ISR*Connector*

HOT RESEARCH

Software Engineering for Sustainability (SE4S)

Sustainability has become a pressing concern, especially given the looming effects of climate change. Sustainable development aims to meet present needs while ensuring sustainability of natural systems and the environment so as to not compromise the ability of future generations to meet their own needs. Current software engineering methods, however, do not explicitly support sustainability or sustainable development. Yet because software systems have such an enormous influence on our daily lives—in many spheres and in varying contexts—comprehensively supporting sustainability in software engineering has considerable potential for making our planet greener in the long run as well as improving our communities and our environment.

Richardson

Professor **Debra J. Richardson** is working to solve this shortcoming through Software Engineering for Sustainability (SE4S), a joint research project with Informatics Professor **Bill Tomlinson** and postdoctoral researcher **Birgit Penzenstadler**, who is visiting UCI from Technische Universität München on a two-year German Research Foundation (DFG) fellowship.

Tomlinson

RESEARCH BRIEFS

Prof. **Debra J. Richardson** and alumni **Stephanie Leif Aha** and **T. Owen O'Malley** received a 2013 SIGSOFT Retrospective Impact Paper Award for their paper "Specification-based Test Oracles for Reactive Systems," which appeared in *ICSE '92: Proceedings of the 14th International Conference on Software Engineering*.

Prof. **Bonnie Nardi** has been elected to the CHI Academy, a group of researchers honored by SIGCHI, the ACM Special Interest Group in Computer–Human Interaction. Members are elected for making significant, cumulative contributions to the development of the field of human–computer interaction and for influencing the research of others.

Prof. **Cristina Videira Lopes** has been awarded $140,000 by the American Heart Association (AHA) for collaborative work with UCI Prof. Steve Cramer, Anatomy and Neurobiology, for their work on "Spatial Augmented Reality Games for Post-Stroke Rehabilitation."

Prof. **James A. Jones** is hosting in-resident visitor and researcher **Myunghee Han**, from Samsung Electronics, Korea from April through September.

The Big Picture

The ultimate goal of SE4S is to support all dimensions of sustainability—human, social, economic, environmental, and technical—throughout the software lifecycle. The SE4S team's primary efforts emphasize environmental sustainability with a focus on requirements engineering (RE) and quality assurance (QA). They believe these touchpoints have the greatest potential—RE will form the foundation for sustainable development and QA will provide the ability to assess progress.

The SE4S team is investigating to what extent and how RE and QA can contribute to improving sustainability of software systems in general, but most importantly on their impact within and on the environment. This involves identifying stakeholder needs, eliciting appropriate goals and requirements, finding metrics to assess realization of the requirements, and evaluating the extent to which the proposed activities help to improve the quality of environmental sustainability. Software engineers can choose to engage in ways that enable the greatest impact on sustainability while still satisfying the other requirements of the system.

Selected Components of the Research

Sustainability Goal Model: Penzenstadler has developed a generic sustainability goal model with process- and product-specific instances to help requirements engineers analyze their project according to the different dimensions of sustainability, instantiate concrete goals for the project, and incorporate actions that will improve the system's sustainability. The goal model emphasizes environmental sustainability in and via software systems, as this dimension of sustainability is the one that is least supported by traditional methods for developing software systems.

Sustainability as a Non Functional Requirement: A non-functional requirements (NFR) framework for sustainability is envisioned as the basis

