
SCS
THE SOCIETY FOR
MODELING & SIMULATION
INTERNATIONAL
PROUDLY PRESENTS
SPRINGSIM
Spring Simulation Multi-Conference 2014
April 13 - 16, 2014
Grand Hyatt Tampa Bay Hotel, Tampa, FL
WACHOVIA

# 2014 SpringSim

# PROGRAM BOOK

April 13—16, 2014
Tampa, Florida, USA

**General Chair**
Mamadou Kaba Traoré

**Vice-General Chair**
Saikou Diallo

**Program Chair**
Navonil Mustafee

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*The Society for Modeling & Simulation International (SCS)*

# GENERAL INFO

# General Information

## Registration

Your registration for SCS's 2014 Spring Simulation Multi-conference (SpringSim'14) includes morning and afternoon breaks each day, the Monday evening reception in the Audubon III/A room and access to all sessions, tutorials and special presentations (unless otherwise noted).

- **Registration Hours** (*Foyer*):
  - ◊ **Sunday**, April 13th – 16:00pm-18:00pm
  - ◊ **Monday**, April 14th – 7:00am–17:00pm
  - ◊ **Tuesday**, April 15th – 7:00am–17:00pm
  - ◊ **Wednesday**, April 16th – 7:30am–15:00pm

## Exhibit Hall

- **Exhibit Hall/Simulation Exploration** (*Audubon III/A*):
  - ◊ **Monday**, April 14th – 7:30am—17:00pm
  - ◊ **Tuesday**, April 15th – 7:30am—17:00pm
  - ◊ **Wednesday**, April 16th – 7:30am—13:00pm

## Breaks

- **Coffee Breaks** (*Audubon III/A*):
  - ◊ **Monday**, April 14th – 10:00am–10:30am | 15:00pm-15:30pm
  - ◊ **Tuesday**, April 15th – 10:00am–10:30am | 15:00pm-15:30pm
  - ◊ **Wednesday**, April 16th – 10:00am–10:30am | 15:00pm-15:30pm

## Plenary

- **Plenary Session and Keynotes** (*Audubon II B/C*):
  - ◊ **Monday** (April 14th) 8:30am-10:00am and 10:30am-12:00pm (See Keynote pages 19-22 for more information on the speakers.)

# General Information



## Conference Meetings

**• • Sunday:**

SCS Board Meeting (8:00am-12:00pm); Kingfisher Room
SCS Board Members

Tutorials (14:30pm-17:30pm); Cormorant Room
Student Colloquium (8:40am-18:30pm) Herring Gull Room
All conference attendees invited (See agenda for details)

Social Event for Student Colloquium (18:30pm) Location
Bahama Breeze, 3045 N. Rocky Point Drive East, Tampa, Florida 33607

Pre-Conference Meeting (17:30pm-18:00pm); Audubon III/A
All conference attendees invited

**• • Monday:**

Plenary Session 8:30am-9:15am
Keynote Address Dr. Brian Goldiez, (9:15am-10:00am)
Keynote Address Dr. Richard Fujimoto, (10:30am-11:15am)
Keynote Address Dr. Simon J.E. Taylor, (11:15am-12:00pm)
Plenary and Keynotes, Audubon II B/C

Conference Organizers Planning Lunch (12pm); Wilson's Plover
By Invitation Topic: Future plans for 2015-2016 Conferences

Reception (17:30pm-19:00pm); Audubon III /A
All conference attendees invited

**• • Tuesday:**

Simulation Exploration Experience Event (8:30am-10:00am);
Audubon III/A, all conference attendees invited
(See agenda for details)

Membership Meeting (12:00pm-12:45pm); Pelican
Topic: What's new for SCS Members?
SCS members and future members invited

Spring 2015 Organization Planning Meeting with Symposia Chairs (Invite only)
(12:45pm-13:30pm); Wilson's Plover

# General Information

## Monday Evening Reception

There will be a reception on the Audubon III /A, open to all SpringSim'14 attendees, on Monday, April 14th, from 5:30pm-7:00pm.

## Speakers' Breakfasts

Speakers' breakfasts will be held Monday – Wednesday from 7am – 8:15am, located in Wilson's Plover. The presenters for each day are invited to join their session chairs at a breakfast on the morning of their presentation. Each paper's presenter should receive a ticket with their registration material indicating the time, day and room for the breakfast they may attend.

## Best Paper Award

The Award for the Best Paper of SpringSim'14 will be presented at the beginning of the SCS Plenary session.

# Upcoming SCS Events



## 2014 Summer Simulation Multi-Conference

July 6-10, 2014

The Hyatt Regency Monterey; Monterey, CA, USA

The Summer Simulation Conference 2014 (SummerSim'14) is SCS's premier international conference in cooperation with ACM SIGSIM. The conference focuses on modeling and simulation, tools, theory, methodologies and applications and provides a forum for the latest R&D results in academia and industry. This year's focus is on hybrid, discrete and continuous systems, and advanced modern applications thereof. We encourage you to take this opportunity to experience the tutorials, tracks, and workshops that will be available. SummerSim'14 includes the following events: International Conference on Bond Graph Modeling (ICBGM 2014), 46th Summer Computer Simulation Conference (SCSC 2014), and the International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS 2014).

## 2015 Power Plant Simulation Conference

January 26-28, 2015

Omni Jacksonville Hotel; Jacksonville, FL, USA

The 2015 Power Plant Simulation Conference (PowerPlantSim'15) is an annual conference sponsored by SCS. This conference focuses on the special needs of the nuclear and fossil power plant simulation community and includes presentations by technology and industry leaders, technical sessions, panel and roundtable discussions, and vendor exhibits. The primary goal of the conference is to promote open exchange of simulator related information between all attendees. All individuals associated with the maintenance, management, regulation, or application of nuclear and fossil power plant simulators are encouraged to participate by submitting original presentations.

## 2015 Spring Simulation Multi-Conference

April 12-15, 2015

The Westin Alexandria Hotel; Alexandria, VA, USA (DC Area)

The Spring Simulation Multi-Conference 2015 (SpringSim'15) brings leading experts in various domains of Modeling and Simulation together. The Theory of Modeling and Simulation (TMS/DEVS 2015) will be a sub-conference of SpringSim. The following symposia are typically organized under SpringSim: Annual Simulation Symposium (ANSS), Agent-Directed Simulation (ADS), Communications and Networking Symposium (CNS), High Performance Computing Symposium (HPC), Symposium on Simulation for Architecture and Urban Design (SimAUD), Poster Session and Student Colloquium.

Please visit www.scs.org/conferences for more information on our conferences.

# Welcome to SpringSim'14

## Welcome from the General Chair

Welcome to Tampa!

As the General Chair, and on behalf of the Organizing Committee, I am delighted and honored to welcome you to the Spring Simulation Multi-Conference 2014 (SpringSim'14). The various members of SCS (The Society for Modeling & Simulation International) have worked hard to make these four days very exciting and to ensure SpringSim continues to be one of the leading events in the M&S community.

SpringSim'14 program includes a world-class selection of peer-reviewed paper, presentations, distinguished keynote speeches and tutorials as well. In addition to such an outstanding choice, the Organizing Committee promotes this year the first Ph.D Colloquium in SpringSim, a forum where opportunity is given to students to showcase their work in progress and link with their peers. SpringSim'14 is also promoting again the Simulation Exploration Experience event (SEE, formerly known as SISO Smackdown), where inter-university teams present their work on utilizing simulation interoperability solution to contribute to a bigger NASA effort and to connect the students with their future as simulation professionals.

My thanks goes to all members of the Organization Committee for their tireless efforts to make SpringSim'14 successful. They are:

| | |
|---|---|
| Vice General Chair: | Saikou Diallo, Old Dominion University |
| Program Chair: | Navonil Mustafee, Exeter University |
| Proceedings Chair: | Mohammad Moellemi, Embry-Riddle Aeronautical University |
| Awards Chair: | Andreas Tolk, SimIS Inc. |
| Tutorial Chair: | Gregory Zachariewicz, Universite Bordeaux I |
| Publicity Chair: | Hala El Aarag, Stetson University |
| Poster Session and Student Colloquium Chairs: | Rodrigo Castro, Universidad de Buenos Aires and ETH Zurich<br>Qi Liu, Microsoft Corporation |

My sincere appreciation goes to the symposia chairs, whose invaluable efforts in their respective sections were key to the success of the overall multi-conference. This year's symposia and chairs are:

- Agent-Directed Simulation (ADS) Symposium, chaired by Levent Yilmaz, Auburn University, and Tuncer Ören, University of Ottawa
- 17th Communications and Networking Symposium (CNS), chaired by Hassan Rajaei, Bowling Green State University
- 22nd High Performance Computing Symposium (HPC), chaired by Karl Rupp, Technische Universität Wien, and Layne Watson, Virginia Tech

# Welcome to SpringSim'14



- Symposium on Simulation for Architecture and Urban Design (SimAUD), chaired by David Gerber, USC School of Architecture, and Rhys Goldstein, Autodesk
- Theory of Modeling and Simulation (TMS/DEVS), chaired by Andrea D'Ambrogio, University of Roma, and Gregory Zachariewicz, Université Bordeaux I
- 47th Annual Simulation Symposium (ANSS), chaired by Andreas Tolk, SimIS Inc., and Eric Imsand, GaN Corporation (my special thanks go here to Francesco Longo, University of Calabria, and Saikou Diallo, Old Dominion University, for making successful the merging of EAIA -Emerging Applications of M&S in Industry and Academia, and MMS -Military Modeling & Simulation, under the umbrella of ANSS)
- Posters Session & Student Colloquium, chaired by Rodrigo Castro, Universidad de Buenos Aires and ETH Zurich, and Qi Liu, Microsoft Corporation

I extend my appreciation to the numerous reviewers for their thorough work and diligence in evaluating the papers accepted for publication, making the Conference Proceedings a high quality document. I also express my gratitude to authors and presenters that we received contributions from all over the world.

It takes the efforts of all these volunteers to make SpringSim possible.

My final thanks go to SCS officers, Oletha Darensburg and her team, for their high level of professionalism and for the smooth running of all the events.

I hope you enjoy SpringSim 2014!

Mamadou Kaba Traoré
General Chair SpringSim 2014
Blaise Pascal University, Clermont-Ferrand, FRANCE

# Simulation Exploration Experience

The Simulation Exploration Experience is a unique, international inter-university activity which will take place at the Spring Simulation Multi-Conference in April. The idea is simple: teams learn simulation by doing it. They create HLA-evolved models, use SISO standards, and meet online with NASA and industry technical experts to create models and develop interactive activities with one another. The result is a simulated mission on the far side of the Moon. The faculty advisors and student teams partner with SCS, SISO, Liophant, government and industry, and utilize state-of-the-art software, tutorials, mentoring, and technical infrastructure for this fourth annual event, hosted this year by SCS.

Teams from the US (California, Nebraska, Alabama and Pennsylvania) join students from Brunel and Exeter (UK), Munich (Germany), Bordeaux (France), Genoa and Calabria (Italy). These highly dispersed teams will work concurrently across time zones and oceans to come together in Tampa, having gained valuable skills and an understanding of modeling and simulation. Check out more at the official website: www.Exploresimulation.com.

SpringSim'14 encourages everyone, including potential employers, to meet and help the students as they set-up, test and configure technical equipment and to take part in the actual event on April 15 at 8:30am-10am. Join us in this adventure of virtual simulation that is out of this world.

### SEE Sponsors 2014

SCS, Liophant, VSEE, AEgis, ForwardSim, VT MAK, Global Institute for Cyber Security and Research, Pitch, MBDA, NASA, SISO

# TUTORIALS

# Tutorials Information

## Tutorial Schedule (April 13th, Sunday)

Tutorial Chair: Gregory Zacharewicz

Room: Cormorant

Introduction to Hierarchy of Discrete Event Formalisms
Time: 14:30pm-15:00pm
Speaker: Norbert Giambiasi
Affiliation: LSIS

Space Exploring Simulation
Time: 15:15pm –15:45pm
Speaker: Priscilla Elfrey and Richard Severinghaus
Affiliation: Strategic Implementation (NASA, KSC) and SISO Representative (AEGIS)

Selecting and Defining Key Performance Indicators for Simulation
Time: 16:00pm— 16:30pm
Speaker: Yves Ducq
Affiliation: Head of Production Engineering Research Group, (IMS)

Keys to Effective Collaborations in the Simulation Domain (including NCS Success Stories)
Time: 16:45pm—17:30pm
Speaker: George E. Cheros
Affiliation: Operations Director (NSC, Orlando)

**Introduction to Hierarchy of Discrete Event Formalisms**
Time Slot: **14:30pm-15:00pm**
Speaker: Norbert Giambiasi
Affiliation: LSIS

## Abstract

Formalisms with a great expressive power are not always needed and can be, in some cases, inconvenient. For example, in the DEVS formalism, the next state depends on the elapsed time in the current state which is an important concept for building accurate discrete event abstractions of continuous systems. However, this leads to models where the number of successors of a state can be infinite. As a result, it is evident that no formal verification method can be used on these models, whereas in many applications, the elapsed time in a state is regarded as not affecting the future state. This is why we believe that less expressive timed formalisms can be useful and can constitute an improved response to solve certain classes of problems.

Hierarchical modelling approaches are well known and used, since the end of the sixteen's, in the field of digital circuits. For example, at the logic gate abstraction level, at least four timed sub-levels are defined and used to solve different classes of problems. The expressive power of the formalism used in a problem solving activity must be adapted to the problem to solve and not be the more expressive as possible. It is for that we have proposed a hierarchy of timed discrete event formalisms. This hierarchy ranges from the well-known sequential machines to the more expressive discrete event formalisms: DEVS, Timed Automata and GDEVS.

We start our presentation by showing that the expressive power of the modelling formalism must be adapted to the problem to solve. Then, we present the proposed hierarchy of formalisms which offers a gradual approach for solving analysis problems or design problems on discrete event systems. In addition; such a hierarchy is very useful for a progressive understanding of the basic concepts of discrete event modelling and simulation.

## Biography

Norbert Giambiasi is full Professor at the University of Aix-Marseille from 1981. In October 1987, he created a new engineer school and a research laboratory LERI in Nîmes (south of France). In 1994, he comes back to the University of Marseilles in which he creates a new CNRS laboratory (LSIS) with more than two hundred researchers.

He has written a book on C.A.D and he is author of more than 400 international publications. He was and is scientific manager of more than 50 research contracts (with E.S Dassault, Thomson-Cimsa, Bull, Siemens, Cnet, Esprit, Euréka, Usinor, Phillips, ...).He was the research director of more than 40 PhD students. He is member of the program committee of several international conferences and he created the international conference ' Neural-network and their Applications'

He is referee for national and European research projects. His main current interests converge on: specification formalisms of hybrid models, discrete event modeling and simulation, CAD systems and Design Automation.

# Tutorials Information (Cont.)

**Space Exploring Simulation**
Time Slot: **15:15pm-15:45pm**
Speakers: Priscilla Elfrey and Richard Severinghaus
Affiliation: Strategic Implementation (NASA KSC) and SISO Representative (AEgis)

## Abstract

*Priscilla:*
*SEE Vision – Simulation excellence through practical experience.* Motivation for providing NASA outreach to promote STEM education and job readiness for 21st Century technical careers. Relevance of SEE enterprise to NASA and its needs for top level talent. Fostering relationships among industry, academia, and government in the context of state of the art simulation educational experiences.

*Rick*
*The Value Proposition for Distributed Simulation – the human aspect.* Providing an environment for students to gain technical experience, interact with industry, and gain perspective to promote better educational choices leading to productive careers. Promotion of alignment of educational programs and the needs of industry. Narrowing the gap between education completion and job readiness.

## Biographies

**Priscilla Elfrey.** Simulation Exploration Experience (SEE2014) Executive Producer, KSC's Center for Life Cycle Design. co-founder, work improvement student, educated Barnard, Columbia, NYU, brings NASA, Yale, organization & career development, storytelling, training, word mongering, video, theater, low-vision design, & media ecology to simulation use & partnering,- local to international.

**Richard Severinghaus.** SEE2014 Chair, SEE Program Coordinator. Education USNA, USC, RPI. Decades experience in simulation based training and performance assessment, program oversight, and coordination. Past Chair, Excom, Simulation Interoperability Standards Organization, member & track/committee chair in Society for M&S International (SCS), and Society for Simulation in Healthcare (SSH).

**Selecting and Defining Key Performance Indicators for Simulation**
Time Slot: **16:00pm-16:30pm**
Speaker: Yves Ducq
Affiliation: Head of Production Engineering Research Group, (IMS)

## Abstract

The Production Engineering research group of IMS Laboratory includes more than 40 researchers mainly dedicated to three research activities: enterprise modelling and performance, models for production system control and design engineering. The past results of the group are for instance the famous GRAI Method for decision system modelling, analysis and design and ECOGRAI Method for the definition and implementation of performance indicator systems.

The domain of simulation uses a lot of different type of performance indicators based on different kinds of models. This presentation aims at presenting first an exhaustive review of the existing methods to define and to implement performance indicator systems that can then be used for simulation. A focus is done on Balanced Score card and ECOGRAI that are based on enterprise models. In a second time, the 35 existing methods are compared and a generalized framework for such methods is presented in order to define which modules a method dedicated to performance indicator system definition and implementation must contain.

## Biography

Yves DUCQ is full Professor at University of Bordeaux from September 2008. He is working on Performance Measurement, Enterprise Modelling and Production Management since fifteen years and has published more than 20 papers in books and international journals and more than 70 papers in international conferences. He is responsible of the research group dedicated to production engineering sciences (GRAI research Group) at IMS laboratory. He has been involved in many European and French projects for twenty years and has also act as research engineer on several contracts with industry on performance improvement. He is also quality manager for University of Bordeaux.

# Tutorials Information (Cont.)

**Keys to Effective Collaborations in the Simulation Domain (including NCS Success Stories)**
Time Slot: **16:45pm-17:30pm**
Speaker: George E. Cheros
Affiliation: Operations Director (NSC, Orlando)

## Abstract

"Team Orlando" is comprised of the Army, Navy, Marines, Air Force and 10 other federal agencies that are all collocated in the Central Florida Research Park, adjacent to the campus of the University of Central Florida. This presentation will show how local civic leaders, a growing university and the Department of Defense/NASA began working in concert over 30 years ago to create a unique high-tech industry that produces approximately $5 billion in direct economic impact. In addition, 30,000 jobs have been created throughout the state of Florida. The catalyst for making Central Florida the epicenter for Modeling & Simulation is the close working relationship between government, academia and industry. The University of Central Florida is the second largest university in the United States with over 60,000 students and has a world renowned M&S graduate program and is also home to the Institute for Simulation and Training (IST). In addition, the Central Florida Research Park is home to over 100 M&S companies and the National Center for Simulation. Several examples of the effective use of collaboration will be discussed throughout the presentation.

## Biography

Mr. George E. Cheros is the Chief Operating Officer of the National Center for Simulation in Orlando, Florida. NCS is a non-profit association that has a mission of growing the M&S industry. The Orlando area is the epicenter of the Modeling and Simulation for the world. For over 20 years, the confluence of industry, military and university research developed a center of excellence that is unmatched. He has over 30 years experience with Fortune 100 companies and

# KEYNOTES

# Keynotes Information

**ABSTRACT: Vertical and Horizontal Interoperability: A Challenge for Simulation**

**AUTHOR:** Dr. Brian Goldiez

**LOCATION:** AUDUBON II B/C

**TIME:** 9:15am - 10:00am

**DAY:** Monday, April 14, 2014

The simulation community has made great strides in the past 20 years in creating and using standards supporting interoperability. This talk will revisit those efforts, but challenge us to reinvigorate our efforts to address challenges in pressing forward to meet the growing interest in connecting different simulators of similar granularity and simulators at different levels of granularity. Moving forward requires action on the technological, teaching, and social fronts. These activities are needed to keep our community relevant in providing the infrastructure required for expanded and economical uses of simulations.

