowledge Seeking and Acceptance Practices in Distributed Development Teams" at ICGSE 2011 in August. The paper is co-authored by alumnae **Hiroko Wilensky** and Prof. **David Redmiles.**

ISR STUDENT NEWSBRIEFS

Michael Gorlick (R. Taylor, advisor) delivered a keynote talk, titled "Testing the 21st Century," at the 6th International Workshop on Automation of Software Test (AST 2011) at ICSE 2011, held in Waikiki, Honolulu, Hawaii in May.



Gorlick

Rosalva Gallardo-Valencia (S. Sim advisor) presented her paper "What Kinds of Development Problems can be Solved by Searching the Web?: A Field Study" at the 3rd Int'l Workshop on Search-driven development: Users, Infrastructure, Tools, and Evaluation (SUITE 2011) at ICSE 2011, held in Hawaii in May. The paper was co-authored by her advisor **Susan Sim**. Gallardo-Valencia also served as Student Volunteer Chair for ICSE.

Gallardo-Valencia

Ruy Cervantes (B. Nardi advisor) presented his paper "Infrastructures for Low Cost Laptop Use in Mexican Schools" at the Conference on Human Factors in Computing Systems (CHI 2011), held in Vancouver in May. The paper was co-authored by Prof. Mark Warschauer, Prof. **Bonnie Nardi** and Ph.D. student **Nithya Sambasivan**. Cervantes has also received a fellowship from UC Mexus-CONACYT, fully funding him for the 2011-2012 year.

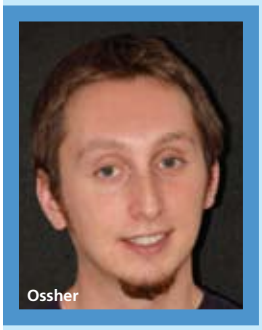
Cervantes

ISR STUDENT NEWSBRIEFS

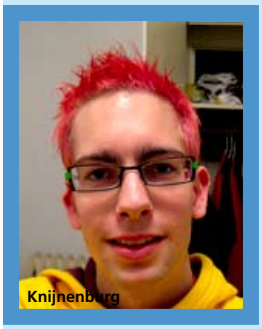
Benjamin Koehne (D. Redmiles, advisor) presented his paper "Extending the Meta-Design Theory: Engaging Participants as Active Contributors in Virtual Worlds" at the 3rd Int'l Symp. on End-User Development (IS-EUD) in Italy in June. The paper was co-authored by Prof. **David Redmiles** and Prof. Gerhard Fischer at the Univ. of Colorado at Boulder. Koehne also participated in the IS-EUD doctoral consortium.


Koehne

Joel Ossher (C. Lopes, advisor) is serving as Student Volunteer Co-Chair for SPLASH 2011, the 26th Conference on Systems, Programming, Languages, Applications: Software for Humanity, to be held in October. Ossher gained experience serving as a student volunteer at ICSE 2011 in May.


Ossher

Bart Knijnenburg (A. Kobsa, advisor) is presenting his paper "Exploring the Effects of Feed-forward and Feedback on Information Disclosure and User Experience in a Context-Aware Recommender System" at the User Modeling, Adaptation and Personalization Conf. (UMAP) in Spain in July. The paper was co-authored by Prof. **Alfred Kobsa** and Simon Moritz and Martin A. Svensson of Ericsson Research, Sweden.


Knijnenburg

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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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sTile has been implemented in a distributed framework, called Mahjong, and an accompanying simulator, called Simjong. sTile's security and privacy guarantees have been formally proven, while its performance has been empirically assessed on private networks, supercomputing clusters, the distributed testbed PlanetLab, and many large simulated networks.

While, as with other similar approaches, sTile has shown that the computational cost of privacy is high, we have demonstrated that cost to be manageable on large clouds. Furthermore, sTile is significantly faster than today's other comparable privacy-preserving approaches, which would require supercomputers to perform the simplest computations.

sTile's implementations—Mahjong and Simjong—as well as more information are available at:

http://csse.usc.edu/~ybrun/Mahjong/

Mor information on Medvidovic can be found at:

http://sunset.usc.edu/~neno/

Medvidovic can be reached at neno@usc.edu.

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Cotran

ISR Participates in Ground System Architectures Workshop (GSAW 2011)

ISR continued its tradition of participating in the Ground System Architectures Workshop (GSAW), which is sponsored by The Aerospace Corporation – one of ISR's long-time supporters. GSAW has been held in cooperation with ISR since 2003. GSAW 2011 was held February 28-March 3 in Los Angeles.

This year, Ph.D. student **Leyna Cotran** (R. Taylor, advisor) organized a working group on the topic of "Beyond 'Shall Statements': Modernizing Requirements Engineering." The working group was co-organized by ISR alumnus Dr. **Eric Dashofy**, now at The Aerospace Corp. Cotran deftly facilitated the workshop which featured two panels, several invited talks, and loads of dynamic interaction.

Cotran opened with an introductory presentation setting the stage for the day. ISR Director **Richard N. Taylor** served on the first panel, and gave a lively and provacative micro-keynote talk on "Requirements Engineering as a Failed Discipline," addressing the premise that classical requirements engineering practice has failed to deliver, and that software architecture is a key to improvement. Project Scientist **Ban Al-Ani** served on the second panel and gave a presentation on "Requirements Engineering at the Margins: Avoiding Technological Hubris through Alternative Approaches," highlighting that current RE approaches do not take into account the target users' context and environment.