Overview of the SE4S process and selected components.
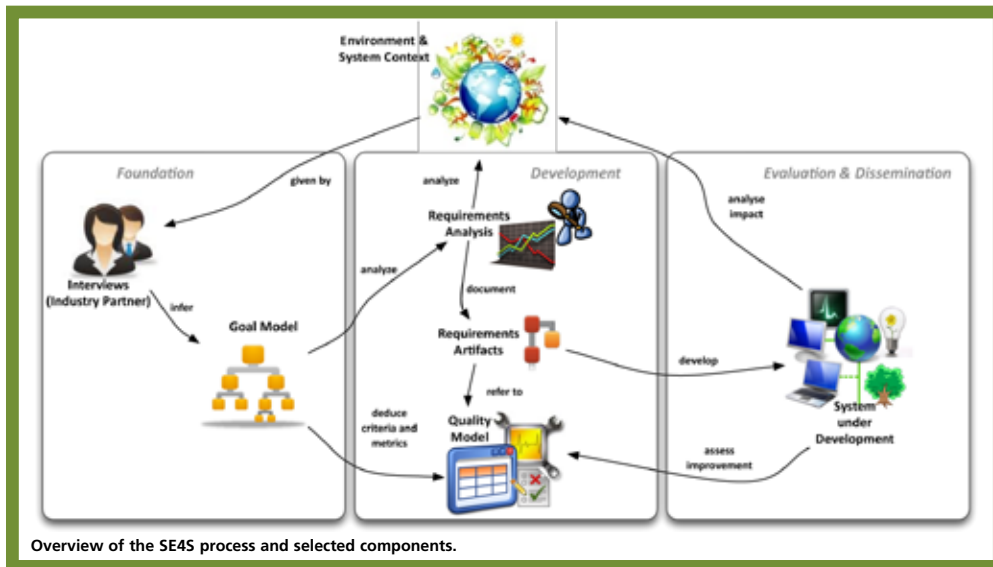
upon which requirements engineers can categorize various sustainability requirements that are elicited for a software system to be built. The framework would allow goals from the sustainability goal model to be categorized based on two dimensions: (1) sustainability aspects – environmental, human, social, economic and technical; and (2) order of effect – direct result of requirement, effect of application, or long-term socio-economic structural changes.

To transition from goals to requirements and adequately document them, the SE4S team, specifically Ph.D. student **Ankita Raturi** (D. Richardson and B. Tomlinson, advisors), is adapting a number of requirements analysis techniques, including life cycle analysis, and integrating sustainability information into requirements artifacts.

Sustainability Quality Model: At present, there is no common understanding of how sustainability can be measured and how the realization of sustainability

requirements can be verified. Development of a sustainability quality model, led by Penzenstadler with Master's student **Anshu Singh** (D. Richardson, advisor), will enable evaluation of the sustainability of software systems, with special emphasis on the environmental aspect of systems in their application domain.

Sustainability Requirements Recommender System: Ph.D. student **Kristin Roher** (D. Richardson, advisor) is working to create a recommender system that will lessen the burden associated with requirements elicitation for incorporating sustainability in software systems. The recommender system will present sustainability requirements patterns (templates from which requirements are constructed) to the user based on application domain, organizational values and guidelines, and deployment locale.

Sustainability Standard: To ensure wider applicability and so that sustainability truly becomes as a first class quality consideration, the SE4S team proposes establishing a governing standard with relevant policies and recommendations included as components for two standards: (1) IEEE 830— Recommended Practice for Software Requirements Specifications (and the related ISO/IEC/ IEEE 29148:2011):

a brief, first definition of sustainability in a software requirements context; and (2) ISO/IEC 9126—Software Engineering— Product Quality (and the related ISO/IEC 25010): application of the sustainability goal model, quality model, and NFR framework to create a hierarchically structured set of characteristics of sustainability as a software quality.

Collaboration Plan – Industry Partners

Research on this topic is only valuable if it can be applied in practice. Therefore, Richardson and Tomlinson would like to engage with industry partners to jointly develop feasibility studies and pilot projects to evaluate their research, to get feedback on their results, and to help their partners improve their current software engineering practices with respect to supporting the objective of sustainability.

They are looking for industrial case studies, such as the following: an existing system built with environmental sustainability considerations; a system (existing or under development) with potential direct impact on environmental sustainability; or a system (existing or under development) where user behavior can be influenced with respect to environment sustainability.

They envision the following phases in such a collaboration: (1) interviews, (2) project reviews, and (3) a collaborative case study:

1. A series of semi-structured interviews with different stakeholders (e.g., business analyst, requirements engineer, project manager, system architect) to explore the state of practice in sustainability support.

2. A review of one or more example projects (sharing artifacts with the research team) to deepen their understanding of the state of practice in RE and QA.