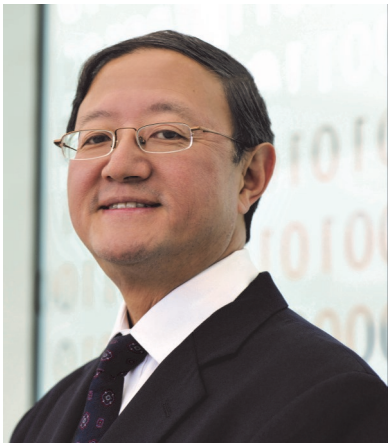
**SHORT BIO:**

Brian Goldiez is the Deputy Director at the Institute for Simulation and Training at the University of Central Florida and a Research Associate Professor at UCF. He has been at UCF for over 25 years and been in the simulation community for over 35 years. Of late, Goldiez has directed simulation research efforts in healthcare simulation and high performance computing. Dr. Goldiez has undergraduate and graduate degrees in engineering from several institutions and received his Ph. D. in Modeling and Simulation from UCF.

# Keynotes Information



**ABSTRACT: Parallel Discrete Event Simulation and the Next Big Thing**
**AUTHOR:** Dr. Richard Fujimoto
**LOCATION:** AUDUBON II B/C
**TIME:** 10:30am -11:15am
**DAY:** Monday, April 14th, 2014



**SHORT BIO:**

Dr. Richard Fujimoto is a Regents' Professor and the founding Chair of the School of Computational Science and Engineering (CSE) at the Georgia Institute of Technology. He is the interim director of the Institute for Data and High Performance Computing at Georgia Tech. He received the Ph.D. and M.S. degrees from the University of California, Berkeley in 1983 and 1980, respectively in Computer Science and Electrical Engineering, and two B.S. degrees from the University of Illinois, Urbana in 1977 and 1978 in Computer Science and Computer Engineering. He has been an active researcher in the parallel and distributed simulation community since 1985, and has published numerous technical papers on this subject. His publications include three books and several award-winning articles on parallel and distributed simulation. He led the development of parallel/distributed simulation software systems including the Georgia Tech Time Warp (GTW) simulation executive and the Federated Simulation Development Kit (FDK), both of which have been distributed worldwide. He has given several keynote addresses and tutorials on parallel and distributed simulation at leading conferences. He led the definition of the time management services for the High Level Architecture (HLA) for modeling and simulation (IEEE Standard 1516). Fujimoto has served as Co-Editor-in-chief of the journal *Simulation: Transactions of the Society for Modeling and Simulation International* as well as a founding area editor for the *ACM Transactions on Modeling and Computer Simulation* journal. He has served on the organizing committees for several leading conferences in the parallel and distributed simulation area.

# Keynotes Information

**ABSTRACT: Cloud-based Simulation for Manufacturing and Engineering**

**AUTHOR:** Dr. Simon J. E. Taylor
**LOCATION:** AUDUBON II B/C
**TIME:** 11:15am –12:00pm
**DAY:** Monday, April 14, 2014

**SHORT BIO:**

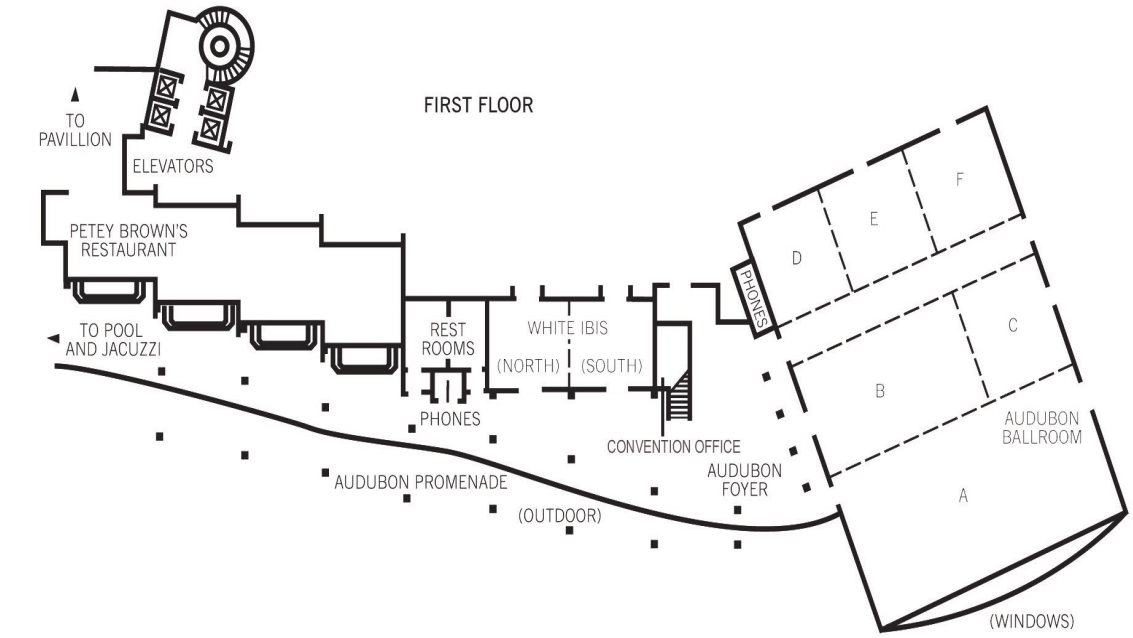
**Simon J E Taylor** (PhD) is the Editor-in-Chief of the Journal of Simulation and is the Chair of the COTS Simulation Package Interoperability Standards Group under the Simulation Interoperability Standards Organization. He was Chair of ACM's SIGSIM (2005-2008) and is a member of the SIGSIM Steering Committee. He is a Reader in the Department of Information Systems and Computing at Brunel and is the head of the ICT Innovation Group. He has published over 150 articles in modelling and simulation. His research has had significant impacts on industrial practice in distributed simulation, high speed simulation and web-based simulation. His recent work has focused on the development of standards for distributed simulation and grid- and cloud-based simulation in industry (www.CloudSME.eu), the creation of the first African e-Infrastructure for e-Science (www.ei4Africa.eu), and convening a new phase of Grand Challenges for Modeling and Simulation. His email address is <simon.taylor@brunel.ac.uk> and his web page is www.brunel.ac.uk/~csstsjt.

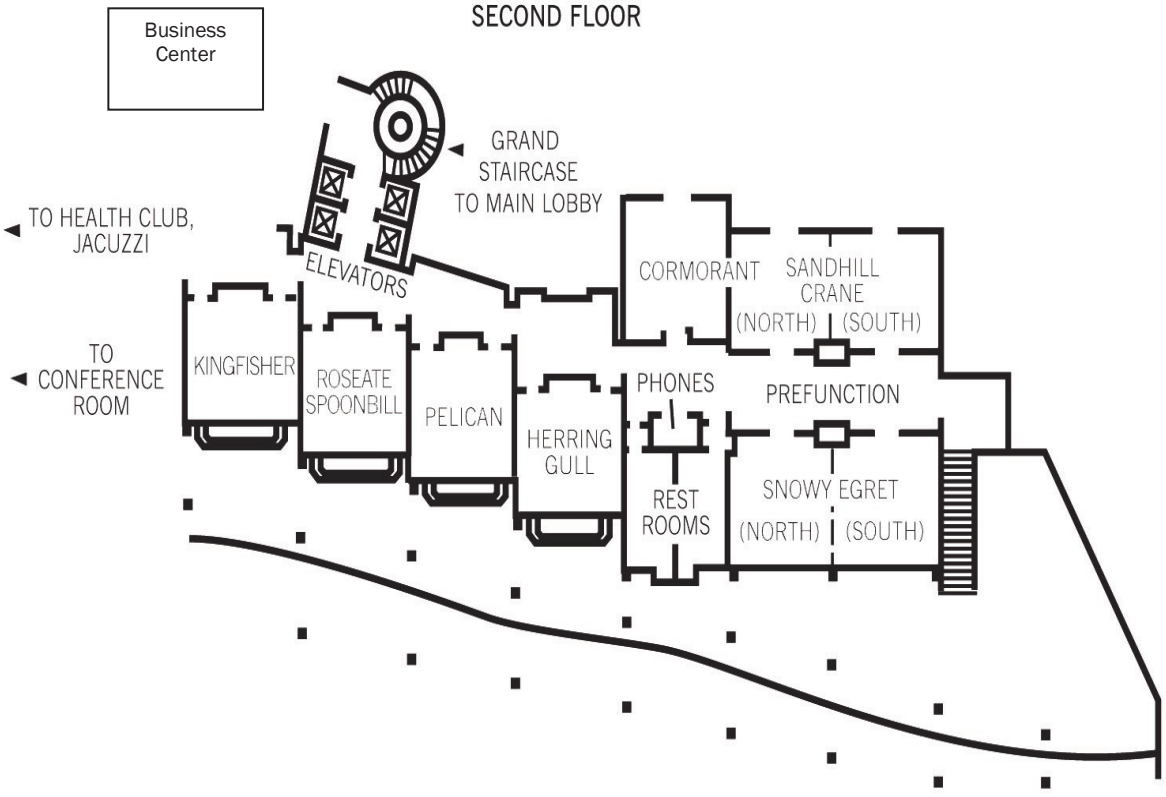
# Notes

# Notes

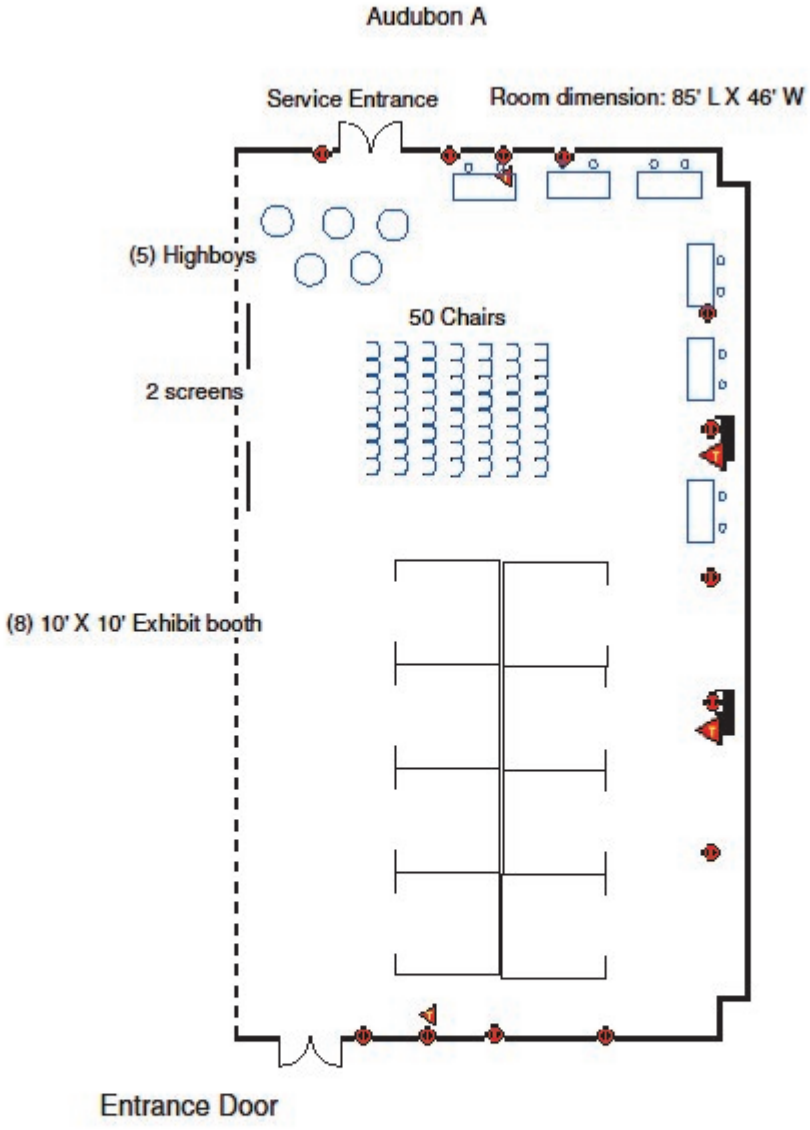
# MAPS

# Hotel Map


FIRST FLOOR
TO PAVILLION
ELEVATORS
PETEY BROWN'S RESTAURANT
TO POOL AND JACUZZI
REST ROOMS
WHITE IBIS
(NORTH)
(SOUTH)
PHONES
CONVENTION OFFICE
AUDUBON PROMENADE
(OUTDOOR)
AUDUBON FOYER
PHONES
D
E
F
C
B
A
AUDUBON BALLROOM
(WINDOWS)

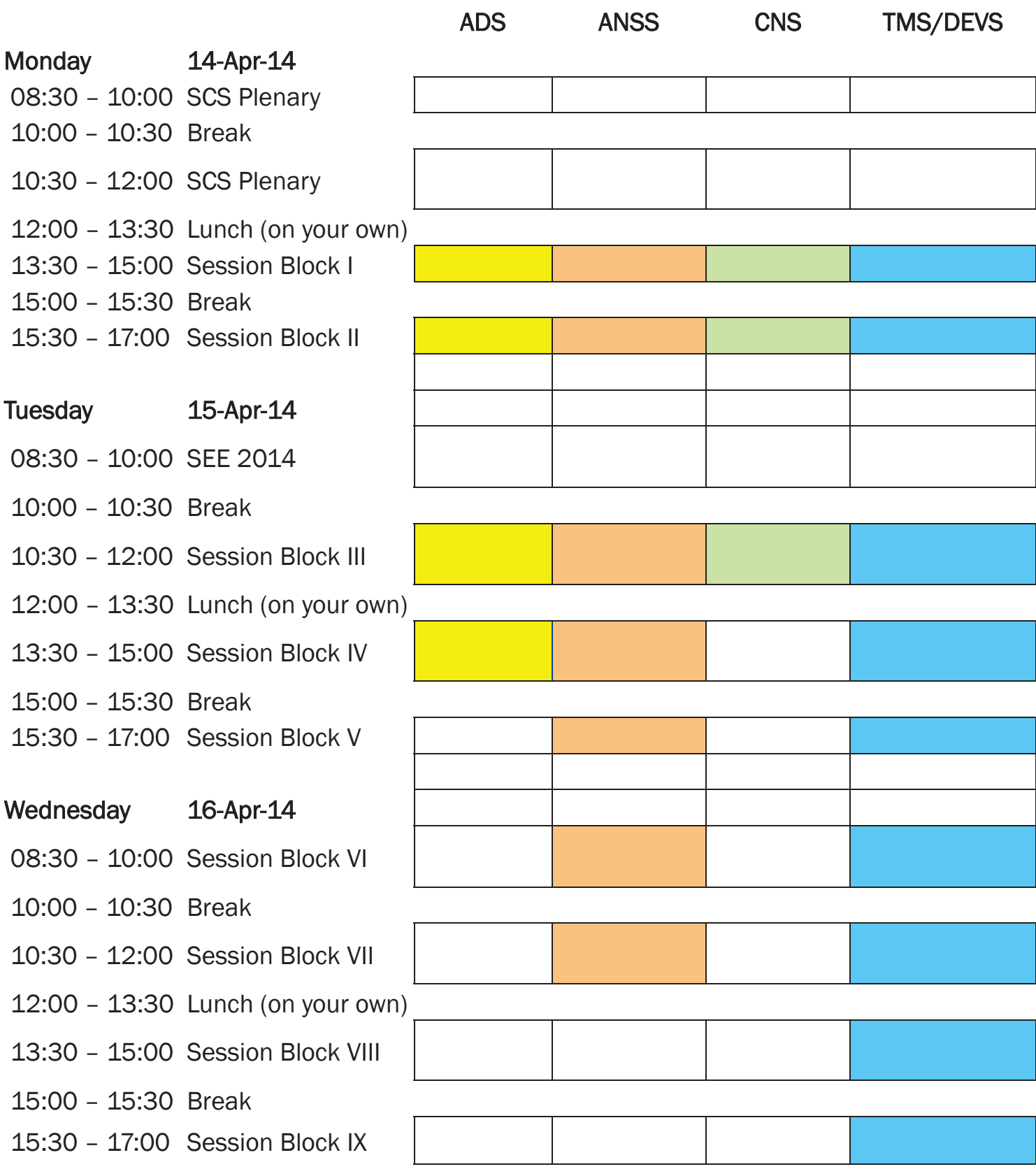

SECOND FLOOR
Business Center
GRAND STAIRCASE TO MAIN LOBBY
TO HEALTH CLUB, JACUZZI
ELEVATORS
CORMORANT
SANDHILL CRANE
(NORTH)
(SOUTH)
TO CONFERENCE ROOM
KINGFISHER
ROSEATE SPOONBILL
PELICAN
HERRING GULL
PHONES
PREFUNCTION
REST ROOMS
SNOWY EGRET
(NORTH)
(SOUTH)

# Audubon Map



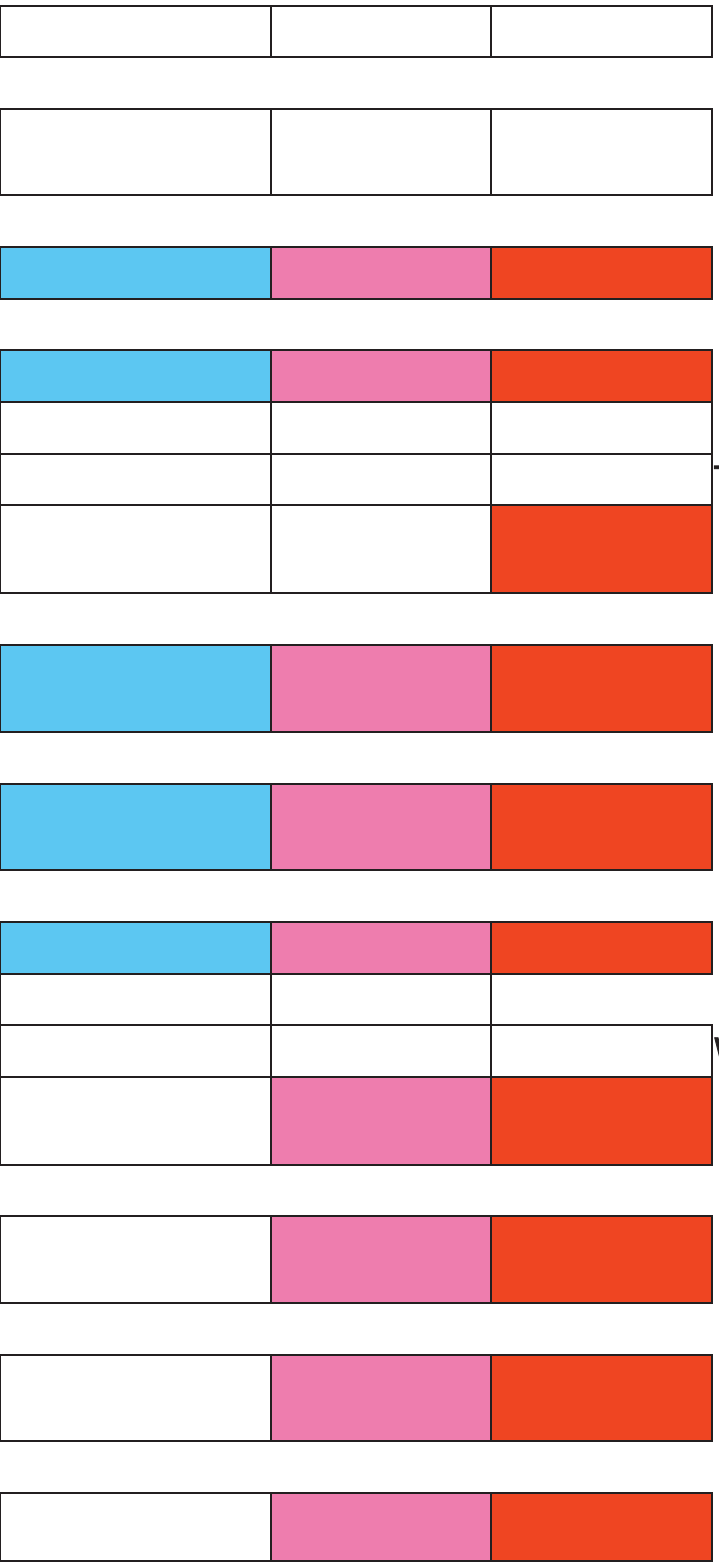

Registration outside room

# SpringSim'14 At A Glance Sessions




*Posters will be on display during breaks Monday 8:00am – 17:00pm, Tuesday 8:00am – 17:00pm,