Al-Ani. Dashofy, and Taylor at GSAW 2011

Ph.D. student **Yongjie Zheng** (R. Taylor, advisor), post-doctoral researcher **Chris Jensen**, and Technical Relations Director **Debra A. Brodbeck** also attended. Jensen observed, "the event brought a practical focus to ISR requirements engineering efforts, highlighting the challenge of achieving innovation in a field constrained by external demands and established practice."

We look forward to seeing you at GSAW 2012!


Dorn

Visitor from Vienna University of Technology Explores Software Architecture Styles and Collaboration Patterns

In March 2011, **Christoph Dorn** from the Vienna University of Technology (TU Wien) in Austria joined ISR as a post-doctoral visiting researcher. Dorn completed his Ph.D. on Adaptation Techniques in large-scale Service-oriented Systems in 2009 and continued as a post-doctoral researcher at the Distributed Systems Group (TU Wien). His general research focus is on adaptation and recommendation mechanisms in socio-technical systems. In such systems, Humans are no longer just the 'users' of a system but also an integral part. Their interactions with other humans and software elements have a significant impact on the runtime management of software components. Dorn's recent work addressed heuristics for team formation in social networks, self-adaptive people-driven workflows, and interaction-driven service composition.

Dorn choose UC Irvine/ISR as the host institution of his Erwin Schroedinger Mobility grant because of its reputation in ground breaking research and innovation in the domain of software engineering, especially software architectures for large-scale, adaptive systems. Software architecture styles have a profound effect on system adaptability, a research area that was fundamentally shaped by faculty host

RESEARCH BRIEFS

Prof. **André van der Hoek** received a 2011Software Engineering Innovation Foundation (SEIF) Award from Microsoft Research. The $40,000 SEIF award is for his project "Calico: Software Design Sketching with a Cloud-based Software Whiteboard." van der Hoek was one of ten awardees, chosen from 88 submissions.

Professor **Alfred Kobsa** received a $35,000 gift from Disney Corporation to support his research on "Privacy in Location Sharing", and a gift from Ericsson Inc. in the amount of $16,000 to support his research on "Privacy in Recommendation."

Prof. **Crista Lopes** is serving as General Chair for SPLASH 2011, the 26th Annual ACM Conference on Systems, Programming, Languages, Applications: Software for Humanity, to be held in October in Portland, OR. Technical Relations Director **Debra A. Brodbeck** is serving as Conference Manager.

Prof. **André van der Hoek** is the new Chair of the ICS Dept. of Informatics, as of July 1. He takes over from Prof. **David Redmiles,** who served in this role for seven years.


Taylor

ISR Director **Richard N. Taylor**. A principled, architecture-drive approach is thus of utmost importance when addressing the complexity of socio-technical systems.

During his stay Dorn will focus on analyzing the interdependencies of software architecture styles and human collaboration patterns, and modeling such relations during system design and system run-time. The ultimate goal is deriving adaptation mechanisms for socio-technical systems that are aware of the human collaboration structure when reconfiguring the supporting software system.

To this end Dorn has collaborated with Prof. Taylor in the recent months to outline a mapping between software architecture styles and collaboration patterns (Table 1). The result is a technical report detailing the similarities of styles such as publish-subscribe, components and connectors (C2), or Representational State Transfer (REST) with collaboration patterns such as Master-Worker, Organizational Control, or Self-organizing Teams. The report also provides a detailed analysis of two large-scale systems: Amazon Mechanical Turk (Map-Reduce) and Twitter (Publish-Subscribe).

Preliminary insights from this technical report highlight the potential synergies between architecture styles and collaboration patterns. Adaptation mechanisms addressing human collaborations are candidates for designing new techniques for managing software systems comprising massive, autonomous, unreliable components. Individual, self-governing components cannot be directly manipulated; they accept only recommendations. They might follow the recommendations or choose to ignore them based on internal, unobservable constraints. Subsequently,

Architecture Style	Collaboration Pattern
(Computational)REST/SOA	Secretary-Principal
Publish-Subscribe	Mailinglists
Tuple spaces	Collaborative Editing
Components and Connectors (C2)	Organizational Control
Map-Reduce	Master-Worker
Peer-to-Peer	Self-Organization

Table 1: mapping between software architecture styles and collaboration patterns

human-inspired properties such as trust, reputation, or cooperativity potentially become applicable to software components. Also, mimicking human trust establishment through joint, repeated interactions provides an alternative, self-regulating security approach in open software systems.


CREST team members Strasser, Baquero, and Gorlick

The technical report, entitled "Mapping Software Architecture Styles and Collaboration Patterns for Engineering Adaptive Mixed Systems," can be downloaded from the ISR website (UCI-ISR-11-4, http://www.isr.uci.edu/tech-reports.html).

Dorn's upcoming research efforts will focus on integrating architecture description languages (ADL) and collaboration pattern models. While exploring design of adaptation mechanisms, he plans to collaborate with ISR Ph.D. students **Michael Gorlick, Kyle Strasser**, and **Alegria Baquero** (R. Taylor, advisor) who are currently working on the CREST framework.

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His publications and additional background information are available at:

http://christophdorn.wordpress.com.

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