3. A collaborative case study (training and support for the industrial partner, evaluation and feedback for the research team) that includes instantiating the sustainability goal model and the corresponding quality model, along with analyzing and documenting sustainability requirements, and if relevant, also experimenting with the sustainability recommender system.

If you are interested in being an industry partner, or if you'd like to learn more about the project, contact Prof. Debra Richardson at djr@ics.uci.edu.

SE4S researchers: Master's student Anshu Singh, Ph.D. student Kristin Roher, post-doctoral researcher Birgit Penzenstadler, Ph.D. student Ankita Raturi, undergrad Taylor Kisor-Smith.

MESSAGE FROM THE DIRECTOR

Retirement! Or not!

If you had the pleasure of attending the most recent ISR Forum, on May 31st, you heard me announce that I am retiring from the University of California, effective July 1st. You also heard me say that I am continuing as Director of ISR for the coming year.

Taylor

What gives?

The retirement is indeed in place. My official university title is now "Professor Emeritus". The great thing about UC's retirement system is that it allows faculty to continue to participate in the life and mission of the university, to the extent that they desire. It is a set of opportunities, rather than a list of obligations.

The "opportunities" that I am going to pursue will come as no surprise to those who know me well: continuing to write, continuing to lead research projects, and continuing to serve as Director of ISR. These are all things I enjoy, and care about deeply.

Retirement is an occasion for parties, though, and have them I did. I want to tell you about one party in particular, because it surfaced a key value for ISR, and indeed one that I think all of us should treasure and nurture. The party was focused around my former Ph.D. students: 28 in all, now scattered around the state, the nation, and abroad. I am extremely proud of them, and it was a great joy to hear of their many and significant accomplishments. Just as a small sample, two of my alumni are or were chairs of their computer science departments; two more are currently serving as associate chairs of their computer science departments. Others have started companies (two have in fact started many companies!). Others have gone on to achievements in large companies, others are just beginning their careers.   But overall the theme was one of success — success in many dimensions.

What has led to such success though? I think a critical ingredient has been community. ISR has held the development and nurturing of community as a key value since its inception. While academics and academic institutions often give pre-eminence to the individual and individualism, I think that the software community that ISR has promoted has enabled these students, indeed all our ISR alumni, to achieve far more than they would have, had they "grown up" in a typical university setting. Community benefits our non-university partners as well. The cross-pollination of ideas, the exposure to new directions, the making of new colleagues – all these come from a conscious effort to build community.

Prof. Richard N. Taylor with Ph.D. graduates, current Ph.D. students, ISR Staff, and family.   Photo by Peyman Oreizy, alumnus.

Community does not come easily, however. It requires mutual commitment, frequent shoulder-rubbing, humility, and patience. The returns on such investments, though, are many.

Community provides a basis for substantive early feedback on ideas, leveraging of the expertise of others, and the development of meaningful collaborations.

I hope that this coming year will see the creation of yet-additional collaborations, whether between graduate students, research groups, or best of all, with our partner companies. The resulting work is so much fun, you just can't leave it behind. Even when you retire!

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

Hitesh Sajnani (C. Lopes, advisor) presented his paper "A Parallel and Efficient Approach to Large Scale Code Clone Detection" at the 7th Int'l Workshop on Software Clones, held at ICSE 2013 in May. The paper was co-authored by his advisor **Cristina Lopes.** He also visited Tata Research Development and Design Center in Pune, India from Jan 14 to Feb 28. While at TTRDDC, he gave two invited talks: "Latent Dirichilet Allocation and its uses in Software Engineering Tasks" and "A Parallel Approach to Clone Detection using MapReduce."

Sajnani

Dakuo Wang (G. Mark, G. Olson, advisors) is spending his summer as an intern at IBM Research China Lab in Beijing where he'll be doing a user study on social media usage in an organizational setting, and building correlations between a user's online behavior and their personality traits.

Wang

Arthur Valadares (C. Lopes, advisor) is interning at Intel, Hillsboro, OR for both Spring and Summer quarters, working on Distributed Scene Graph (DSG), Intel's architecture for scalable virtual worlds. The goal is to achieve a working architecture for up to 500 concurrent and interacting users in the same virtual environment.