# SpringSim'14 At A Glance Sessions




| | | |
|---|---|---|
| **Monday** | **14-Apr-14** | |
| 08:30 -10:00 | SCS Plenary | |
| 10:00 - 10:30 | Break | |
| 10:30 12:00 | SCS Plenary | |
| 12:00 - 13:30 | Lunch (on your own) | |
| 13:30 - 15:00 | Session Block I | |
| 15:00 - 15:30 | Break | |
| 15:30 - 17:00 | Session Block II | |
| **Tuesday** | **15-Apr-14** | |
| 08:30 - 10:00 | SEE 2014 | |
| 10:00 - 10:30 | Break | |
| 10:30 - 12:00 | Session Block III | |
| 12:00 - 13:30 | Lunch (on your own) | |
| 13:30 - 15:00 | Session Block IV | |
| 15:00 - 15:30 | Break | |
| 15:30 - 17:00 | Session Block V | |
| **Wednesday** | **16-Apr-14** | |
| 08:30 - 10:00 | Session Block VI | |
| 10:00 - 10:30 | Break | |
| 10:30 - 12:00 | Session Block VII | |
| 12:00 - 13:30 | Lunch (on your own) | |
| 13:30 - 15:00 | Session Block VIII | |
| 15:00 - 15:30 | Break | |
| 15:30 - 17:00 | Session Block IX | |

, and Wednesday, 8:00am – 15:00pm

# Notes

# AGENDAS

# Agent-Directed Simulation (ADS)

# Agenda

## Monday, 14 April 2014

**Session I 13:30 – 15:00 Room: Roseate Spoonbill Session Chair: Greg Madey**

- A Composable PRS-based Agent Meta-Model for Multi-agent Simulation Using the DEVS Framework (*Mingxin Zhang and Alexander Verbraeck)*
- *Simulation Experiment of Routing Strategy for Evacuees and Disaster Responders (SeHoon Lee, Jang Won Bae, JunSeok Lee, Jeonghee Hong and Il-Chul Moon)*
- *A Methodology for Environment and Agent Development for Modeling Population Displacement (John Sokolowski and Catherine Banks)*

**Session II 15:30 – 17:00 Room: Roseate Spoonbill Session Chair: Jonathan Hood**

- *A Simulation Framework for Design-Oriented Studies of Interaction Models in Agent Teamwork (Omid Alemi, Desanka Polanjnar, Jernej Polajnar and Denish Mumbaiwala)*
- *Sampo: An Agent-based Mosquito Point Model in OpenCL (Klaus Kofler, Gregory Davis and Sandra Gesing)*
- *Decentralized K-Means Clustering with MANET Swarms (Ryan McCune and Greg Madey)*

## Tuesday, 15 April 2014

**Session III 10:30 – 12:00 Room: Roseate Spoonbill Session Chair: Greg Madey**

- *We Didn't Start the Fire: Using an Agent-Directed Thermal Simulator to Keep Servers Cool (Jonathan Hood, Timothy Scott, Jiao Yu, Xiao Qin, Levent Yilmaz and Drew Hamilton)*
- *Toward a Spatial Agent-Based Prediction Market: Would the Spatial Distribution of Information Matter? (Bin-Tzong Chie and Shu-Heng Chen)*
- *Strategic Evolution of Adversaries Against Temporal Platform Diversity Active Cyber Defenses (Michael Winterrose and Kevin Carter)*

**Session IV 13:30 – 15:00 Room: Roseate Spoonbill Session Chair: Greg Madey**

- *Agent Based Modeling of Consumer Choice and Aggregate Demand: Maximizers vs Satisficers (Omid Roozmand and DG Webster)*
- *An Agent for Simulating Cognitive Impairment in Elders (Work in Progress) (Chris Wilson)*
- *Optimizing Leader Proportion and Behavior for Evacuating Buildings (Paul McCormack and Tzu-Yi Chen)*

- *How to Model the "Human Factor" for Agent-Based Simulation in Social Media Analysis? (Work in Progress) (Fabian Lorig and Ingo Timm)*

# 47th Annual Simulation Symposium (ANSS)

# Agenda

## Monday, 14 April 2014

**Session I 13:30 – 15:00 Room: Snowy Egret North Session Chair: Shafagh Jafer**

- *Assessing Instructional Strategies for Training Robot-Aided ISR Tasks in Simulated Environments (Stephanie Lackey and Julie Salcedo)*
- *Human Behavior Simulation For Complex Scenarios Based On Intelligent Agents (Agostino Bruzzone, Marina Massei, Francesco Longo, Simonluca Poggi, Matteo Agresta, Christian Bartolucci and Letizia Nicoletti)*
- *OSM: An Evolutionary System of Systems Framework for Modeling and Simulation (Clinton Winfrey, Benjamin Baldwin, Mary Ann Cummings and Preetam Ghosh)*

**Session II 15:30 – 17:00 Room: Snowy Egret North Session Chair: Saikou Diallo**

- *System of Systems based Approaches to Global Simulation in Africa (Adedoyin Adegoke and Mamadou K. Traore)*
- *Make eXperience Count: Use the Experience Application Programming Interface for More Efficient Learning Management Systems (Invited Paper) (George Stone, William Gerber and Perakath Benjamin)*
- *Sustainability of a Growing Higher Education Institution: a Simulation Approach to Analyze the Dynamics of Campus Parking Lots (Work in Progress) (Anatoly Kurkovsky)*

## Tuesday, 15 April 2014

**Session III 10:30 – 12:00 Room: Snowy Egret North Session Chair: Mohammad Moallemi**

- *On The Generalization Of Continuous-Time Stochastic Processes Simulation For Industrial Production Modeling (Fabio Bursi, Andrea Ferrara, Andrea Grassi and Chiara Ronzoni)*
- *Distributed Reactive Simulation (Work in Progress) (Robert Kewley and Joseph McDonnell)*
- *Biodiesel Sim: Crowdsourcing Simulations for Complex Model Analysis (Derek Riley, Xiaowei Zhang and Xenofon Koutsoukos)*

**Session IV 13:30 – 15:00 Room: Snowy Egret North Session Chair: Jose Padilla**

- *Evaluating Pricing Options at a Museum by Simulation (Murat M. Gunal and H. Kemal Sezen)*
- *A Simulation-based Framework for the Generation and Evaluation of Traffic Management Strategies (Vinh An Vu, Giho Park, Gary Tan and Moshe Ben-Akiva)*
- *A Journal Profiling and Co-citation Study of Simulation: The Transactions of the Society for Modeling and Simulation International (Invited Paper) (Navonil Mustafee, Korina Katsaliaki and Paul Fishwick)*

## Tuesday, 15 April 2014

**Session V 15:30 – 17:00 Room: Snowy Egret North Session Chair: Shafagh Jafer**

- *Solving Instability Problem in Soft Body Dynamics (Jaruwan Mesit)*
- *Development of a Marked Structure for Workload Traces of Parallel and Distributed Systems (Diogo Silva, Aleardo Manacero, Renata Lobato, Denison Menezes and Roberta Spolon)*
- *Modeling and Simulation of Electricity Generated by Renewable Energy Sources for Complex Energy Systems (Marco Pruckner and Reinhard German)*

## Wednesday, 16 April 2014

**Session VI 8:30 – 10:00 Room: Snowy Egret North Session Chair: Harry Johnson**

- *Unsupervised Model Generation for Geological Events (Work in Progress) (Joaquim Assuncao, Paulo Fernandes, Tiago Fischer and Afonso Sales)*
- *Leveraging Social Media Data in Agent-based Simulations (Invited Paper) (Jose Padilla, Saikou Diallo, Hamdi Kavak, Olcay Sahin and Brit Nicholson)*
- *Cloud Computing for Simulation in Manufacturing and Engineering: Introducing the CloudSME Simulation Platform (Simon J. E. Taylor, Tamas Kiss, Gabor Terstyanszky, Peter Kacsuk and Nicola Fantini)*

**Session VII 10:30 – 12:00 Room: Snowy Egret North**

- *Panel Discussion:* Cloud Standards *(Simon J. E. Taylor (Brunel, UK) Saikou Diallo (Old Dominion University) and Harry Johnson (Old Dominion University)*

# 17th Communications and Networking Symposium (CNS)

# Agenda

## Monday, 14 April 2014

**Session I 13:30 – 15:00 Room: Pelican Session Chair: Abdolreza Abhari**

**TOPIC: Big Data and Social Networks**

- *CNS Welcome by CNS General Chair*
- *DarknetSim– A Simulation Framework for Social Overlays (Patrick Weizel, Stefanie Roos, Andreas Hofer and Thorsten Strufe)*
- *Applying Supervised Learning Algorithms on Information Derived from Social Network to Enhance Recommender Systems (Hesaneh Behzadfar, and Abdolreza Abhari)*

**Session II 15:30 – 17:00 Room: Pelican Session Chair: Aftab Ahmad**

**TOPIC: Network Simulation**

- *Twitter Simulation using Multi Agent Systems (or Distributed Recommender System Using Multi Agents) (Lubaid Ahemd and Abdolreza Abhari)*
- *A GPU-Accelerated Physical Layer for Simulating Wireless Networks (Robert Konrad, Benjamin Hamilton and Bow-Nan Cheng)*
- *Unified Metric Calculation of Sampling-Based Turbo-coded Noncoherent MFSK for Mobile Channel (Mona Nasseri, Junghwan Kim and Mansoor Alam)*

## Tuesday, 15 April 2014

**Session III 10:30 – 12:00 Room: Pelican Session Chair: Hala ElAarag**

**TOPIC: Network Security**

- *A Bayesian Game Approach to Coexistence with Malicious and Selfish Nodes in Wireless Ad-Hoc Networks (James Roles, Hala ElAraag and Errich Friedman)*
- *Threat Modeling for Aircraft Access to National Airspace System Wide Information Management Program (Mohammad Moallemi, Remzi Seker, Massood Towhidnejad, Janathan Standley, Robert Klein and Paul Jackson)*
- *Anti-Spoofing Cooperative Localization in Cellular Networks (Thabet Mismar, Junghwan Kim and Mansoor Alam)*

## Notes

# Symposium on Theory of Modeling & Simulation - DEVS (TMS/DEVS)

# Agenda

## Monday, 14 April 2014

**Session I 13:30 – 15:00 Room: Sandhill Crane North Session Chair: Helena Szcerbicka**

- *Optimization Based on Dynamic and Hybrid Metaheuristics via DEVS Simulation (Bastien Poggi, Jean-Francois Santucci and Thierry Antoine-Santoni)*
- *Expanding DEVS and SES Applicability: Using M&S Kernels within IT Systems (Chungman Seo, Wontae Kang, Bernard P. Zeigler and Doohwan Kim)*
- *Context Activity Selection and Scheduling in Context-driven Simulation (Jae Woong Lee, Abdelsalam Helal, Yunsick Sung and Kyungeun Cho)*

**Session II 15:30 – 17:00 Room: Sandhill Crane North Session Chair: Andrea D'Ambrogio**

- *Simulation Optimization of Police Patrol District Design Using an Adjusted Simulated Annealing Approach (Yue Zhang and Donald Brown)*
- *The Peace Game: A Software-Based Model for Understanding the Complexities of Modern Conflict at the strategic Level (Matthew Powers, Jeff Appleget and Danny Heerlein)*
- *Simulation of Aircraft Boarding Strategies with Discrete-Event Cellular DEVS (Shafagh Jafer and Wei Mi)*

## Tuesday, 15 April 2014

**Session III 10:30 – 12:00 Room: Sandhill Crane North Session Chair: Gabriel Wainer**

- *Geometric Algorithms and Data Structures for Simulating Diffusion Limited Reactions (Shaun Bloom, Shuang Luan, Mathieu Karamitros and Sebestien Incerti)*
- *Efficient Matrix-Exponential Random Variate Generation using a Numeric Linear Combination Approach (M. Todd Gardner, Appie van de Liefvoort and Cory Beard)*
- *Modeling Attention Switching in Resource-constrained Complex Intelligent Dynamical Systems (RCIDS) (Saurabh Mital and Bernard Zeigler)*

**Session IV 13:30 — 15:00 Room: Sandhill Crane North Session Chair: Hessam Sarjoughian**

- *A Highly Efficient Simulation Core in C++ (Andreas Blunk and Joachim Fischer)*
- *Timed Synchronizing Sequences (Norbert Giambiasi and Claudia Frydman)*
- *Fenix: A Framework for Power System and Communication Networks Co-Simulation (Selim Ciraci, Jeff Daily, Jason Fuller, Andrew Fisher, Laurentiu Marinovici and Khushbu Agarwal)*

**Session V 15:30 – 17:00 Room: Sandhill Crane North Session Chair: Andrea D'Ambrogio**

- *Rule-Based Model Transformation For and In Simulink (Joachim Denil, Pieter Mosterman and Hans Vangheluwe)*
- *Computational Fluid Dynamic Solver Based on Cellular Discrete-Event Simulation (Michael Van Schyndel and Gabriel Wainer)*

# Symposium on Theory of Modeling & Simulation - DEVS (TMS/DEVS)

# Agenda

## Wednesday, 16 April 2014

**Session VI 8:30 – 10:00 Room: Sandhill Crane North Session Chair: Fernando Barros**

- *The Modular Architecture of the Python (P) DEVS Simulation Kernel (Yentl Van Tendeloo and Hans Vangheluwe) (Work in Progress)*
- *DEVS-Ruby: A Domain Specific Language for DEVS Modeling and Simulation (Romain Franceschini, Paul-Antoine Bisgambiglia, and David Hill) (Work in Progress)*
- *DEV-Based Case Management (Shaowei Wang and Mamadou Traore)*
- *A Simulation-Based Model for a Multi-Domain GMPLS Based IP-over-Optical Network Using the OMNeT++Platform (Saud Albarrak) (Work in Progress)*

**Session VII 10:30 – 12:00 Room: Sandhill Crane North Session Chair: Norbert Giambiasi**

- *Temporal Capabilities in Support of Conceptual Process Modeling using Object-Role Modeling (Daniele Gianni, Paolo Bocciarelli and Andrea D'Ambrogio) (Work in Progress)*
- *An Analytical Method or Assessing the Effectiveness of Human in the Loop Simulation Environments: (Glenn Hodges, Rudolph Darken and Michael McCauley) (Work in Progress)*
- *Lessons Learned from Independent Verification and Validation of Models and Simulations (James Elele, David Hall, Allie Farid, David Turner, Mark Davis, and David Keyser) (Work in Progress)*
- *A Compact and Flexible C++ Framework to Support Modular Development of Hierarchical Dynamic Systems Simulators (Adauto Luiz Mancini, Luis Gustavo Barioni, Hemerson Nobre Lima, Jefferson William Santos, Rodrigo Dias Ribeiro Silva, Edgard Henrique Santos and Fernando Rodrigues Teixeira Dias) (Work in Progress)*

**Session VIII 13:30 – 15:00 Room: Sandhill Crane North Session Chair: Moon Ho Hwang**

- *Taxonomy of DEVS Variants (Moon Ho Hwang) (Work in Progress)*
- *Heterogeneous DEVS Simulations with Connectors and Reo Based Compositions (Ahmet Kara, Halit Oguztuzun and M. Nedim Alpdemir) (Work in Progress)*
- *A Study on Effective Operations of Sound Underwater Signal Using DEVS Modeling and Simulation (Min Kwak and Chungman Seo) (Work in Progress)*
- *DEVS-Based Scenario Manager of Multibody Dynamics Simulator for Shipbuilding Production Process (Sol Ha, Namkug Ku, Myung-Il Roh, Ki Su Kim, Jung-woo Hong, Xing Li, and Hyewon Lee) (Work in Progress)*

**PHD Sessions 15:30 – 16:30 Room: Sandhill Crane North Session Chair: Claudia Frydman**

# Symposium on Theory of Modeling & Simulation - DEVS 2 (TMS/DEVS)

# Agenda

## Monday, 14 April 2014

**Session I 13:30 – 15:00 Room: Sandhill Crane South Session Chair: Hans Vangheluwe**

- *Dynamic Data Driven Simulation with Soft Data (Yuan Long and Xiaolin Hu)*
- *Explicit Modelling of Casual Block Diagram Simulation Environments (Hans Vangheluwe, Daniel Riegelhaupt, Sadaf Mustafiz, Joachim Denil and Simon Van Mierlo)*
- *Stochastic Hierarchical Simulation (Leandro Watanabe and Chris Myers)*

**Session II 15:30 – 17:00 Room: Sandhill Crane South Session Chair: Gregory Zacharewicz**

- *Semantic Mashups for Simulation as a Service with Tag Mining and Ontology Learning (Sixuan Wang and Gabriel Wainer)*
- *On the Representation of Dynamic Topologies: The Case for Centralized and Modular Approaches (Fernando Barros)*

## Tuesday, 15 April 2014

**Session III 10:30 – 12:00 Room: Sandhill Crane South Session Chair: Halit Oguztuzun**

- *Empowering Business Process Simulation Through Automated Model Transformations (Paolo Bocciarelli, Andrea D'Ambrogio, Andrea Giglio, Emiliano Paglia and Daniele Gianni)*
- *Business Process Simulation: Transformation of BPMN 2.0 to DEVS Models (Hassan Bazoun, Youssef Bouanan, Gregrory Zacharewicz, Yves Ducq and Hadrien Boye)*
- *RAMASAS4Modelica: A Simulation-driven Method for System Dependability Analysis centered on the Modelica language and related tools (Alfredo Garro and Andrea Tundis)*

**Session IV 13:30 - 15:00 Room: Sandhill Crane South Session Chair: Andrea D'Ambrogio**

- *High Level Modeling of Elastic Circuits in SystemC (Mohamed Ammar Ben Khadra, Yu Bai and Klaus Schneider)*
- *Generation of Co-simulation Compliant Functional Mock-up Units From Simulink, Using Explicit Computational Semantics (Bart Pussig, Joachim Denil, Paul De Meulenaere and Hans Vangheluwe)*

# Symposium on Theory of Modeling & Simulation - DEVS 2 (TMS/DEVS)

## Agenda

## Tuesday, 15 April 2014

**Session V 15:30 – 17:00 Room: Sandhill Crane South Session Chair: Gregory Zacharewicz**

- *Toward Model-Driven Engineering Principles and Practices for Model Replicability and Experiment Reproducibility (Joseph Ledet, Alejandro Teran-Somohano, Zachary Butcher, Levent Yilmaz, Alice Smith, Halit Oguztuzun, Orcun Dayibas and Bilge Kaan Gorur) (Work in Progress)*
- *Sprat: Hierarchies of Domain-Specific Languages for Marine Ecosystem Simulation Engineering (Arne Johanson and Wilhelm Hasselbring) (Work in Progress)*
- *A Model-based Approach to Modeling a Hybrid Simulation Platform (Asli Soyler Akbas, Konstantinos Mykoniatis, Anastasia Angelopoulou and Waldemar Karwowski) (Work in Progress)*
- *How to Avoid Model Interferences for Test-driven Agile Simulation based on Standardized UML Profiles (Vitali Schneider, Anna Yupatova, Winfried Dulz and Reinhard German) (Work in Progress)*

# 22nd High Performance Computing Symposia (HPC)

# Agenda

## Monday, 14 April 2014

**Session I 13:30 – 15:00 Room: Cormorant Session Chair: Karl Rupp**

- *GPU Virtualization for High Performance General Purpose Computing on ESX Hypervisor (Lan Vu, Hari Sivaraman and Rishi Bidarkar)*
- *Beat-based Parallel Simulated Annealing Algorithm on GPGPUs for the Mirrored Traveling Tournament Problem (Saurabh Jha and Vijay Menon)*
- *CufftShift: High Performance CUDA-accelerated FFT-Shift Library (Marwan Abdellah)*

**Session II 15:30 – 17:00 Room: Cormorant Session Chair: Karl Rupp**

- *Efficient Parallel Image Clustering and Search on a Heterogeneous Platform* ****Winner, HPC Best Paper**** *(Dong Ping Zhang, Lifan Xu and Lee Howes)*
- *Multiobjective Optimization Using Direct Search Techniques (Shubhangi Deshpande and Layne Watson)*
- *PseudoNUMA for Reducing Memory Interference in Multi-core Systems (Gangyong Jia, Jian Wan, Xi Li, Dong Dai and Chao Wang)*

## Tuesday, 15 April 2014

**Session III 10:30 – 12:00 Room: Cormorant Session Chair: William Thacker**

- *Tracking constrained clustering solutions with a probability-one homotopy map (David Easterling, Layne Watson and Naren Ramakrishnan)*
- *A New Highly Parallel Non-Hermitian Eigensolver (Ping Tak Peter Tang, James Kestyn and Eric Polizzi)*
- *Fortran 95 implementation of QNSTOP for global and stochastic optimization (Brandon Amos, David Easterling, Layne Watson, Brent Castle, Michael Trosset and William Thacker)*

**Session IV 13:30 – 15:00 Room: Cormorant Session Chair: Layne Watson**

- *Parallel Cooperating Ant Colonies with Improved Periodic Exchange Strategies (Bishad Ghimire, David Cohen and Ausif Mahmood)*
- *A Characterisation of the Workload on an Engineering Design Grid (Andrew Burkimsher, Iain Bate and Leandro Soares Indrusiak)*
- *A Performance study of InfiniBand Fourteen Data Rate (FDR) (Qian Liu and Robert Russell)*

**Session V 15:30 – 17:30 Room: Comorant Session Chair: Masha Sosonkina**

- *Monte Carlo Methods and Partial Differential Equations: Algorithms and Implications for High-Performance Computing-Invited Presentation (Michael Mascagni)*
- Accelerated Design Space Pruning for CMP Memory Architectures (Work in Progress) (Hadrien Clarke, Antoine Trouve and Kazuaki Murakami)

## Wednesday, 16 April 2014

**Session VI 8:30 – 10:00 Room: Cormorant Session Chair: William Thacker**

- *American Basket Option Pricing on a multi GPU Cluster (Michael Benguigui and Francoise Baude)*
- *Fast Radix Sort for Sparse Linear Algebra on GPU (Lukas Polok, Viorela Ila and Pavel Smrz)*
- *Solving 3D incompressible Navier-Stokes equations on hybrid CPU/GPU systems (Yushan Wang, Marc Baboulin, Karl Rupp, Olivier Le Maitre and Yann Fraigneau)*

**Session VII 10:30 – 12:00 Room: Cormorant Session Chair: Layne Watson**

- *Autonomous Control of Issue Queue Utilization for Simultaneous Multi-Threading Processors (Yilin Zhang and Wei-Ming Lin)*
- *A High-Level Programming Model to Ease Pipeline Parallelism Expression on Shared Memory Multi-core Architectures (Nader Khammassi and Jean-Christophe Le Lann)*
- *Cache Matching: Thread Scheduling to Maximize Data Reuse (Wei Zhang, Fang Liu and Rui Fan)*

**Session VIII 13:30 – 15:00 Room: Cormorant Session Chair: Masha Sosonkina**

- *Deterministic Partitioning Strategy to Parallelize the Constraint Programming Search Space (Tarek Menouer and Bertrand Le Cun)*
- *Energy Measurement and Prediction for Multi-threaded Programs (Thomas Rauber, Gudula Runger and Michael Schwind)*
- *DVFS and Duplication based scheduling for optimizing Power and Performance in heterogeneous multiprocessors (Jagpreet Singh and Nitin Auluck)*

**Session IX 15:30 – 17:00 Room: Cormorant Session Chair: Karl Rupp**

- *Accelerating Option Risk Analytics in R using GPUs (Matthew Dixon, Sabbir Khan and Mohammad Zubair)*
- *Multi-GPU/CPU Deflated Preconditioned Conjugate Gradient for bubbly flow solver (Rohit Gupta, Martin B. van Gijzen and Kees Vuik)*
- *A Large-Scale Mobile Facial Recognition System using Embedded GPUs (Ahmed El-Mahdy and Radwa Elsersy)*

# Symposium on Simulation for Architecture and Urban Design (SimAUD)

# Agenda

## Monday, 14 April 2014

**Session I 13:30 – 15:00 Room: Herring Gull Chair: David Gerber**

- *SimAUD Welcome (David Gerber)*
- *SimAUD Keynote 1: **Simulating Human Behavior in Built Environments** (Yehuda Kalay)*
- *Prototyping Interactive Nonlinear Nano-to-Micro Scaled Material Properties and Effects at the Human Scale (Jenny Sabin, Andrew Lucia, Giffen Ott and Simin Wang)*

**Session II 15:30 – 17:00 Room: Herring Gull Chair: Rhys Goldstein**

- *Parametric Spatial Models for Energy Analysis in the Early Design Stages (Wassim Jabi)*
- *Simulation Supported Precedent Analysis: Disclosing the Sustainable Attributes of Vernacular Structures in the Southern U.S. (Tim Frank)*
- *SimAUD Keynote 2: **Elastic Matters: The Role of Simulation and Visualization in Trans-disciplinary Research** (Jenny Sabin)*

# Symposium on Simulation for Architecture and Urban Design (SimAUD)

# Agenda

## Tuesday, 15 April 2014

**Beginning Session 8:30 – 10:00 Room: Herring Gull Chair: Yehuda Kalay**

- *SAFEgress: A Flexible Platform to Study the Effect of Human and Social Behaviors on Egress Performance (Mei Ling Chu, Paolo Parigi, Kincho Law and Jean-Claude Latombe*
- *Using Agent-Based Modelling to Simulate Occupants' Behaviour in Response to Summer Overheating (Alaa Alfakara and Ben Croxford)*
- *Towards Visualization of Simulated Occupants and their interactions with Buildings at Multiple Time Scales (Simon Breslav, Rhys Goldstein, Alex Tessier and Azam Khan)*

**Session III 10:30 – 12:00 Room: Herring Gull Chair: Johannes Braumann**

- *Tangible 3D Urban Simulation Table (Flora Salim)*
- *Typologies of Architectural Interaction: A Social Dimension (Seoug Oh, Veronica Patrick and Daniel Cardoso Llach)*
- *Designing Fluvial Sites: Digitally Augmented Physical Hydraulic Modeling (Alexander Robinson)*

**Session IV 13:30 – 15:00 Room: Herring Gull Chair: Daniel Cardoso Llach**

- *Parameters Tell the Design Storey: Ideation and Abstraction in Design Optimization (Erin Bradner, Francesco Iorio and Mark Davis)*
- *Genetic Based Form Exploration of Mid-Rise Structures Using Cell Morphologies (Omid Oliyan Torghabehi and Peter von Buelow)*
- *Design Agency: Prototyping Multi-Agent System Simulation for Design Search and Exploration (David Jason Gerber, Rodrigo Shiordia, Sreerag Veetil Palangat, Arjun Mahesh)*

**Session V 15:30 – 17:00 Room: Herring Gull Chair: Erin Bradner**

- *Visual Robot Programming—Linking Design, Simulation, and Fabrication (Johannes Braumann and Sigrid Brell-Cokcan)*
- *A Freeform Surface Fabrication Method with 2D Cutting (Andres Sevtsuk and Raul Kalvo)*
- *Design-Friendly Strategies for Computational Form-Finding of Curved-Folded Geometries: A Case Study (Shajay Bhooshan, Mustafa El Sayed and Suryansh Chandra)*

## Wednesday, 16 April 2014

**Session VI** **8:30 – 10:00** **Room: Herring Gull** **Chair: Alex Tessler**

- *Tensegrity Systems Acting as Windbreaks: Form Finding and Fast Fluid Dynamics Analysis to Address Wind Funnel Effect (Panagiota Athanallidi, Ava Fatah gen Schieck, Vlad Tenu and Angelos Chronis)*
- *Optimizing the Form of Tall Buildings to Achieve Minimum Structural Weight by Considering Along Wind Effect (Matin Alaghmandan, Mahjoub Elnimeiri, Anders Carlson and Robert Krawczyk)*
- *Approximating Urban Wind Interference (Samuel Wilkinson, Gwyneth Bradbury and Sean Hanna)*

**Session VII** **10:30 – 12:00** **Room: Herring Gull** **Chair: Flora Salim**

- *Comparison of Control Strategies for Energy Efficient Building HVAC Systems (Mehdi Massoumy and Alberto Sangiovanni Vincentelli)*
- *Causality in Hospital Simulation based on Utilization Chains (Gabriel Wurzer and Wolfgang E. Lorenz)*
- *Full-Automated Acquisition System for Occupancy and Energy Measurement Data Extraction (Dimosthenis Ioannidis, Stellios Krindis, Georgios Stavropoulos, Dimitrios Tzovaras and Spiridon Likothanassis)*

**Session VIII** **13:30 – 15:00** **Room: Herring Gull** **Chair: Shajay Bhooshan**

- *Experimental Design of Energy Performance Simulation for Building Envelopes Integrated with Vegetation (Work in Progress) (Xiao Sunny Li, Ultan Byrne and Ted Kesik)*
- *Transit-Oriented Development (TOD): Analyzing Urban Development and Transformation in Stockholm (Todor Stojanovski, Tesad Alam and Marcus Janson)*
- *Scenario Modeling for Agonistic Urban Design (Trevor Patt and Jeffrey Huang)*

**Session IX** **15:30 – 17:00** **Room: Herring Gull** **Chair: Azam Khan**

- *Acacia: A Simulation Platform for Highly Responsive Smart Facades (Daniel Cardoso Llach, Avni Argun, Dimitar Dimitrov and Qi Ai)*
- *Sustainability Performance Evaluation of Passivhaus in Cold Climates (Work in Progress) (Kyoung-Hee Kim, Seung-Hoon Han)*

# Poster Session and Student Colloquium

# Agenda

**Posters will also be on display during breaks Monday (8:00am – 17:00pm), Tuesday (8:00am – 17:00pm) and Wednesday (8:00am – 15:00pm) in Audubon III/A**

## Sunday, 13 April 2014

**Session I 08:40 – 10:00 Room: Herring Gull Session Chair: Shafagh Jafer**

- *A Virtual Crowd-Sourcing Approach for Pedestrian Simulation (Eric Kolstad)*
- *Decentralized K-Means for MANET Swarms (Ryan McCune and Greg Madey)*
- *Development of Correlated Terrain Databases for Simulation and Command and Control Systems (Maher Ali, Cody Kester, Stuart Topp and Wesley Trumbauer)*
- *Development of Smart Micro-Grid in Energy Efficiency Technologies on Workplace Level (Shahryar Habibi)*

**Session II 10:40 – 12:00 Room: Herring Gull Session Chair: Mohammad Moallemi**

- *A System-theoretic Approach to Case Management (Shaowei Wang and Mamadou Traore)*
- *Simulation Analysis for Squad Technologies (Nolan Anderson, John Burk, Nicholas Miles and Charles Tobin)*
- *Consideration for M&S in Africa (Adedoyin Adegoke and Mamadou K. Traore)*
- *N To P Portfolio Solver using a Learning Algorithm (Tarek Menouer and Bertrand Le Cun)*

**Session III 13:00 – 14:00 Room: Herring Gull Session Chair: Shafagh Jafer**

- *Method of Ground Weapon Effectiveness Data Estimation for Generating Combat Samples (Ahreum Kim, Youngjae Lim, Youngbo Suh, Chanwoo Park and Hyung-Kon Moon)*
- *Nondeterministic and Elapsed-Time Sensitive DEVS (Ji-Hyeon Yoon and Hae Young Lee)*
- *A Generic Layered Modeling for Cognitive Radio Networks (Syed Rizvi and Nathan Showan)*

**Session IV 17:45 – 18:30 Room: Herring Gull**

*Everybody Stands by their posters*

**Social Event at Bahama Breeze 18:30 Location: 3045 N. Rocky Point Drive, East Tampa**

# Notes

# ABSTRACTS

# Agent-Directed Simulation (ADS)

# Abstract

## A Composable PRS-based Agent Meta-Model for Multi-agent Simulation Using the DEVS Framework

*Mingxin Zhang and Alexander Verbraeck*

### Summary

This paper presents a composable cognitive agent meta-model for multi-agent simulation based on the DEVS (Discrete Event System Specification) framework. We describe an attempt to compose a PRS-based cognitive agent by merely combining "plug and play" DEVS components, show how this DEVS-based cognitive agent meta-model is extensible to serve as a higher-level component for M&S of multi-agent systems, and how the agent meta-model components are reusable to ease cognitive agent modelling development. In addition to an overview of our agent meta-model, we also describe the components of the model specification and services in detail. To test the feasibility of our design, we constructed a simulation based on a Rock-Paper-Scissors game scenario. The results of the simulation prove good benefits compared to other cognitive agent models. Our agent meta-model is novel in terms of both agent and agent components as these are all abstracted using the DEVS formalism. As different implementations of agent model components are based on the same meta-model components, all the developed agent model components can be reused in the development of other agent models which increases the composability of the agent model, and the whole cognitive agent model can be considered as a coupled model in the DEVS model hierarchy which supports multi-hierarchy modelling.

## Simulation Experiment of Routing Strategy for Evacuees and Disaster Responders

*SeHoon Lee, Jang Won Bae, JunSeok Lee, Jeonghee Hong and Il-Chul Moon*

### Summary

Under urban crisis situations, one of the most important response tasks is routing the vehicles. Such crisis initiates a massive evacuation from the disaster scene to the outside; at the same time, crisis responders have to enter the scene. Whereas we need routes for responders, current disaster response plans frequently dictates to turn bidirectional roads into one-ways to ensure quick evacuation. This routing conflict should be resolved prior to actual crises, and we approach this problem with simulation based experiments. We model and simulate the urban traffic network, the responder agents and the evacuation agents. Our major decision factor is how to choose road lane utilization to facilitate the evacuation as well as the response. We evaluate the efficiency of the route planning with responder arrivals and evacuation durations.

## A Methodology for Environment and Agent Development for Modeling Population Displacement

*John Sokolowski and Catherine Banks*

### Summary

Governmental and institutional service providers assigned to areas where involuntary or forced population movement occurs are required to provide goods and security as well as policies and strategies to distressed peoples. This type of population displacement took place on an epic scale in 2011. Modeling and simulation presents a constructive approach to critical analysis and projections needed for decision-making via the representation and characterization of distressed populations to envisage why, when, and where migration will occur. This paper presents a multi-disciplinary methodology to researching and modeling population displacement in a broad, yet inclusive sweep. An Environment Matrix and an Agent Matrix are presented that can be used as a template to develop an agent-based model to capture this phenomenon. These matrices facilitate an accurate representation of an environment and a thorough characterization of agents. The crisis in Syria serves as a use-case for matrix development. This type of agent-based modeling and analysis can proffer insight on how to prevent, hold constant, or moderate escalating effects of threats to populations in jeopardy as well as anticipate when forced migration might occur.

# Agent-Directed Simulation (ADS)

# Abstract

## SAMPO: An Agent-based Mosquito Point Model in OpenCL

*Klaus Kofler, Gregory Davis and Sandra Gesing*

### Summary

Agent-based modeling and simulations are applied for problems where population-level patterns arise from the simulation of many autonomous individuals. These problems are compute-intensive and excellent candidates for the use of parallel algorithms and architectures. As a cross-platform software development framework for parallel architectures, OpenCL appears as an ideal tool to implement such algorithms. However, OpenCL does not natively support object-oriented development, which most of the toolkits and frameworks used to build agent-based models require.

The present work describes an OpenCL implementation of an existing agent-based model, simulating populations of the Anopheles gambiae mosquito, one of the most important vectors of malaria in Africa. Discussed are the methods and techniques used to overcome the design challenges which arise when transitioning from an object-oriented program to an efficient OpenCL implementation. In particular, the parallelism inside the program has been maximized, dynamic divergent branching was reduced, and the number of data transfers between the OpenCL host and device has been minimized as far as possible.

Even though our novel data model was designed for this specific use case, the approach can be generalized to other contexts. Comparisons between the object-oriented and the OpenCL implementation illustrate that using an OpenCL approach offers two important performance benefits: an overall simulation time speedup of up to 465 with no measureable loss of accuracy, and better scalability as the agent-population size increases. The tradeoffs necessary to achieve these performance benefits and the implications for future agent-based software development frameworks are discussed.

## Decentralized K-Means Clustering with MANET Swarms

*Ryan McCune and Greg Madey*

### Summary

The development of distributed, self-organizing behavior in multi-agent systems would benefit many emerging technologies. For instance, Wireless Sensor Networks (WSN) are plagued by battery-limited system lifetimes, with recently introduced Wireless Charging Vehicles (WCV) offering a panacea. However, problems arising from centralized control, including costly communication and intensive computation, have limited implementation of effective protocols. In contrast, emergent behavior, as demonstrated in swarm intelligent systems, arises from local communication and simple computation. How to engineer applicable emergent behavior, like for WCVs in WSNs, is an open problem.
An emergent behavior is introduced that computes cluster centroids, called Decentralized K-Means Clustering. The behavior, based off of ant systems, is presented in the context of a WSN subclass where nodes are mobile, called Mobile Ad Hoc Networks (MANET). The system is robust, scalable, adaptable, computationally practical, and requires no non-local communication. Agent-based simulation presents results for supervised and unsupervised clustering.

## We Didn't Start the Fire: Using an Agent-Directed Thermal Simulator to Keep Servers Cool

*Jonathan Hood, Timothy Scott, Jiao Yu, Xiao Qin, Levent Yilmaz and Drew Hamilton*

### Summary

As energy use by datacenters has risen over the years, the costs required to run a datacenter have substantially increased. Several algorithms for thermal management and thermal-aware job placement exist; however, choosing the scheme that will most efficiently cool a datacenter can be challenging. Thermal models offer a great solution to help choose which algorithm will perform best by juxtaposing different thermal-aware algorithms. When temperatures can be observed over all servers through simulated steps, the differences and advantages of one thermal-aware algorithm over another can be deciphered. Existing thermal models, however, can be slow and may take a while to learn to use. Waiting for hours for the modeled result of one thermal-aware algorithm may mean that not as many algorithms can be compared.