Valadares

Prof. Walt Scacchi and visitor Prof. Christian Wagner

Visitor from Hong Kong with Orange County Ties— To Investigate Knowledge Transfer through Games

From June 2013 through May 2014, ISR is hosting Prof. **Christian Wagner**, on invitation by his ISR faculty host Prof. **Walt Scacchi**. Wagner is Chair Professor of Social Media and Associate Provost at the City University of Hong Kong, where he also oversees innovation related initiatives, such as CityU's Idea Incubator. Glad to take a semi-break from his administrative duties—Christian also served as Associate Dean at CityU's School of Creative Media until May 2013—he is looking forward to recharging his research agenda in online games, social media, and collective intelligence. Wagner's academic background includes undergraduate and graduate degrees in industrial engineering, followed by a Ph.D. in management information systems. After many years as a business

faculty member, both at the University of Southern California and at CityU, Wagner decided to transfer to CityU's School of Creative Media, to embark on a new research adventure by engaging with artist scholars.

While a faculty member in Hong Kong, Wagner is also a long-time bi-continental resident, living in Orange County and Hong Kong. Orange County has also been the location of a VC backed start-up company he co-founded more than a decade ago to develop enterprise planning software.

Wagner chose to visit UCI and ISR for several reasons. First, he was eagerly looking forward to re-connecting with former colleague Walt Scacchi, whom he describes as one of the most creative and broadly knowledgeable individuals he knows. While Scacchi and Wagner exchanged research ideas for many years, they never collaborated on publishing research studies together. So this will be the time. Second, UCI has emerged as a powerhouse in research and teaching on computer games virtual worlds, and all aspects of software research. Wagner's research in software engineering has focused on software maintenance and the effectiveness of user developed applications. He is also proud to say that CityU's School of Creative Media recently hired ISR alumnus **Yong Ming Kow**, who in 2011

Prof. **Alfred Kobsa** received $60,000 from Samsung Information Systems America to foster his research on privacy attitudes and behaviors in the use of mobile devices. He also recently gave a presentation on his research at IBM Haifa, and gave invited talks at the Symp. on Data Mining for Business Intelligence, Beersheba, Israel, and at the 21st Conf. on User Modeling, Adaptation and Personalization in Rome, Italy.

Prof. **André van der Hoek** is collaborating with Boeing, Intel, and Mirth in trialing the use of Calico – a distance collaboration tool for software design sketching – to learn how it behaves in supporting real-world design performed by teams distributed across the US.

Prof. **Bonnie Nardi** co-authored the book *Ethnography and Virtual Worlds: A Handbook of Method*, together with Tom Boellstorff, UCI Anthropology, Celia Pearce, Georgia Tech, and T. L. Taylor, MIT. Nardi also co-edited the book *Materiality and Organizing: Social Interaction in a Technological World*, together with Paul M. Leonardi, Northwestern University, and Jannis Kallinikos, London School of Economics and Political Science.

received his Ph.D. from UCI's Department of Informatics as a student of ISR's **Bonnie Nardi**. Third, Orange County has been attracting game software companies from start-ups to mature firms, which actively engage with ISR. Wagner is looking forward to participating in the idea exchange between practice and academia at UCI.

While at UCI, Wagner has several goals. He plans to explore the ability of computer games, and virtual worlds in general, to transfer especially tacit knowledge, expanding on the theme of one of his presentations "All I need to know about business I learned in World of Warcraft." He also plans to extend his research on collective intelligence expressed through social media activity, as illustrated in his work "Tell me which Wikipedia pages you read and I tell you who will win the next election." Plus he hopes to further his work on the use of social media to facilitate major purchasing decisions under the theme "buying physical and digital assets sight unseen based on collective intelligence drawn from social media." Finally, he seeks to complete a project on open collaboration using wikis.

"I feel very fortunate to be at UCI and I look forward to learning from, and sharing ideas with UCI colleagues," says Wagner. "I also hope this visiting appointment helps intensify future collaboration between UCI and CityU."

Wagner can be reached at cwagner1@uci.edu or c.wagner@cityu.edu.hk.