Agent-Directed Thermal Modeler (ADTM) provides a solution that has a low learning curve and still quickly produces visualizations of a datacenter. It is aimed at being easy to configure while still producing very meaningful data through graphs and images. A single time-step of the simulation takes milliseconds. The graphical and pictorial output of ADTM can then be used to determine which thermal-aware algorithm works best for a given datacenter in a much shorter time than other thermal modeling approaches. ADTM is used to compare XInt-GA to random job placement in order to show that a 5% increase in energy savings is expected in an overloaded datacenter. This simulation for both algorithms takes only a few seconds, so many thermal-aware algorithms can be compared quickly in order to determine the most effective and realistic algorithm that can be chosen to cool a datacenter.

## Toward a Spatial Agent-Based Prediction Market: Would the Spatial Distribution of Information Matter?

*Bin-Tzong Chie and Shu-Heng Chen*

### Summary

In this paper, an agent-based political futures market is built upon the Schelling segregation model, in which the heterogeneity in ethnicity is replaced by the heterogeneity in political identity. A two-parameter segregation model is proposed as a first step to explore the effect of information distribution on accuracy of the prediction market.

## Strategic Evolution of Adversaries Against Temporal Platform Diversity Active Cyber Defenses

*Michael Winterrose and Kevin Carter*

### Summary

Adversarial dynamics are a critical facet within the cyber security domain, in which there exists a co-evolution between attackers and defenders in any given threat scenario. While defenders leverage capabilities to minimize the potential impact of an attack, the adversary is simultaneously developing countermeasures to the observed defenses. In this study, we develop a set of tools to model the adaptive strategy formulation of an intelligent actor against an active cyber defensive system. We encode strategies as binary chromosomes representing finite state machines that evolve according to Holland's genetic algorithm. We study the strategic considerations including overall actor reward balanced against the complexity of the determined strategies. We present a series of simulation results demonstrating the ability to automatically search a large strategy space for optimal resultant fitness against a variety of counter-strategies.

## Agent Based Modeling of Consumer Choice and Aggregate Demand: Maximizers vs Satisficers

*Omid Roozmand and DG Webster*

### Summary

In this paper we propose an agent-based model approach to determining the effects of consumer choice on aggregate demand (CCAD). Our overall goal is to better understand how the availability of information, heuristic decision making, and social norms affect: 1) total aggregate demand and 2) the aggregated demand for disposable vs. more durable goods. In the preliminary model presented here, consumer agents select among baskets of goods with different combinations of quality and disposability. Consumer choices are based on individual agent preferences and subject to a discretionary income constraint. Agents may be either maximizing, which means that they choose the best basket of goods that they can afford, or satisficing, which means that they choose the first affordable basket of goods that they can find with utility greater than their satisfaction threshold. When run at different price levels, the resulting models can be used to generate aggregated demand curves for each group of consumers. Here we show that the curves generated by the prototype CCAD ABM are downward sloping and convex and that they respond to changes in income level as would be expected by basic economic theory. We also demonstrate that, ceterus paribus, satisficers buy more than maximizers overall. Further analysis shows that this is because maximizers focus their trading on more durable products to gain the highest utility, however satisficers purchase more disposable products because they shop for convenience rather than utility maximization.

## An Agent for Simulating Cognitive Impairment in Elders (Work in Progress)

*Chris Wilson*

### Summary

Assistive technologies for cognition are designed to help elders with various forms of cognitive impairment maintain an independent style of living for as long as possible. This work discusses the use of an agent simulation to model the behaviors of an elder with dementia in an effort to facilitate preliminary operational and performance testing of emerging assistive technologies.

## How to Model the "Human Factor" for Agent-Based Simulation in Social Media Analysis? (Work in Progress)

*Fabian Lorig and Ingo Timm*

### Summary

Social networks have evolved to a key technology for information diffusion. Consequently, discourse behavior and communication dynamics have become an important research area. However, privacy settings limit data acquisition extremely, such that empirical online content and discourse analysis are hardly applicable here. Since the "human factor" mostly influences the behavior of individual actors, network analysis also provides a restricted perspective. This leads to the question: How to present the "human factor" in combination with network dynamics?

In this paper, we propose the application of agent-based simulation (ABS) and intelligent agents for analysis of information propagation in social networks. The benefit of a simulation approach is, that dynamic analysis of communication behavior as well as artificial scenarios can be produced. In contrast to conventional ABS, where agents are modeled in a reactive or stochastic way, intelligent behavior of the agents should lead to a more realistic behavior of the simulated human actors. Thus, intelligent agents should provide a comprehensive perspective on communication processes taking place in social networks. We discuss our current state of work in using a variety of psychological theories for accomplishing a representation of different personal traits and relationships between actors.

## Optimizing Leader Proportion and Behavior for Evacuating Buildings

*Paul McCormack and Tzu-Yi Chen*

### Summary

We demonstrate how to combine the Helbing Social Force Model with algorithms for facilitating collision avoidance and high-level way finding to accurately simulate the evacuation of high-occupancy buildings. Our simulation demonstrates appropriate emergent behavior and can be used to make conjectures about how leader behavior affects evacuation success. In particular, we find that an evacuee to leader ratio of 20:1 is optimal and that leaders should guide rather than lead agents out of the building. Providing leaders with real-time communication and surveillance can help them optimize evacuee flow, especially in large buildings. These results are consistent with previous research and guidelines set by the leader proportion guidelines set by the Occupational Safety and Health Administration.

## A Simulation Framework for Design-Oriented Studies of Interaction Models in Agent Teamwork

*Omid Alemi, Desanka Polajnar, Jernej Polajnar and Denish Mumbaiwala*

### Summary

This paper introduces a new software framework for design-oriented simulation studies of interaction models used in agent teamwork. The framework provides a generic simulator that can be instantiated with concrete multi-agent system (MAS) models to obtain custom simulators for specific experimental studies. The main purpose of such a custom simulator is to reduce the design decision space through feedback from experiments performed during the early stages of interaction model development. The combined emphases on design-oriented early feedback, low coupling between the MAS models and the simulation environment, openness towards external systems, extendibility, and distributed execution have resulted in a novel architecture which is the main contribution of the paper. An essential feature that facilitates early feedback is the interactive concurrent simulation of multiple teams, with immediate visualization. It enables the experimenter to control the experiment scenario in progress and simulation parameters while observing the behavior and performance of several teams that employ alternative design solutions. Motivated by the emphasis on abstraction and simplicity in early design studies, each MAS model is currently based on a specialized microworld. We outline two variations of a board game microworld that have been used in the design of specific interaction models for agent teamwork: a mutual assistance protocol for direct help between teammates, and a model of mutual help in teams of artificial agents based on a concept analogous to empathy in natural systems. For the purposes of analysis, optimization, and more complex MAS modeling, the framework supports interoperability with external systems. In one experimental study, the simulator provides team performance scores as fitness values to a genetic algorithm running on an external Matlab system. The framework also supports the distribution of runs of the same experiment across a potentially large number of nodes in a computing cluster.

## OSM: An Evolutionary System of Systems Framework for Modeling and Simulation

*Clinton Winfrey, Benjamin Baldwin, Mary Ann Cummings and Preetam Ghosh*

### Summary

In this paper, we propose a novel Orchestrated Simulation through Modeling (OSM) framework that allows output visualizations and Discrete Event System Specification (DEVS) modeling and simulation (M&S) frames to be developed separately as plug-ins and combined to form a complete system. Independently developed plug-ins can be added and removed as desired to dramatically change the system. This design allows input plug-ins (model, experimental), execution plug-ins (simulator), and output plug-ins to be developed separately and pieced together to form a unique system while allowing development to be compartmentalized. With the OSM framework, an evolutionary system of systems can be intelligently created by a community. Each community member only needs to fully understand the pieces they personally develop. The performance and scalability of our proposed OSM framework is discussed in an evolutionary system of systems domain pointing to its efficiency and usability.

## Assessing Instructional Strategies for Training Robot-Aided ISR Tasks in Simulated Environments

*Stephanie Lackey and Julie Salcedo*

### Summary

Simulation-based Training (SBT) bridges the gap between classroom instruction and live military training exercises. Simulation offers the opportunity to train events in the absence of a live training range, tasks too difficult or dangerous to train in a live setting, and familiarization training for emerging technologies. As the role of Unmanned Ground Systems (UGSs) expands to include Intelligence, Surveillance, Reconnaissance (ISR) missions, SBT is primed to support emerging UGS operator training requirements. However, the use of simulation technology does not guarantee improved performance. In the absence of skilled instruction, SBT has shown to impact negative training. This research focuses on identifying specific instructional strategies most beneficial for training perceptual skills involved in Robot-aided ISR tasks within a SBT paradigm. The specific objective of the experiment was to empirically assess the training efficiency of two strategies, Highlighting and Massed Exposure, identified as effective instructional strategies for perceptual skills training. Perceptual skills, specifically behavior cue analysis, play a critical role in intelligence gathering activities and the identification of High Value Individuals. During the experiment, participants performed a behavior cue analysis task, which involved detecting virtual human targets and classifying behaviors within a SBT testbed. Participants in treatment groups received Highlighting or Massed Exposure instructional support, while participants in the Control group did not receive strategies to guide their practice. Performance measures were compared between groups to assess the impact of instructional strategies on performance outcomes. This timely investigation of instructional strategies provides recommendations for the SBT acquisition community driven by empirical findings.

## Biodiesel Sim: Crowdsourcing Simulations for Complex Model Analysis

*Derek Riley, Xiaowei Zhang and Xenofon Koutsoukos*

### Summary

Biodiesel is an alternative fuel source that can be easily made by novices with an inexpensive home-made reactor using waste vegetable oil, but producing high quality fuel using a home-made reactor is difficult due to the complexity of the chemical interactions and the configurations of the processor. A biodiesel processor is a complex system that can be modeled and simulated using formal modeling methods, but accurate modeling can require prohibitively expensive analysis. In this work we present our iPad application called Biodiesel Sim that is designed to `crowdsource' simulations of a formal Stochastic Hybrid System model of biodiesel production. The application allows iPad users to play a simulation game that calculates trajectories of a formal stochastic model of biodiesel production. The results of any simulations run in the game are collected in a centralized database, which can be searched via a website to encourage users to improve their simulations. The framework used in this application can be used as a template for analysis of other formal models.

## Modeling and Simulation of Electricity Generated by Renewable Energy Sources for Complex Energy Systems

*Marco Pruckner and Reinhard German*

### Summary

All over the world energy systems are faced with the integration of electricity generated by highly fluctuating decentralized renewable energy sources (RES). The situation in Germany is even more pronounced because of the nuclear phase-out until the end of 2022. Generally, the complexity of energy systems will continue to increase within the next years. Simulation models can help to analyze future energy systems with a high amount of electricity generated by decentralized RES and to study the satisfaction of electricity demand by different energy sources. For instance, the modeling and simulation of the aggregated feed-in of photovoltaic systems and wind energy plants in a high time resolution are very important to investigate the use of conventional power plants in the future. In order to capture fluctuations and typical characteristics of photovoltaic systems and wind energy plants for a region such as the German federal state Bavaria, we developed a hybrid simulation approach using Discrete-Event and System Dynamics techniques. In this paper we describe the modeling and simulation of time series for the aggregated feed-in of photovoltaic systems and wind energy plants in detail. Furthermore, we present simulation results about the covering of electricity demand for different seasons in a weekly and hourly resolution.

## Evaluating Pricing Options at a Museum by Simulation

*Murat M. Gunal and H.Kemal Sezen*

### Summary

Museums around the world make the cultural and historical artifacts available for public viewing and therefore are popular places for tourists. In this study, we present a project which was conducted for Topkapi Palace Museum (TPM) in Istanbul, Turkey. As part of the project, a simulation model is developed for evaluating alternative strategies for pricing the entrance ticket at the museum. TPM is visited by more than three million visitors annually and generate revenue. Due to its popularity and physical constraints at the site, it is common to observe long queues before the exhibition halls inside the museum. The simulation model is developed which considers physical layout of the museum including open space walking area and exhibition halls. By using the model, effects of creating a new ticket type, "exclusive ticket", are evaluated. The new ticket type costs more but has the advantage of gaining priority in waiting line queues. Based on the simulation results, we estimate that the new ticket type will increase the revenue and provide fast-track visiting option for tourists.

## Development of a Marked Structure for Workload Traces of Parallel and Distributed Systems

*Diogo Silva, Aleardo Manacero, Renata Lobato, Denison Menezes and Roberta Spolon*

### Summary

The evaluation of high-performance systems, including grids, depends strongly of the workload applied during benchmarks or simulations. This is even more evident when the technique used for evaluation is simulation, where the workloads may be created in two approaches: random loads or trace files. Although several models for generating random workloads have been proposed, trace files are the only form to assure reproducible simulations. Unfortunately there are very few trace files available in workload databases, and most of them have not been maintained after few years of launching. Another problem with these trace files is that the structure for the data in the files is not easy to read and collect. In this paper we present a framework that allows the creation of trace files where data is marked through XML tags, making easy their reading, and provides front-end converters for some of the trace patterns found in the literature, while it is easy to design converters for other patterns. It also can be used to collect traces from grid simulations performed in iSPD, which is a grid simulator with an iconic modeling interface, allowing for the use of the simulated workload in a later simulation. We also present tests executed using this framework, where an important result is that the converted files are smaller than the original files, even with the addition of markups. All of these features indicate that this approach could create a stronger pattern for workload trace files.

## On The Generalization Of Continuous-Time Stochastic Processes Simulation For Industrial Production Modeling

*Fabio Bursi, Andrea Ferrara, Andrea Grassi and Chiara Ronzoni*

### Summary

The paper presents a new generalized framework for carrying out simulations of continuous-time stochastic processes by exploiting a discrete event approach, taking also into consideration the possibility to implement control policies for the machines. The application scope of this work mainly refers to industrial production processes executed on a continuous flow of material (e.g. food and beverage industry) as well as production processes working on discrete units but characterized by a high production rate (e.g. automated packaging lines). The proposed model, developed adopting the DEVS formalism, extends a previous work of the same Authors by introducing the possibility to send logical signals triggered by parameter variations. Hence, it is possible both to keep trace of additional measures of parameters related to the process and the flowing material (i.e. temperature, concentration of pollutant and so on) and to implement custom policies to control the behavior of the production system.

## Solving Instability Problem in Soft Body Dynamics

*Jaruwan Mesit*

### Summary

For computer simulation, a soft body has been used in many fields such as medical application and entertainment. The soft body is composed of a list of point. Each point in the soft body has its own properties which of them are position, force, and velocity. In each time step, new position is computed by applying a new force using integration method such as explicit method or implicit method. In explicit Euler method is simple and fast in a term of computation. However, a disadvantage of this method is that the simulation becomes unstable and causes the soft body to disappear from the simulation scene when the force is too large. Thus, implicit method has been used to avoid this problem. Unfortunately, the implicit Euler method is time consuming since it requires high computation. In this paper, an embedded Runge Kutta is adopted to efficiently implement the soft body models because it can solve instability problem and requires lass computation. The comparison between explicit Euler method, implicit Euler method, and our embedded Runge Kutta is also presented in this paper and the results show that the embedded Runge method can avoid instability problem and can run faster than implicit Euler method

## A Simulation-based Framework for the Generation and Evaluation of Traffic Management Strategies

*Vinh An Vu, Giho Park, Gary Tan and Moshe Ben-Akiva*

### Summary

We present a new simulation-based framework for the generation and evaluation of traffic management strategies during non-recurrent incidents. The new framework sets up a closed-loop integration of a microscopic simulator MITSIMLab, a mesoscopic simulator DynaMIT and a Strategy Generation Module. MITSIMLab acts as a proxy to real world, DynaMIT is a real time Dynamic Traffic Assignment (DTA) tool with traffic prediction capability trying to simulate MITSIMLab and the Strategy Generation Module is responsible for generating the traffic management strategies based on the predictive information from DynaMIT. The new framework offers strategy developers full control of traffic scenarios, models, algorithms and verification in case real field tests are too costly. Two case studies in a synthetic network are demonstrated to illustrate the applications of the new framework. The first case study works on generating cost-effective route guidance strategies during incidents by focusing on diverting only vehicles with a specific Origin-Destination (OD). The second case study investigates the sensitivity of route guidance strategies to the number of OD pairs selected for intervention. Both case studies show positive result of route guidance strategies in improving the traffic condition.

## Human Behavior Simulation For Complex Scenarios Based On Intelligent Agents

*Agostino Bruzzone, Marina Massei, Francesco Longo, Simonluca Poggi, Matteo Agresta, Christian Bartolucci and Letizia Nicoletti*

### Summary

The focus of this paper is to develop a scenario and realistic case study to be applied in the human behavior simulation for complex scenarios involving coalition operations; for this purpose the intelligent agents will be used in order to reproduce the interactions among forces, local population and interest groups as well as the consequences of different COAs (Courses of Actions). The proposed modeling approach considers the complex interactions among many variables and resulting as effects of the Commander decisions in a comprehensive scenario involving multiple layers(i.e. Political, Military, Economic, Diplomatic, Social, Media and Infrastructure); the authors proposes here a realistic scenario for using Interoperable Simulation on Crisis Management related to a NEO (Non-combatant Evacuation Operation).

## System of Systems based Approaches to Global Simulation in Africa

*Adedoyin Adegoke and Mamadou K. Traoré*

### Summary

Simulation modeling, the third pillar of science has grown beyond the walls of academia and has successfully permeated real world applications. Most of these evidences including facts and data seem to have come from other continents with a little from Africa. The aim of this paper is to propose an approach to global simulation in Africa, from existing results, using System of Systems based approaches. We bring to the fore front some of the efforts and advances made by using modeling and simulation techniques for tackling problems in different parts of Africa. We then suggest two options to a global simulation approach: one is the System of Systems approach where interconnection of existing simulation systems leads to a bigger simulation system, the other is what we call the Simulation of Simulations approach where a simulation model is built from the results drawn from existing simulation systems. We envision that this work will encourage in-depth research into using systems thinking approach to tackle problems beyond the African case taken here.

## Cloud Computing for Simulation in Manufacturing and Engineering: Introducing the CloudSME Simulation Platform

*Simon J E Taylor, Tamas Kiss, Gabor Terstyanszky, Peter Kacsuk and Nicola Fantini*

### Summary

There are many benefits of implementing simulation software on a Cloud. These include the use of scalable, on-demand access to resources that can be used to speed up simulation and the development of composable Modeling & Simulation services (Modeling & Simulation as a Service (MSaaS)). However, developing Cloud computing solutions for simulation in industry is difficult without appropriate expertise due to the complex technologies involved. This paper introduces the CloudSME Simulation Platform that is based on the proven technologies of gUSE and CloudBroker and is being used to create Cloud computing versions of industrial simulation software including Simul8's discrete-event simulation environment, Ascomp's TransAT computational fluid dynamics application, Ingecon's 3D Scan Insole Designer tool and 2MORO's Bfly software for aircraft maintenance logistics. The paper discusses the Platform and outlines how it is used to implement Cloud-based simulation software.

## Sustainability of a Growing Higher Education Institution: a Simulation Approach to Analyze the Dynamics of Campus Parking Lots

*Anatoly Kurkovsky*

### Summary

Sustainability of universities and colleges is an important component of higher education institutions, especially for a new fast growing educational organization. Within a wide range of various aspects of sustainability in a growing educational organization we identified a problem related to the availability of parking spaces on campus. This problem was formalized as a campus parking lot system with a specific subject domain scope, analysis goals, constraints and assumptions. We used ARENA professional simulation software environment to design and to implement a preliminary simulation model of the campus parking lot system. The created simulation model can be used not only as a tool for systems analysis of a campus transportation problem, but also as a portion of the future bigger simulation "umbrella" to analyze the sustainability of a university/college. Such a future bigger simulation model will include economics, facilities, administrative structures, educational technologies, and environmental aspects of sustainability at a university/college.

## Make eXperience Count: Use the Experience Application Programming Interface for More Efficient Learning Management Systems (An Alphabet Soup of Training Capabilities)

*George Stone, William Gerber and Perakath Benjamin*

### Summary

This paper describes how to use Sharable Content Object Reference Model (SCORM) 2004 and other Advanced Distributed Learning (ADL) training methodologies to: 1) Establish methods for combining Computer Based Training (CBT) and Simulation Based Training (SBT). Accomplishing this objective will determine effective strategies and techniques for combining CBT and SBT. 2) Establish hybrid architecture mechanisms for the synergy of SCORM-compliant Learning Content Management Systems (LCMS) and High Level Architecture (HLA)-distributed Interactive Simulation (DIS) compliant Learning Management Systems (LMS). Accomplishing this objective will show effective and efficient architecting strategies and tradeoffs for combining SCORM-compliant and HLA-DIS compliant learning management systems. This effort also includes the new Experience API (xAPI).

## Distributed Reactive Simulation

*Robert Kewley and Joseph McDonnell*

### Summary

As systems become more complex, there is an increasing call for modeling capabilities to support tradespace decisions in a complex or system of systems environment. In simulation federations using Distributed Interactive Simulation (DIS) or High Level Architecture (HLA), simulations are federated sharing a subset of state data and event data with each other. They each have their own instances of initialization data, state data, events, time advance, and output data. The greatest challenge is to manage and coordinate these individual copies to form a coherent scenario run. This coordination and management task is intractable for any realistically complex scenario. It typically requires significant effort from a team of simulation professionals. This paper describes some early research for a proposed distributed reactive simulation paradigm that federates discrete functions while centrally maintaining the initialization data, state data, the event schedule, and time advance. In order to compose models, the analyst must first break them apart – assembling a set of functions required by the systems of interest. We hypothesize that this approach will better enable analysis in the federated environment. Analysts will have greater access to initialization data and static properties. They will only have to look in one place for state trajectories and output data. They will be able to develop and compose functions that map to the systems architecture. The distributed reactive approach enables transparent verification and validation of the federation and supports design and execution of experiments.

## Unsupervised Model Generation for Geological Events

*Joaquim Assuncao, Paulo Fernandes, Tiago Fischer and Afonso Sales*

### Summary

So far, large stochastic models require considerable amounts of time to be created. In fact, to simulate systems or events, there is a constant need to perform an analysis of the system and its variables. In this paper we propose a method to automatically generate Stochastic Automata Networks (SAN) models for geological events. Based on user -defined input data, the method creates a model in SAN formalism for the prediction of geological stratal stacking patterns through time. Although models automatically generated tend to be less accurate, we believe that the time saved compensates for the precision lost.

## Leveraging Social Media Data in Agent-based Simulations

*Jose Padilla, Saikou Diallo, Hamdi Kavak, Olcay Sahin and Brit Nicholson*

### Summary

One of the limitations of agent-based simulations is the lack of appropriate input data to move simulations from theoretical to practical. Appropriateness ranges from data relevant to individuals (granularity) to identifying percentages of a population that abide by certain characteristics or behavior which in some instances are assumed or placed under “ranges” based on a uniform distribution within a simulation. This paper briefs on current research efforts on using social media data to provide empirical grounding of agent-based simulations. Three examples on how data from social media can be used in agent-based modeling are presented: 1) using large data set processing and sentiment analysis to identify preferences of a population, 2) using agents with machine learning capabilities to learn mobility patterns from individuals in a population, and 3) identifying preferences and communication patterns based on graph analysis. Current research shows that these techniques show promise to create smart agents to complement those based on complex rule-based behavior especially using simulations what-if capabilities. However, they bring their own set of challenges.

## A Journal Profiling and Co-citation Study of SIMULATION: The Transactions of the Society for Modeling and Simulation International

*Navonil Mustafee, Korina Katsaliaki and Paul Fishwick*

### Summary

Our purpose in this paper is to extract quantitatively derived observations about a corpus of information centered on the publications of the Society for Modeling and Simulation International (SCS), which celebrated its 60th anniversary in 2012. Since its inception, the Society has widely disseminated the advancements in the field of Modeling & Simulation (M&S) through its peer-reviewed journals. In this paper we profile research that has been published in the journal SIMULATION: Transactions of the Society for Modeling and Simulation International. We use two forms of content analysis, namely, journal profiling and co-citation analysis. It is expected that this paper will lead to further appreciation of the contribution of the Society in influencing the growth of M&S as a discipline and in steering its future direction.

## Threat Modeling for Aircraft Access to National Airspace System Wide Information Management Program

*Mohammad Moallemi, Remzi Seker, Massood Towhidnejad, Jonathan Standley, Robert Klein and Paul Jackson*

### Summary

Within the Federal Aviation Administration's (FAA) NextGen project, System Wide Information Management (SWIM) program is the essential core in facilitating the collaborative access to the aviation information by various stakeholders. The Aircraft Access to SWIM (AAtS) is a Service Oriented Architecture (SOA) that provides the technical platform for the exchange of situational information between the aircraft and the National Airspace System (NAS). In this research project , we investigate the challenges in one and two way communication between the Electronic Flight Bag (EFB) and the SWIM network architecture. EFBs are utilized for allowing aircrafts' access to SWIM through a Data Link Service (DLS) provided by a Data Link Service Provider (DLSP). Issues such as cybersecurity, performance, availability, and quality of service in the AAtS are investigated and mitigation approaches toward more secure and efficient service provided to the aircraft and to NAS are discussed. To this end, a set of comprehensive tests are carried out in an emulated network in a lab environment to identify and assess some of the issues associated with quality of service (QoS) as well as cybersecurity in both wired and wireless connectivity of Electronic Flight Bags (EFBs).This work also aims to assess the efficiency of different approaches in the downlink and uplink data transmission between aircraft and the AAtS system. Nine operational scenarios are identified in AAtS, where they are tested with three technical communication scenarios that are further correlated with messaging patterns using web-services.

## DarknetSim - A Simulation Framework for Social Overlays

*Patrick Welzel, Stefanie Roos, Andreas Höfer and Thorsten Strufe*

### Summary

Social Overlays are a candidate solution to satisfy the increasing demand for privacy-preserving social applications. In Social Overlays, also called Darknets, direct communication only exists between participants sharing a real-world trust relationship. Existing solutions, such as Freenet and GnuNet, suffer from long delays and high message overhead. The development and evaluation of alternative solutions is drastically complicated by the lack of common models and evaluation methods. In this paper, we describe a general simulation framework for Darknets as well as our implementation of the most common routing approaches. The framework contains the basic functionalities of Social Overlays and is easily extensible to include a wide range of routing algorithms. Our implementation, based on OMNeT++ and INET, proves to be highly scalable in comparison to simulation frameworks for structured Peer-to-Peer systems such as OverSim. We can easily simulate realistic network sizes of a hundred thousand nodes.

## A GPU-Accelerated Physical Layer for Simulating Wireless Networks

*Robert Konrad, Benjamin Hamilton and Bow-Nan Cheng*

### Summary

In recent years, graphics processing units (GPUs) have been leveraged to speed-up massively parallel computations. Knowing the path loss between nodes in a wireless network is crucial in accurately simulating physical layer effects in wireless network simulators and emulators. Because path loss and interference calculations are often repeated for every transmitter and receiver pair, leveraging GPU computing to parallelize these calculations can lead to significant reduction in processing time. In this paper, we present an implementation of a high-fidelity GPU-accelerated PHY that calculates path loss and interference over time for every receiver/transmitter pair using realistically defined node antenna patterns. Performance results are compared against traditional CPU calculations and we demonstrate that by offloading parallel computations to the GPU, significant gains can be had for wireless network simulation and emulation. Additionally, GPU limitations and design considerations are presented to aid in future GPU-based wireless simulation implementations.

## Distributed Recommender System using Multi Agents

*Lubaid Ahmed and Dr. Abdolreza Abhari*

### Summary

In the last few years, social networks have been used by millions of people. This makes social network a huge source of data that has valuable information. This information can be used for commercial, politics and security etc. Therefore mining social networks has become a significant tool due to its vast and useful information found in these networks. This paper presents a framework to extract real-time tweets using multi-agent system. This framework is used to provide recommendation to its users. The proposed framework consists of the following processes: distributed data extraction using multi-agents from social network websites, data cleansing, tweets analysis using TF/IDF, and providing recommendations. In this paper we detailed the followings: twitter simulator was developed using multi agent system architecture. Two different information retrieval methods are analysed in distributed environment. The performance metrics of information retrieval method is evaluated based on scalability and their distributed processing effectiveness. The best evaluated information retrieval method is used in distributed recommender system..

## Applying Supervised Learning Algorithms on Information Derived from Social Network to Enhance Recommender Systems

*Hesaneh Behzadfar and Abdolreza Abhari*

### Summary

The aim of this research is to show how social networks can be used for marketing reasons. This is implemented by the assistance of learning algorithms; in this case SVM's (Support Vector Machines). In the first two decades of the second millennium, social networking websites have become so popular where more and more people interact day by day, exchange information online and even look for advice or obtain new ideas through other peoples social networking sites. The method used in this research is mainly based on "Support Vector Machines" to be able to learn through all the information gathered from people's social websites. In this regard, first a review of literature on already known methods is performed to explain the status of the proposed method in this research. Then, there will be clarifications on the advantages of this research over previous works in this field.

## Unified Metric Calculation of Sampling-Based Turbo-coded Noncoherent MFSK for Mobile Channel

*Mona Nasseri, Junghwan Kim and Mansoor Alam*

### Summary

In mobile/wireless channel, transmitted signal experiences interference, diffraction and reflection resulting the received signal with different path losses and time delays.This paper is on the derivation of the soft decision metric of turbo codes and BER analysis of Noncoherent (NC) M-ary FSK (M=2, 4 and 8)using punctured turbo code for the mobile applications whose channels are modeled by Rayleigh and Nakagami-m distribution. For this, we initially develop the method of unified metric calculation of turbo code suitable for the respective order of modulation M (of NC-MFSK). Since different values of M require different code rates, multiple choice of puncturing patterns are sought to identify the best puncturing pattern.For the validation of the proposed metric calculation per respective NCMFSK, BERs are evaluated under AWGNat first.In addition, to see the robustness of the turbo-codedNCMFSK further, realistic mobile channels modeled as Rayleigh or Nakagami-m are applied. Results of extensive sampling-based computer simulationshow that application of properly selected punctured turbo code can enhance the BER performance of the NCMFSK under the adverse effect of mobile channels and effectively compensate the degradation due to noncoherent detection. In fact, the best puncturing pattern identified under AWGN also work best under mobile channel conditions modeled. Further investigation of suitable puncturing pattern for higher order NCMFSK also reveals that there is certain limitation and inter-relation betweenthe selection of punctured bits and performance of turbo coded modulation schemes

## A Bayesian Game Approach to Coexistence with Malicious and Selfish Nodes in Wireless Ad-Hoc Networks

*James Roles, Hala ElAarag and Errich Friedman*

### Summary

Mobile Ad-hoc networks are self-organized systems of nodes or installations, all cooperating to provide network functions such as routing and forwarding. Utilized in open environments, mobile ad-hoc networks are vulnerable to attack by malicious nodes, causing harm or disorder. These nodes do not reveal their identities while disrupting service. Thus, early detection is important. The network may also contain selfish nodes, installations that choose to conserve power resources rather than provide network function. Identification of selfish nodes, too, is necessary so that functional nodes do not waste resources attempting to communicate with them. It is our goal to be able to identify both malicious and selfish nodes in mobile ad-hoc networks. Malicious node detection has previously been modeled as a Bayesian game with imperfect information. In this attacker/defender game the defender is unsure of the type of its opponent and must select strategies based on this incomplete information. Malicious nodes attempt to avoid detection by masquerading as regular nodes, providing useful network function at interval. This small contribution to the network may, however, be entirely necessary in a mobile ad-hoc network with extremely limited resources and selfish nodes. Thus, exploiting the malicious node may be a viable option. In this paper we seek to demonstrate that selfish and malicious nodes can be successfully identified through our proposed attacker/defender game. In addition we wish to show that once identified, a malicious node may be exploited if the benefit it provides to the network is greater than the damage accrued.

## Anti-Spoofing Cooperative Localization in Cellular Networks

*Thabet Mismar, Junghwan Kim and Mansoor Alam*

Although proven possible, not many spoofing attacks were reported for the GPS [1]. With the introduction of cooperative localization, spoofing attacks can be easier and more effective, resulting in users, and eventually the whole network, not knowing their exact location. This paper shows that the effects of any spoofing attack can be minimized by processing information from seven or more transmitting users instead of the main stream approach of only using three or four information transmitting users or anchors (base stations). Then by filtering the extreme estimates resulting from the spoofing attack, the user is able to estimate his location close to the location estimate in the case where no spoofing attack happened.

## Heterogeneous DEVS Simulations with Connectors and Reo Based Compositions (Work in Progress)

*Ahmet Kara, Halit Oguztuzun and M. Nedim Alpdemir*

### Summary

Composition of DEVS models in heterogenous environments requires resolutions for manifold incompatibilities including data type and time resolution mismatch. This paper proposes a solution for implementing DEVS simulations in heterogenous environments with the help of connectors in the sense of component based software engineering. Our solution involves implementing connectors as atomic models to be used in mediation of data type and time resolution mismatches. Employing atomic models as connectors allows connector composition in the style of Reo and promotes higher level of reuse in simulation construction. In this paper we describe our solution formally and present a case study to demonstrate its application.

## Geometric Algorithms and Data Structures for Simulating Diffusion Limited Reactions

*Shaun Bloom, Shuang Luan, Mathieu Karamitros and Sebestien Incerti*

### Summary

An ultimate goal in radiobiology is to directly calculate the radiation damage to living organisms, which impacts the fields of health science (e.g., radiation therapy) and space science (e.g., exploration flight to Mars).

As ionizing radiation enters a living organism, a vast amount of energy is released through physical interactions between particles and the abundance of water molecules. The process creates a variety of thermalized radiolytic species (e.g., OH•, e-, etc.) and sets off a chain of diffusion limited chemical reactions. A key to accurately estimating radiobiological damage is the calculation of the concentration of the radiolytic species over time. Computationally the underlying problem is the following: Given n kinetic and dynamic particles in 3-dimensional space, maintain the distribution of the particles with respect to time.

The current method for solving the problem is based on the use of a kd- tree that must be rebuit after every time step since the particles are in constant random motion. The approach will take O(mnlogn) expected running time, where m is the number of iterations, and O(nlogn) is the time to build the tree and the expected time to find the closest pair.

In this paper, we present a geometric algorithm for simulating diffusion limited reactions. Our algorithm is inspired by kinetic data structures and randomization. Our approach uses a layered directed acyclic graph, where each layer is a hash table to store the particles. The use of hash tables allows us to locate the closest pair in linear expected time. We use techniques that reduce the simulation time to O((n+k)logn). Implementation and experiments have shown that with the new algorithm the actual time is nearly linear in the number of input particles and is considerably faster than the current hierarchical approach.

## Fenix: A Framework for Power System and Communication Networks Co-Simulation

*Selim Ciraci, Jeff Daily, Jason Fuller, Andrew Fisher, Laurentiu Marinovici and Khushbu Agarwal*

### Summary

This paper describes the Fenix framework that uses a federated approach for integrating power grid and communication network simulators. Compared existing approaches, Fenix allows co-simulation of both transmission and distribution level power grid simulators with the communication network simulator. To reduce the performance overhead of time synchronization, Fenix utilizes optimistic synchronization strategies that make speculative decisions about when the simulators are going to exchange messages. GridLAB-D (a distribution simulator), PowerFlow (a transmission simulator), and ns-3 (a telecommunication simulator) are integrated with the framework and are used to illustrate the enhanced performance provided by speculative multi-threading on a smart grid application. Our speculative multi-threading approach achieved on average 20% improvement over the existing synchronization methods.

## Optimization Based on Dynamic and Hybrid Metaheuristics via DEVS Simulation

*Bastien Poggi, Jean-François Santucci and Thierry Antoine-Santoni*

### Summary

In this paper we present an efficient decision-making framework allowing optimization via simulation combining metaheuristics algorithms and DEVS formalism. Our proposed object-oriented approach provides an universal interface between any existing DEVS models and some existing metaheuristics. To do this we explode the optimization algorithms into several actions involved in an optimization loop. Concerning the evaluation step which one can find in each metaheuristic we propose to externalize it towards the studied model using DEVS messages. This hierarchy of components generates the following new concepts: (i) event-driven metaheuristic parametrization that allows an automatic execution of the associated algorithm; (ii) creation of dynamic and hydrid metaheuristics used for hard-optimization problems; (iii) decision support variables temporization that allows optimization on a specific time interval. We validated the effectiveness of the previous concepts through the implementation of the popular genetic algorithms and the more recent harmonic search algorithm. Furthermore the validation is completed on a real case example concerning medical treatment through a simple glycemic DEVS model. Simulation results show that the resulting treatement reduces the risk of over-tratement or under-treatement.

## Rule-Based Model Transformation For, and In Simulink

*Joachim Denil, Pieter Mosterman and Hans Vangheluwe*

### Summary

Over the past decade, the design of embedded systems has come to rely on models as electronic artifacts that are executable. Such executable models are at the core of Model-Based Design. Simulink® is a popular Model- Based Design tool that supports simulation of models in various stages of design such as an originally continuous-time control, a discrete-time corresponding version, a tasked-based implementation, etc. While Simulink supports relating the various different models used in design, the technology to do so relies on the underlying Simulink code base. Instead, this paper employs explicit models of the relations between the various different design models. In particular, a rule-based approach is presented for model-to-model transformations. The abstraction from the code base provides benefits such as a more intuitive representation and the ability to more effectively reason about the transformations. The transformation rules and schedules are designed by augmenting standard Simulink model elements (e.g., blocks) for use in model transformation based on the structured RAMification approach. The transformations are exported to the Py-T-Core transformation language with a corresponding execution kernel that allows in-place or out-place tansformation of Simulink models. The approach is illustrated by the transformation of continuous-time model parts of an adaptive controller to disrete-time counterparts, which are consecutively optimized before simulated.

## A Highly Efficient Simulation Core in C++

*Andreas Blunk and Joachim Fischer*

### Summary

In this paper we present a method which allows to implement the core of a process-oriented high-level simulation language named DBL. The core is based on a C extension known as Labels as Values, which was originally introduced by FORTRAN under the name Assigned Goto. The extension allows to implement the first part of a context switch in a process-oriented simulation model, which is the transfer of control. It defines a special go to statement which allows to jump to a program location saved in a variable. As a result, the transfer of control between processes is fast. The second part of a context switch is storing and restoring the state of a process, including its function call stack. Here, we present a solution in which the call stack is emulated by using plain C++. However, using goto statements and function call stack emulation incurs the cost of hardly readable code. Therefore, we introduce the extensible high-level simulation language DBL, which is compiled to C++. We evaluate the efficiency of the approach by comparing it to other known implementations of context switches used by different simulation frameworks. The results show that this approach allows for a highly efficient implementation of a simulation core based on widely-used C++ compilers.