Become Part of the ISR Family

Rubbing elbows with ISR faculty, staff and students gives you a valuable window into the technology landscape of the future. But a relationship with ISR can be much more: Think of us as an extension of your company — a think tank, an R&D department, a research library, a consulting firm, a training department, and an employment agency, all rolled into one. More importantly, when you sponsor ISR you become part of a friendly group of folks who speak the same language and are eager to work with you to solve your current technical problems in the most cost-effective way possible.

Brodbeck

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   http://isr.uci.edu/partnerships/sponsorship/
or contact:

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

ISR STUDENT NEWS

Kristin Roher (D. Richardson, advisor) has been awarded the prestigious NSF Graduate Research Fellowship, which recognizes outstanding graduate students in

Roher

science, technology, engineering, and mathematics disciplines, and provides three years of support including a $30,000 annual stipend. Roher also presented her paper "A Proposed Recommender System for Eliciting Software Sustainability Requirements" at the 2nd Workshop on User Evaluations for Software Engineering Researchers (USER) at ICSE 2013 in May. The paper was co-authored by her advisor **Debra Richardson**.

Lee Martie (A. van der Hoek, advisor) presented his short paper "Toward Social-Technical Code Search" as a poster

Martie

at the 6th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE) at ICSE 2013 in San Francisco in May. The paper was co-authored by his advisor, **André van der Hoek.**

Mingming Fan (C. Lopes, advisor) is spending the summer as an intern at the FX Palo Alto Laboratory (FXPAL) where he is working on multi-device control and gesture control system design.

Fan

Maryam Khademi (C. Lopes, advisor) presented her paper "Comparing 'Pick and Place' task in Spatial Augmented Reality versus Virtual Reality for Rehabilitation Setting" at the 35th Int'l Conf. of the IEEE Engineering in Medicine and Biology Society in Osaka, Japan in July. The paper was co-authored by Hossein Mousavi, UCI Neurology, Lucy Dodakian, UCI Occupational Therapy, Steven Cramer, UCI Neurology, and her advisor **Cristina Lopes**.

Khademi

Oliver Yi Wang (D. Redmiles advisor) presented his paper "Understanding Cheap Talk and the Emergence of Trust in Global Software Engineering: An Evolutionary Game Theory Perspective" at the 6th Int'l Workshop on Cooperative and Human Aspects of Software Engineering (CHASE) at ICSE 2013 in San Francisco in May.

Wang

Eugenia Gabrielova (C. Lopes advisor) is spending her summer at the Lawrence Livermore National Laboratory on the Earth System Grid Federation (ESGF) team as a Computation Research intern. ESGF is an open source data distribution and computation infrastructure for Peta/Exa-scale earth system science data.

Gabrielova

Ph.D. student Nicholas DiGiuseppe presents poster to industry attendees at Forum Open House.

ISR Forum: *Where Research meets the Real World*

ISR's headline event, the ISR Research Forum, was held on May 31. Building on the success of last year's Forum, the program was expanded to include a closing reception with posters and demonstrations to provide additional opportunity for attendees to learn about ISR research projects, and foster interaction between industry and ISR researchers. A record number of people, drawn from over 20 companies, government agencies, and universities attended the day-long event.

The program featured: eight faculty talks on current research emphasizing areas of interest to industry; an 'open house' enabling attendees to visit research labs, see demonstrations and poster presentations, and interact with researchers one-on-one; a keynote by Prof. **Nenad Medvidović** of USC titled "When, Where, and Why Software Systems Decay and What We Can Do About It"; and the reception with posters and demonstrations. Feedback was altogether enthusiastic! Attendees said they appreciated meeting the faculty presenters, attending the open house, seeing demonstrations up close, interacting with graduate students and hearing their poster presentations, talking with both researchers and industry colleagues, exchanging ideas from the field, and comparing approaches.

For more information, including videos of the talks and presenters' slides, visit:

http://isr.uci.edu/events/Research-Forum-2013/

And be sure to mark your calendars for the 2014 ISR Forum, to be held Friday, May 16!