## An Analytical Method for Assessing the Effectiveness of Human in the Loop Simulation Environments (Work in Progress)

*Glenn Hodges, Rudolph Darken and Michael McCauley*

### Summary

The Integrated Training Environment Assessment Methodology (ITEAM) is a human-focused systems engineering approach to human in the loop simulation environment analysis that leverages human ability research and affordance theory. The goal of this research is to develop an analytical assessment methodology that is able to predict task elements within an integrated training environment with the highest likelihood of positive training transfer. Predicting these elements improves our ability to reduce system development and evaluation costs leading to improved training environments for Soldiers. Preliminary results from two completed studies indicate that ITEAM is reliable and repeatable. ITEAM begins by defining the true need for the ITE using details derived from specific analysis as opposed to the primitive need often found in operational needs statements. Once a need is defined, an operational concept of how the user views ITE employment is explored. This step provides insight into the specific types and kinds of training that the ITE must support. With this information, a series of course job/task analyses (JTA's) are conducted to identify the tasks that make up the training that the user intends to execute. Once completed, the JTA's are then annotated with the human abilities associated with each of the tasks and subtask elements. Human abilities provide a lens through which the training environment is viewed providing insight about the specific aspects of human performance that the ITE must support in terms of physical, sensory, psychomotor or cognitive abilities. With this information, the analyst is able to describe the affordances necessary for the ITE. Affordances are elements that exist in the ITE that are necessary to stimulate the trainee's human abilities so that he may engage in the deliberate practice of the necessary skills that support the training tasks.

## Expanding DEVS and SES Applicability: Using M&S Kernels within IT Systems

*Chungman Seo, Wontae Kang, Bernard P. Zeigler and Doohwan Kim*

### Summary

In this paper, we show how the SES construction, pruning, and model generation process, can support a web-based system for personal wellness planning and self-management. Our focus is on the process by which modeling and simulation kernels are integrated within other layers of a web-application. The System Entity Structure (SES), Pruned Entity Structures (PES), and libraries for pruning processes from the MS4 MeTM platform technology are used to implement the personal wellness plan web application. This paper discusses the approach taken to support user graphic and web service requirements for interfaces to the embedded SES/PES kernels. We conclude with a discussion of how this example generalizes to integration of Discrete Event System Specification (DEVS) and SES with information technology systems thus increasing their applicability within such systems.

## A Study on Effective Operations of Sound Underwater Signal Using DEVS Modelling and Simulation (Work in Progress)

*Min Kwak and Chungman Seo*

### Summary

In this paper, we discuss a DEVS modeling and simulation approach to effective operations of sound underwater signal (SUS) which is an underwater signal transmission system to communicate between a submarine and surface forces in case of emergency in Navy in Republic Of Korea. To find submarine's location with a theoretical method, a paging concept, used in a mobile communication system to find a receiver, is employed. With MS4 MeTM software tool, this research includes generation of the probability information of the submarine location, calculation of optimal dropping methods of SUS, and validating the number of expected SUSs and expected communication time for the optimal dropping methods using a simulation approach. Results of the study suggest an effective SUS dropping method minimizes the number of expected SUSs and communication time.

## Context Activity Selection and Scheduling in Context-Driven Simulation

*Jae Woong Lee, Abdelsalam Helal, Yunsick Sung and Kyungeun Cho*

### Summary

Human activities in smart spaces are traced by sensors and logged, as sensor events, in the form of sensory values, when the sensors detect elements of the activities. The event-driven approach that models the combination of the sensor events is one of the most common human activity simulation approaches. However, this approach is scale-wise challenged as activities and spaces get more complex. A large volume of sensor events demands more human efforts in modeling, and requires higher processing overhead. We observe that rather than simulating by combining sensor events, semantical abstraction could offer a scalable alternative in managing such complexity. In our previous work, we proposed a context-driven such an approach, which scales well in complex simulation. The approach evaluates current state space and advances the simulation loop by units of context, not by sensor events. By changing the domain of simulation from event to context, we could measure a remarkable performance advantage. Through the experiment, we noticed that activity design was critical to end performance. In this paper, therefore, we focus on modeling activities for a better fit to the context-driven approach. We introduce a new activity model along with associated algorithms to select and schedule the activities. We also provide an evaluation of the performance and computational complexity of the algorithms.

## DEVS-Based Scenario Manager of Multibody Dynamics Simulator for Shipbuilding Production Process (Work in Progress)

*Sol Ha, Namkug Ku, Myung-Il Roh, Ki Su Kim, Seung-Ho Ham, Jung-woo Hong, Xing Li and Hyewon Lee*

### Summary

This paper proposed a scenario manager capable of creating and editing shipbuilding production processes for multibody dynamics-based simulation. The proposed scenario manager was composed of two components: 'Actor' and 'Scenario Executor'. Actor represents a minimum unit of action in multibody dynamics kernel and it can be connected with specific component of dynamics kernel such as body, joint, wire, and so on. A shipbuilding production process can be made by combining these actors sequentially and in parallel. Including these combination of actors, Action List contains information for executing actors. Scenario Executor has this action list, and executes actors according to the execution order in the action list. Since the process of shipbuilding production is a kind of event-based sequence, all components of the scenario manager were configured using DEVS (discrete event system specification) formalism. To verify the effectiveness of the proposed scenario generator, it was applied to various shipbuilding production simulation such as lifting and erection of a block, heavy load lifting operation using multi-crane, and launching operation of an icebreaker using two floating cranes.

## A Simulation-Based Model for a Multi-Domain GMPLS-based IP-Over-Optical Network using the OMNeT++ Platform (Work in Progress)

*Saud Albarrak*

### Summary

This paper is concerned with the development of a comprehensive simulation-based model for a multi-domain GMPLS-based IP-over-optical network using the OMNeT++ platform. The work ensured that such an implementation mirrored as far as possible the operation and performance of real multi-domain/multi-layer structure. Therefore, this model can be considered as a basis for research to investigate key issues that affect the operation of multi-domain GMPLS-based IP-over-optical networks. a number of preliminary simulation-based experiments will be presented. The prime aim of these experiments is to validate model behaviour and assumptions.

## The Peace Game: A software-Based Model for Understanding the Complexities of Modern Conflict at the Strategic Level

*Matthew Powers, Jeff Appleget and Danny Heerlein*

### Summary

The Peace Game is a software-based model of peace and stability operations that are underway in regions such as South Sudan and Afghanistan with the potential to revolutionize campaign planning. The Peace Game is an immersive environment requiring no special installation that is designed to expose decision-makers to the complexities and non-linear qualities of modern conflict. The Peace Game facilitates multiple players assuming roles as government leaders, military and coalition commanders, NGO representatives, or various militia camps as they attempt to cooperate with or undermine the strategies being implemented by the other players. Simply put, the Peace Game inspires deep exploration of the operational environment at a strategic level, as opposed to the mechanical procedure of reverse-engineering lines of effort through an environment that is not understood. While the Peace Game differs from simulation models that are often run many times, the spirit of simulation modeling is apparent in the Peace Game's use of stochastic parameters and in the objective of understanding the problem. The Peace Game and simulation modeling both utilize sophisticated software capability for capturing complexities of the real world instead of trying to force those complexities into nice, neat shapes.

## The Modular Architecture of the Python(P)DEVS Simulation Kernel (Work in Progress)

*Yentl Van Tendeloo and Hans Vangheluwe*

### Summary

We introduce two sequential simulation languages and tools: PythonDEVS, a Classic DEVS simulator, and PythonPDEVS, its variant which supports Parallel DEVS. Python(P)DEVS is fully compliant with the standard definition of the DEVS formalism and complex simulation initialization and termination conditions are supported. The main contribution is a modular architecture which supports both as-fast-as-possible and (scaled) real-time simulation. This allows for both simulation and deployment of models. For real-time simulation, three different platforms for time management are supported: thread-based, integration with UI event processing, and integration with the game loop of modern game environments such as Unity. A variety of state and event tracers are supported. The simulation kernel is highly optimized and its performance is studied in detail.

## DEVS-Ruby: a Domain Specific Language for DEVS Modeling and Simulation (Work in Progress)

*Romain Franceschini, Paul-Antoine Bisgambiglia, Paul Antoine Bisgambiglia and David Hill*

### Summary

This paper introduces a new Discrete EVent system Specification (DEVS) modeling and simulation library implemented in Ruby. Its syntactic sugar and features such as monkey patching, lexical closures, custom dispatch behavior and native plug-in API provides strong support to grow a Domain Specific Language (DSL). The library, by providing an internal DSL, allows formal specifications of DEVS models. The greatest strength of DEVS-Ruby lies in the extensibility of the DSL, allowing to meet each modeler's domain specific vocabulary and thus, to evolve from a general modeling and simulation formalism to a specialized tool.

## Lessons Learned From Independent Verification and Validation Of Models and Simulations (Work in Progress)

*James Elele, David Hall, Allie Farid, David Turner, Mark Davis and David Keyser*

### Summary

This paper describes lessons learned while conducting Independent Verification and Validation (IV&V) efforts for a number of models and simulations (M&S) within the U. S. Department of Defense (DOD), and it describes the issues and solutions identified during those efforts. These examples and the lessons learned from them are based on verification, validation and accreditation (VV&A) of existing “legacy” M&S tools used within DOD. Most DOD M&S were developed for a specific purpose, and then were transitioned into more general use for other purposes, or they have been improved and expanded to enhance their capabilities beyond their original design. Because of this evolution, they may have deficiencies in design documentation, design and coding requirements documents, and software specifications that need to be discovered and documented as part of IV&V activities. The lessons described in this paper can be linked to two “cardinal rules” for VV&A programs in general: (1) V&V activities must be driven by the requirements of the intended uses of the M&S; and (2) V&V activities must be designed to reduce the risk of using the M&S for those intended purposes.

## Simulation Optimization of Police Patrol District Design Using an Adjusted Simulated Annealing Approach

*Yue Zhang and Donald Brown*

### Summary

In this study, a simulated annealing approach is developed to find optimal police patrol district design using a discrete-event simulation to evaluate the performances of districting plans, such as average response time and workload variation among districts. Similar to the solution neighborhood definition in an existing simulated annealing approach, the new solution (districting plan) in each iteration is developed by making changes to the current solution. Instead of changing the assignment of only one atom (atomic geographical unit), the new approach makes relatively big changes to a current districting plan through a cutting and merging process of current districts. A case study on Charlottesville, VA is conducted. Experimental results shows that the new approach uses fewer iterations to reach optima so it is well-suited for discrete-event simulation. It evaluates districting plans in a more detailed way but uses longer computational times than PCAM. In addition, the new approach is more robust for the adjacency pattern where atoms have relatively fewer adjacent neighbors. The adjusted simulated annealing approach is also compared with a response surface method of optimizing district design. Experimental result shows that the simulated annealing approach provides better solution. It is also an automatic method and thus better for practical application.

## Efficient Matrix-Exponential Random Variate Generation using a Numeric Linear Combination Approach

*M. Todd Gardner, Appie van de Liefvoort and Cory Beard*

### Summary

Matrix Exponential (ME) probability distributions form a versatile family of distributions and enable an accurate description and simulation of a wide variety of situations where a positive distribution is required. In queueing theory they are used for arrival and service processes. Random Number Generators (RNG) for ME's are not commonly available. In this work, we create a new ME RNG by scaling a uniform random number using a weighting function, which is then converted to the ME random variate using an exponential inverse transformation. The weighting function is created by arranging the distribution as a linear combination (allowing negative and complex components) of exponentials and numerically solving the cumulative distribution function (CDF) for $e^{-x}$. Of the techniques have been proposed to compute ME random variables, our method is more efficient and can be applied to a wider subclass of ME distributions. Additionally, we have incorporated our RNG into OPNET and it could readily be integrated into other simulation packages as well. Distributions incorporated are specified through their moments, by a matrix representation (include Phase Type), or by selecting from a palette of common distributions (hyper-, hypo-, exponential). The accuracy of the RNG is determined by analyzing the first three moments of the generated random numbers. Finally, the performance of our RNG is compared to other methods to generate ME random variates.

## Timed Synchronizing Sequences

*Norbert Giambiasi and Claudia Frydman*

### Summary

State-identification experiments are designed to identify the final state of a DES, which is seen as a black box, when its initial state is unknown. A classical solution to this problem constitutes determining a Synchronizing Sequence or a Homing Sequence. In this paper, we show that some classical methods for state identification in untimed sequential machines can be easily extended to Timed Sequential Machines.

## Taxonomy of DEVS Variants

*Moon Ho Hwang*

### Summary

This paper clarifies the class hierarchy among DEVS and its variants in terms of their expressiveness. Like \cite {HwangC:2011}, the expressiveness of a given formalism is the scope of event trajectories that can occur to a model described by the formalism. However, unlike \cite{HwangC:2011}, the article follows a mathematical convention: a function is a mapping in which for a given value of domain, it maps to only one image of codomain. Due to this approach, the interpretation of DEVS is also restrict to `deterministic'. Finally, this paper clarifies the hierarchy of DEVS, FDDEVS, and Timed Automata (TA) and Clock-based DEVS in terms of their expressiveness.

## Modeling Attention Switching in Resource-constrained Complex Intelligent Dynamical Systems (RCIDS)

*Saurabh Mital and Bernard Zeigler*

### Summary

Sustainable natural systems require energy. This requirement of energy is proportional to the activity they manifest. In a scalable self-similar artificial system, information gateways at every level must limit the information/activity to-from their subsystems based on computational algorithms. We discuss some of the implemented algorithms in these gateways for focusing attention to the most active component. We validate that attention switching is an emergent property of such a system and happens when there is goal-directed behavior within the system or an agent. We describe the structural elements that are needed to deal with the bottom-up and top-down phenomenon and model the behavior using DEVS-based hierarchical system capable of focusing attention. We define resource-constrained complex intelligent dynamical system (RCIDS) and summarize various application areas that can leverage these concepts.

## Temporal Capabilities in Support of Conceptual Process Modeling using Object-Role Modeling

*Daniele Gianni, Paolo Bocciarelli and Andrea D'Ambrogio*

### Summary

Conceptual data modeling languages must be provided with temporal capabilities to support the data evolution throughout the execution of a conceptual process model. Asides from supporting the storage of historical data, temporal capabilities must also provide the means for verifying the consistency between the data temporal properties and the data modification resulting from the process execution. The Object-Role Modeling (ORM) language is a conceptual data modeling language that is based on the concepts of Fact (i.e. true statements on the represented world), Fact Type, and Fact Base (i.e. the set of all the Facts). Currently, the ORM language does not address the specification of Facts temporal properties, and therefore does not also support the verification of Facts variations during a process execution. The paper introduces an initial ORM overlay methodology that aims to laying the foundation of the conceptual modeling structures that can support the verification of temporal evolution of conceptual data models (i.e., whether a Fact can be asserted or retracted, depending on its temporal properties). Moreover, the overlay methodology also defines a temporal visual notation and an initial semi-formal temporal verbalization that eases the use of the methodology to the ORM modelers. A simple example illustrates the potential application of the overlay methodology.

## Computational Fluid Dynamic Solver Based on Cellular Discrete-Event Simulation

*Michael Van Schyndel and Gabriel Wainer*

### Summary

Computational Fluid Dynamics (CFD) deals with computing the equations of fluid flows using numerical methods instead of partial differential equations. The Discrete-Event System specification (DEVS) theory has already been used to approximate various continuous systems by applying a quantized state system approach. In this research, we experiment with a new method: using Cell-DEVS theory to create a uniform set of rules for CFD to apply to each cell and execute the state changes of the cells asynchronously. This harmonized set of state changes can effectively render the fluid dynamics, by applying the accurate rules that represents the behavior of the fluid.

## Simulation of Aircraft Boarding Strategies with Discrete-Event Cellular DEVS

*Shafagh Jafer and Wei Mi*

### Summary

Time is a critical factor in airlines industry. Among all factors contributing to an aircraft turnaround time, passenger boarding delays is the most challenging one. Airlines do not have control over the behavior of passengers, thus their only key in reducing passenger boarding time is in implementing efficient boarding strategies. In this work we attempt to use discrete-event cellular DEVS to provide a comprehensive evaluation of aircraft boarding strategies. We have developed a simulation benchmark consisting of various boarding strategies including Back-to-Front, Window Middle Aisle, and Reverse Pyramid. Our simulation models are highly precise and adaptive, providing a powerful analysis apparatus for investigating any existing or yet to be discovered boarding strategy. We explain the details of our models and present the results both visually and numerically to evaluate the three implemented boarding strategies. This research is an on-going effort aiming to optimize and reduce passenger boarding delays in commercial aircrafts.

## A Compact and Flexible C++ Framework to Support Modular Development of Hierarchical Dynamic Systems Simulators (Work in Progress)

*Adauto Luiz Mancini, Luís Gustavo Barioni, Hemerson Nobre Lima, Jefferson William Santos, Rodrigo Dias Ribeiro Silva, Edgard Henrique Santos and Fernando Rodrigues Teixeira Dias*

### Summary

This paper describes the core of an object-oriented simulation framework (SF), implemented in C++, to support hierarchical dynamic systems simulators development. The simulation framework (SF) presented herein arose from the need for a tool to facilitate and standardize the development of process-based simulation models in research projects at Embrapa (Brazilian Agricultural Research Corporation). This SF targeted modularity and simplicity of code to facilitate model development by multidisciplinary research teams and implementation by high turnover groups of student trainees. Model components, typically developed by teams of experts in specific processes, can be developed independently and later connected, sequentially or aggregated in a hierarchical way. The SF allows compiling simulators as libraries and provides a general interface to allow simulations to be carried out by client applications, e.g. graphical user interfaces, databases, statistical or mathematical packages. In contrast to other existing frameworks, this SF does not store the trajectories of the variables but allows the client application to get the values of the outputs along the simulation through the use of callbacks. The client application can store the variables trajectories in the most convenient way for its specific purpose. The SF supports continuous, discrete-event and hybrid simulations. An example application is provided.

## Devs-Based Case Management (Work in Progress)

*Shaowei Wang and Mamadou Traoré*

### Summary

The Object Management Group (OMG) defined Case Management Model and Notation (CMMN) in January 2013, which is a modeling specification for case management processes. However, no supporting tools exist until now, and the capability of simulation is not taken into account. For this reason, in this paper we present a DEVS-based case management system, with which case workers are able to manipulate with case models on one hand, and run the simulation on the other hand. Moreover, case workers are able to verify and validate models by using formal analysis, and obtain sufficient information in terms of system enactment. The capabilities are enabled through a model-to-model transformation, where the source model is CMMN models, and the target model is DDML (DEVS-Driven Modeling Language) models, where DDML is a high level modeling language for the simulation of discrete event systems. A case study is given to demonstrate the principles of CMMN to DDML transformation.

## Explicit Modelling of Causal Block Diagram Simulation Environments

*Hans Vangheluwe, Daniel Riegelhaupt, Sadaf Mustafiz, Joachim Denil and Simon Van Mierlo*

### Summary

In this paper, we propose to explicitly model and synthesize experimentation environments for the interactive simulation of Causal Block Diagram (also known as Synchronous Data Flow) models. We choose the Statecharts formalism as the most appropriate formalism to model and synthesize such an environment. We take inspiration from software debugging as well as from simulation experimentation to explicitly model the detailed reactive behaviour of our environment. We map program debugging techniques such as execution modes, steps, and breakpoints to the simulation domain. We further explore how to integrate the notion of simulation time for the purpose of both as-fast-as-possible and (scaled) real-time visualisation. This leads to an architecture where both the modal behaviour of the simulation kernel and the interaction with the experimenter are explicitly modelled and merged. We provide support for a (browser) client-server architecture, again making use of the features of Statecharts. We build the experimentation model on top of the model to be simulated by instrumenting the model-to-be-simulated. The entire Causal Block Diagram modelling, simulation, and experimentation environment described in this work is supported by our tool AToMPM, A Tool for Multi-Paradigm Modelling.