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:

"Motile: Reflecting an Architectural Style in a Mobile Code Language"
Michael M. Gorlick, Richard N. Taylor
UCI-ISR-13-1, June 2013

"A Tagging-Based Approach for Eliciting Engineering Requirements in Established Domains"
Leyna C. Cotran, Eric M. Dashofy, Richard N. Taylor
UCI-ISR-12-12, December 2012

"Communication and Capability URLs in COAST-based Decentralized Services"
Michael M. Gorlick, Richard N. Taylor
UCI-ISR-12-11, December 2012

All ISR technical reports are available at:

http://isr.uci.edu/publications/

Dr. David Levine (right) with his advisor ISR Director Richard N. Taylor.   Photo by Peyman Oreizy, alumnus.

ALUMNI PROFILE

Dr. David Levine, 1993 ISR Graduate

David Levine has always tread a fine line between academia and industry. He entered the ICS Ph.D. program at UCI in 1987 after working at The Aerospace Corporation on projects for the Department of Energy. Those included fuel-saving programs for cars and trucks and early electric and hybrid vehicles, ranging from on-board control systems to very detailed drivetrain simulations. As those programs were winding down, he looked for opportunities in software research. UCI was a natural fit, and Professor **Richard Taylor's** group a natural home. Levine worked on analysis and design of software for performance as part of the Arcadia research project.

After graduating with his Ph.D. and a stint with a spinoff out of the CS department at Washington University in St. Louis (WUSTL), Levine was hired by alumnus **Douglas Schmidt** to work in the Distributed Object Computing lab at WUSTL. A startup opportunity with other WUSTL computer science faculty came along, and Levine eventually crossed the line back into industry. April 2000 was not the ideal time to form a startup, but CombineNet has succeeded. The original goal was to find useful applications for combinatorial auctions, where a bid covers more than one item with a single price. This helps avoid the exposure problem of bidders ending up with items that are of no use because they don't obtain complementary items.

CombineNet applies the concept to procurement; it produces an on-line procurement platform that supports very large bids and very complex analysis. "Items" in its events include a wide variety of products, ranging from raw materials for

Bart Knijnenburg (A. Kobsa, advisor), has been awarded a Google Ph.D. fellowship; this global program supports outstanding graduate students

Knijnenburg

pursuing work in computer science, related disciplines, or promising research areas. He also presented his paper "Preference-based Location Sharing: Are More Privacy Options Really Better?" at the ACM SIGCHI Conf. on Human Factors in Computing, held in Paris, France. The paper was co-authored by his advisor, **Alfred Kobsa,** and Hongxia Jin of Samsung.

Xinru Page's (A. Kobsa, advisor) paper "FYI: Communication Style Preferences Underlie Differences in Location-Sharing Adoption and

Page

Usage" has been accepted to the Int'l Joint Conf. on Pervasive and Ubiquitous Computing (Ubicomp) to be held in Zurich, Switzerland in Sept. The paper is co-authored by Ph.D. student **Bart Knijnenburg** and their advisor **Alfred Kobsa**.

Leyna Zimdars (R. Taylor advisor) gave an invited talk "Developing

Zimdars

Requirements using a Twin Peaks Paradigm: A Practitioner's Perspective" at the TwinPeaks workshop held at ICSE 2013 in San Francisco in May. Zimdars received her Ph.D. in June.

RESEARCH BRIEFS

Post-doctoral researcher **Birgit Penzenstadler** presented her paper "Who is the Advocate? Stakeholders for Sustainability," co-authored by Henning Femmer, Tech.Univ. Munich and ISR Prof. **Debra Richardson**, at the 2nd Int'l Workshop on Green and Sustainable Software (GREENS), held at the Int'l Conf. on Software Engineering (ICSE) in San Francisco in May. She also co-organized a working session at the IEEE Int'l Requirements Engineering Conf. (RE), in Rio de Janeiro in July, and co-authored and presented three papers at the 2nd Int'l Workshop on Requirements Engineering for Sustainable Systems (RE4SuSy), held at RE.

Post-doctoral researcher **Thomas LaToza** presented two posters at the 6th Int'l Workshop on Cooperative and Human Aspects of Software Engineering (CHASE) held at ICSE 2013 in May. The first, "A Study of Architectural Decision Practices," was co-authored by Ph.D. student **Evelina Shabani** and Prof. **André van der Hoek**. The second, "Crowd Development," was co-authored by Ph.D. student W. Ben Towne, of CMU, Prof. van der Hoek, and Prof. James D.Herbsleb, of CMU.

manufacturing processes to equipment to packaging to finished products. And they include services, such as transportation, legal and other professional, and facilities maintenance. In this age of outsourcing and virtual companies with a focus on supply chain, a transparent, robust and efficient procurement process is critical to success. Customers typically see a 5-40% reduction in procurement cost, 15-50% reduction in time spent, and a 45X ROI.

Both bid takers (buyers) and bidders (suppliers) benefit from being able to specify their needs and capabilities, with as little or as much precision as they like. So in contrast to usual auctions where bidders can only compete on price, there is much more opportunity to craft and update offers based on any of their parameters. This results in a much more collaborative environment than with usual auctions. And it relies on improving efficiency in production and delivery systems. A good example is that about 30% of truck traffic is empty backhauls; by bidding combinatorially on complementary routes, trucking companies can reduce that directly.

But deciding the winning bids requires complex analysis. As part of the Arcadia project at UCI, Levine worked on analysis and design of concurrent programs, along with Prof. Taylor, alumnus **Michal Young**, and staff programmers **Kari Nies** and **Debra Brodbeck**. They utilized static analysis, which required constructing a very large, typically, graph of all possible states of a concurrent program, called a state space. Levine built on that approach to analyze all possible combinations of offers in the bidding events at CombineNet. Searching through those offers builds a graph, called a search space, where each node is an assignment of values to decision variables. That representation lends itself to solution methods of Computer Science and Operations Research, along with some proprietary techniques. Those solution approaches have advanced to the point that customers can solve useful problems; assignments of values to on the order of 10 million variables is now routine. Levine notes that "we usually don't have to explain to customers that we can or can't solve their NP-complete problems. In fact, we almost always spend more time pulling data out of a database than actually solving the problem itself."

Levine's experiences with Arcadia and at

Washington University left him at ease with distributed software. Not surprisingly, CombineNet's initial deployment in 2000 was over the Internet. The company has provided Software as a Service since long before that term were invented. Levine notes that "When we started in 2000, I could act as sys admin. I wouldn't do that now, just keeping up with platforms, standards, and security in the web world is more than a full time job now."

One of Levine's favorite projects at CombineNet has been for the Department of Agriculture, helping with the periodic procurement of grains and transportation from farms in the U.S. to worldwide destinations for the last four years. "It's very gratifying to be a part of the delivery of food to those in need. And to do so as efficiently as possible, in order to help as many as possible." said Levine.

Levine retains another UCI tie as one of the maintainers of the nmh mail user agent. nmh is a derivative of MH, which was designed and implemented starting in 1977 at RAND Corp., then further developed and maintained at UCI from 1982 to 1994. "I enjoy looking for ways to inject newer approaches and techniques into the older design and implementation" said Levine. His motivations for contributing to open-source projects are "the opportunities to engage in very focused technical debates, and to reach the compromises that are necessary at the end of the day. And while funding isn't a constraint, the time invested by contributors certainly is."

In addition, Levine likes to "keep his hands dirty" by actually working on software.

SPECIAL THANKS

"Software engineering, like other engineering disciplines, is about producing artifacts. It's different from other engineering disciplines in that its artifacts aren't physical, but more importantly, its tools and processes are also software, its own artifacts. One important lesson I learned from the Arcadia project is that robust and powerful techniques, tools, and processes are keys to successful development. The best way to produce and maintain quality software is to remain deeply involved with the entire development cycle."

Levine attended Professor Taylor's retirement celebration in June, along with 21 of his 28 other Ph.D. graduates as well as ISR staff – some of whom have been with the ICS Software group since the late 1980's, before the establishment of ISR and even its predecessor the Irvine Research Unit in Software (IRUS). It provided a great opportunity to renew old friendships, make new ones, and rekindle professional relationships. Levine commented, "It was truly amazing to see such a vibrant, successful group of people all together in one small room." We concur!

Levine may be contacted at levined@ieee.org.

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