## Dynamic Data Driven Simulation with Soft Data

*Yuan Long and Xiaolin Hu*

### Summary

Dynamic data driven simulation dynamically assimilates observation data at runtime to improve the simulation results. Typically, the observations are “hard data” that are data collected from sensors. In this paper we consider dynamic data driven simulation with soft data, which are data coming from human reports. Compared with the quantified hard data, soft data are qualitative, fuzzy and subject to human judgment. This paper proposes a method to convert soft data information to quantified data based on fuzzy set theory, and then combines soft and hard data to carry out data assimilation. We apply this method to dynamic data driven simulation of wildfire spread and show that the accuracy of simulation is significantly improved by assimilating both hard and soft data. Keywords—Dynamic Data Driven Simulation; soft data; data assimilation; particle filter; wildfire simulation.

## Business Process Simulation: Transformation of BPMN 2.0 to DEVS Models (Work in Progress)

*Hassan Bazoun, Youssef Bouanan, Gregory Zacharewicz, Yves Ducq and Hadrien Boye*

### Summary

Industrial enterprises gradually move their goals towards production of physical products, but increasingly supplemented by intangible services to differentiate themselves from the competition. The study of these services, their set up and the evaluation of their efficiency is a rising research domain. In the frame of Model Driven Service Engineering Architecture (MDSEA), a service system is modeled from different point of views (static and dynamic) at the different MDSEA levels (BSM, TIM, and TSM). Dynamicof such system deals with simulation; in consequence it needs a sound M&S formalisms for simulation activities.Accordingly, this paper presents the simulation of service systems based on DEVS models. It defines a transformation approach of BPMN models into DEVS simulation models based on the metamodel approach, and describes the enrichment of obtained DEVS models with performance indicators (time and costs).

## High Level Modeling of Elastic Circuits In SystemC

*Mohamed Ammar Ben Khadra, Yu Bai and Klaus Schneider*

### Summary

Synchronous design is currently by far the mainstream design paradigm of digital circuits. However, the move to modern nano-meter technologies has brought unprecedented delay variability issues. That makes maintaining clock synchronization challenging and costly in terms of power and area. Elastic circuits is an emerging method for tackling delay variability while avoiding the technology disruption and design issues of asynchronous circuit design. We discuss a model-based approach to elastic circuits that starts from a system (circuit) specified in the synchronous language Quartz. The system is then elasticized i.e. partitioned to an elastic network consisting of inter-connected synchronous modules. The scope of this work is on synthesizing the elastic network by generating code for SysteMoC which is an actor-oriented modeling library based on SystemC. That enables rapid simulation of different partitioning and scheduling strategies at a high-level of abstraction. We have developed a synthesis library capable of generating code for most Quartz features including all of its datatypes. We show some experimental results based on synthesizing different synchronous models that have been elasticized using a simple partitioning strategy.

## Semantic Mashups for Simulation as a Service with Tag Mining and Ontology Learning

*Sixuan Wang and Gabriel Wainer*

### Summary

Nowadays, there is a trend for delivering the Simulation as a Service using web-based/cloud-based services. Existing simulation services cannot be easily discovered and com-posed. Although semantic mashups have become popular for implementing service composition in the Web 2.0, there are yet no semantic mashups applications focusing on modeling and simulation. Here, we propose the first existing layered architecture based on semantic mashups improving the composition of Simulation as a Service. Besides, we propose using ontology learning and tagging systems to avoid pre-defined ontology efforts and to increase the automation of composition through user participation. The general idea is to mine tag signatures from the user-interested simulation-related services automatically, to generate a tag ontology tree from the mined tag signatures automatically, and then to compose the services based on the learnt tag tree ontology. This unique approach for simulation services mashups can boost the reusability, integration, interoperability of Simulation as a Service.

## Sprat: Hierarchies of Domain-Specific Languages for Marine Ecosystem Simulation Engineering (Work in Progress)

*Arne Johanson and Wilhelm Hasselbring*

### Summary

Scientific software is becoming more complex and its development nowadays is often an interdisciplinary process in which usually scientists -- most of them without training in software engineering -- implement the software themselves. To help them achieve a good code quality, we propose to employ a process called Sprat based on the concept of hierarchies of domain-specific languages (DSLs). In such a hierarchy, every DSL constitutes an implementation platform for the DSL directly above it. Each role in the development process (i.e., a scientist from a specific discipline) implements a layer of the software in a DSL belonging to the hierarchy. Therefore, the scientists only deal with abstractions they are familiar with from their respective domain and a clear separation of components is attained. To evaluate the Sprat approach, we present its application to the development of the Sprat simulation -- a marine ecosystem model for long-term fish stock prediction.

# Symposium on Theory of Modeling & Simulation - DEVS 2 (TMS/DEVS 2)

# Abstract

## Toward Model-Driven Engineering Principles and Practices for Model Replicability and Experiment Reproducibility (Work in Progress)

*Joseph Ledet, Alejandro Teran-Somohano, Zachary Butcher, Levent Yilmaz, Alice Smith, Halit Oguztuzun, Orcun Dayibas and Bilge Kaan Gorur*

### Summary

Recent years have seen a proliferation of the use of simulation models in computational science. Most of these models have never been independently replicated by anyone but the original developer. Furthermore, there is a growing credibility gap due to widespread, relaxed attitudes in communication of experiments, models, and validation of simulations used in computational research. We examine various issues and challenges involved in model replication and simulation experiment reproducibility. Model-driven simulation engineering principles and model transformation concepts are adopted as solution strategies to improve replicability of models and reproducibility of experiments. A process model, an architectural framework, and an implementation strategy is introduced to address identified issues in simulation experiment management and model replication.

## RAMSAS4Modelica: a Simulation-Driven Method for System Dependability Analysis Centered on the Modelica Language and Related Tools

*Alfredo Garro and Andrea Tundis*

### Summary

The paper presents RAMSAS4Modelica, a method for supporting the Dependability. Analysis of systems centered on the Modelica language and related tools. RAMSAS4Modelica is the result of a redefinition of the four main phases of the RAMSAS method as well as of their activities and related work-products. Moreover, new activities have been introduced so to benefit of some proposed extensions to the Modelica language. These enhancements allow not only the modeling of dependability requirements but also their traceability and verification by combing Simulation with classical analysis techniques. Indeed, starting from a Modelica-based system design, such extensions also enable the generation of Fault Tree Diagrams for performing Fault Tree Analysis. The paper exemplifies these distinctive features of RAMSAS4Modelica through a case study concerning a Tank System.

## A Model-Based Approach To Modeling a Hybrid Simulation Platform (Work in Progress)

*Asli Soyler Akbas, Konstantinos Mykoniatis, Anastasia Angelopoulou and Waldemar Karwowski*

### Summary

The availability of large data and immense improvements in technology have extended the boundaries of simulation modeling. As the intricacy of the simulated systems has been increasing, challenges in the process of modeling also emerged due to complexities hidden in different levels of the system. The purpose of this paper is to initiate the design of a framework for extrapolating a hybrid simulation model, composed of agent-based and system dynamics models, from its model-based architecture designed using Systems Modeling Language (SysML). The process is recognized as complex adaptive and a software training management system (STMS) is selected to demonstrate the initial research findings. Furthermore, the ongoing efforts to develop the simulation model of STMS, which can support organizations in critical decision making, and requirements and risk management, using a model-based systems engineering approach.

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## How to Avoid Model Interferences for Test-driven Agile Simulation Based on Standardized UML Profiles (Work in Progress)

*Vitali Schneider, Anna Yupatova, Winfried Dulz and Reinhard German*

### Summary

A main goal of the Test-driven Agile Simulation (TAS) approach is to improve the overall quality of the development process of complex systems. The approach is premised on the combination of the standard model-based engineering, simulation, and testing techniques. It provides the transformation of specification models to executable simulation code using standardized model-to-text transformation methods. By simulating a given system and running tests on it, we intend to provide a cheap and agile technique to validate the involved specification models. To cover all aspects existing in such a multidisciplinary domain we use UML as a common base language and apply multiple specialized extension profiles standardized by the OMG group. Thus, we use the SysML profile to model requirements as well as the high level structure and behavior of system elements. For non-functional properties, time and analysis aspects the MARTE profile is employed. Furthermore, UTP is used to satisfy testing aspects. In this paper we discuss the modeling methodology for the TAS approach based on the combination of these standards. Thereby, we focus on the main challenges of such combination and implement a strategy that allows avoiding conflicts caused by the overlapping specifications of the used profiles.

## Generation of Co-simulation Compliant Functional Mock-up Units From Simulink, Using Explicit Computational Semantics (Work in Progress)

*Bart Pussig, Joachim Denil, Paul De Meulenaere and Hans Vangheluwe*

### Summary

With the advent of Software-Intensive and Cyber-Physical Systems, heterogeneous formalisms are used to model different parts of the system. Co-simulation is often used to simulate the heterogenous models simultaneously with exchange of information. One emerging industry standard in this field is the Functional Mock-up Interface. This standard defines the interface for such a co-simulation, using so called Functional Mock-up Units (FMUs). These FMUs are zipfiles containing XML-files and C-code. The C-code consists of the model and its solver. Nowadays solvers are coded instead of being explicitly modeled. However, this does not allow straightforward analysis or detection of e.g. algebraic loops and optimization possibilities. Explicitly modeling the solvers might offer a solution to overcome these limitations, since this allows for the use of model-driven engineering techniques, like model transformations. The paper will present a method to generate FMUs from Causal Block Diagram models, more specific Simulink models, with explicit modeled ODE solvers. The execution performance is compared between FMUs with explicitly modeled solvers and FMUs with coded solvers. We conclude that modeling the solver has a significant positive impact on the run-time efficiency of the generated FMU.

## Stochastic Hierarchical Simulation

*Leandro Watanabe and Chris Myers*

### Summary

This paper describes a stochastic hierarchical simulation methodology which has been implemented within iBioSim, a tool used to model, analyze, and visualize genetic circuits. Many biological analysis tools flatten out hierarchy before simulation, but there are many disadvantages associated with this approach. First, the memory required to represent the model can quickly expand in the process. Second, the flattening process is computationally expensive. Finally, when modeling a dynamic cellular population within iBioSim, inlining the hierarchy of the model is inefficient since models must grow dynamically over time. This paper discusses a new approach to handle hierarchy on the fly to make the tool faster and more memory-efficient. This approach yields significant performance improvements as compared to the former flat analysis method.

# Symposium on Theory of Modeling & Simulation - DEVS 2 (TMS/DEVS 2)

## Abstract

### Empowering Business Process Simulation Through Automated Model Transformations

*Paolo Bocciarelli, Andrea D'Ambrogio, Andrea Giglio, Emiliano Paglia and Daniele Gianni*


#### Summary

Simulation is one of the most relevant techniques that can be used in the business process management domain to effectively enact a continuos enhancement of business processes (BPs). However, the effectiveness of BP simulation is still limited for several reasons (e.g., lack of simulation know-how of BP analysts, simulation model parameters that can be hard to gather, large semantic gap between the business process model and the simulation model). To overcome these limitations, this paper proposes a model-driven method that introduces a set of model transformations to automate the generation of executable simulation code of a BP from its abstract definition in BPMN, the standard language for specifying business processes. The simulation code is specified in eBPMN, a Java-based domain-specific language that has been designed and implemented according to the BPMN execution semantics.


### On the Representation of Dynamic Topologies: The Case for Centralized and Modular Approaches

*Fernando Barros*


#### Summary

In the development of formalism for representing models with a dynamic structure two policies have emerged: centralized and distributed. In this paper we compare these two approaches under several criteria, including, modularity, implementability and predictability. While distributed control strategies seem to enable a better representation for some systems that have no centralized control over their topology, we show that this advantage is only apparent since ultimately a central manager is required to enforce decisions, irrespective to the nature of the decision process itself. To make the comparison we use HFSS, a centralized formalism, and an hypothetical version of HFSS based on distributed principles.

## A New Highly Parallel Non-Hermitian Eigensolver

*Ping Tak Peter Tang, James Kestyn and Eric Polizzi*

### Summary

Calculating portions of eigenvalues and eigenvectors of matrices or matrix pencils has many applications. An approach to this calculation for Hermitian problems based on a density matrix has been proposed in 2009 and a software package called FEAST has been developed. The density-matrix approach allows FEAST's implementation to exploit a key strength of modern computer architectures, namely, multiple levels of parallelism. Consequently, the software package has been well received and subsequently commercialized. A detailed theoretical analysis of Hermitian FEAST has also been established very recently. This paper generalizes the FEAST algorithm and theory, for the first time, to tackle non-Hermitian problems. Fundamentally, the new algorithm is basic subspace iteration or Bauer bi-iteration, except applied with a novel accelerator based on Cauchy integrals. The resulting algorithm retains the multi-level parallelism of Hermitian FEAST, making it a valuable new tool for large-scale computational science and engineering problems on leading-edge computing platforms.

## GPU Virtualization for High Performance General Purpose Computing on ESX Hypervisor

*Lan Vu, Hari Sivaraman and Rishi Bidarkar*

### Summary

Graphics Processing Units (GPU) have become important components in high performance computing (HPC) systems for their massively parallel computing capability and energy efficiency. Virtualization technologies are increasingly applied to HPC to reduce administration costs and improve system utilization. However, virtualizing the GPU to support general purpose computing presents many challenges because of the complexity of this device. On VMware's ESX hypervisor, DirectPath I/O can provide virtual machines (VM) high performance access to physical GPUs. However, the technology does not allow multiplexing for sharing GPUs among VMs and is not compatible with vMotion, VMware's technology for transparently migrating VMs among hosts inside clusters. In this paper, we address these issues by implementing a solution that uses “remote API execution” and takes advantage of DirectPath I/O to enable general purpose GPU on ESX. This solution, named vmCUDA, allows CUDA applications to run concurrently in multiple VMs on ESX while sharing the GPU(s). Our solution requires neither recompilation nor even editing of the source code of CUDA applications. Our performance evaluation has shown that vmCUDA introduces an overhead of 0.6% - 3.5% for applications with moderate data size and 14% - 20% for those with very large data (e.g. 13GB - 231GB in our experiments).

## Beat-based Parallel Simulated Annealing Algorithm on GPGPUs for the Mirrored Traveling Tournament Problem

*Saurabh Jha and Vijay Menon*

### Summary

The problem of scheduling sports leagues has received considerable attention in recent years, especially since mathematically optimized schedules often have a large impact both economically and environmentally. The Mirrored Traveling Tournament Problem (mTTP) is an optimization problem that represents certain types of sports scheduling where the main objective is to minimize the total distance traveled by all the participating teams. In this paper, we propose a GPU based parallel simulated annealing algorithm for mTTP and test the available instances using NVIDIA’s Compute Unified Device Architecture (CUDA). The approach taken here, especially keeping in mind the computationally intensive nature of mTTP, involves exploiting the thread level parallelism available in CUDA - where each thread starts with a random schedule from the discrete solution space and cooperate at regular intervals - called 'Beats' - to search for optimized solutions. Additionally, in this paper, we also introduce a new mTTP instance - IPL09 - which concerns with arriving at an optimized schedule for the Indian Premier League - one of India’s most popular sports league. Applying the proposed BbmTTP to IPL09 we were successful in generating a schedule which reduced the total distance traveled by 30.20%, or nearly 37,000 kilometres.

## Parallel Cooperating Ant Colonies with Improved Periodic Exchange Strategies

*Bishad Ghimire, David Cohen and Ausif Mahmood*

### Summary

Keywords: Ant Colony Optimization, Ant Colony System, Max-Min Ant Colony, Parallel ACO, Meta-heuristics, Soft Computing, Travelling Salesman Problem.

Abstract Ant Colony Optimization (ACO) has consistently demonstrated superior results to other meta heuristics such as Genetic Algorithms, Particle Swarm Optimization, Simulated Annealing and Kohonen Self Organizing Maps. With the wide availability of multicore processors and multi-CPU shared memory machines, the parallelization of ACO has recently been investigated and different information exchange strategies between ant colonies have been proposed and investigated. However, unlike the island model in a genetic algorithm where the periodic exchange of a small population between islands results in a better overall optimization, the best performing parallel ACO algorithm is concluded to be the one running parallel independent runs (PIR) i.e., without any information exchange [6]. In this paper, we propose some new information exchange strategies between parallel ant colonies and demonstrate that one of our new techniques consistently converges faster as well as produces better optimization results than the PIR model that was previously considered to be the best parallel ACO approach. We also combine both the modified Ant Colony System (ACS) as well as the Max-Min ACO algorithms in a parallel cooperative ant colony design to enhance the overall optimization. For a fair comparison between our new algorithm and the PIR model, we provide reproducible results on the TSPLIB benchmarks (i.e., with an option to start with a fixed seed value for the random number generator) to show the effectiveness of our new parallel cooperating ACO algorithm.

## CufftShift: High Performance CUDA-accelerated FFT-Shift Library

*Marwan Abdellah*

### Summary

In this paper we present a high performance implementation for 1D/2D/3D FFT-shift operations on the GPU relying on CUDA. This work complements what's missing FFT-shift implementation in the CUFFT library.

## PseudoNUMA for Reducing Memory Interference in Multi-core Systems

*Gangyong Jia, Jian Wan, Xi Li, Dong Dai and Chao Wang*

### Summary

The growing gap between microprocessor speed and DRAM speed is a major problem that computer designers are facing. In order to narrow the gap, it is necessary to improve DRAM’s speed and throughput. Moreover, on multi-core platforms, DRAM memory shared by all cores usually suffers from the memory contention and interference problem, which can cause serious performance degradation and unfairness of the overall system. To address these problems, this paper proposes techniques to take advantage of partitioning cores, threads and memory banks into group to form pseudoNUMA architecture which each thread runs on one core group using unique memory bank group to reduce interference among different groups. We implement pseudoNUMA in both 4-core and 8-core platforms. Experimental results show pseudoNUMA reduces 9.8% and 11.4% row buffer miss rate than buddy algorithm on average and improves 15.3% and 16.5% fairness on average in 4-core and 8-core respectively. Moreover, pseudoNUMA saves 6.1% of the energy consumption of memory system.

## Cache Matching: Thread Scheduling to Maximize Data Reuse

*Wei Zhang, Fang Liu and Rui Fan*

### Summary

Datacenters today often execute multiple data-intensive threads concurrently. To improve the latency to slow external storage, data is often cached in memory. The way in which the cache is shared between concurrent threads has a significant impact on overall system performance. Two widely used methods are processing thread requests on a first-come first-serve (FCFS) basis, and partitioning the cache and assigning each thread its own region. In some types of applications, certain data may be requested by multiple threads. Neither FCFS nor cache partitioning effectively capture this type of \emph{inter-thread} data locality. To show this, we first prove that partitioning leads to an $O(m^{\frac{1}{2} - \epsilon})$ times lower hit rate compared to not partitioning when processing $m$ threads containing random read requests, where $\epsilon > 0$ is an arbitrarily small constant. We then propose the \emph {Cache Matching (CM)} algorithm which captures data locality both within threads and across multiple threads. The algorithm uses a small buffer to store parts of the incoming request sequences, then interleaves these into a single sequence that has a high cache hit rate. We compare CM against FCFS and uniform cache partitioning on a variety of synthetic workloads capturing different data characteristics such as item popularity, temporal locality, and data size. For 16 threads, CM achieves on average 2.18x and 4.95x higher hit rate than the alternatives, and is up to 3.03x and 12.64x better on certain workloads.

## A Characterisation Of The Workload On An Engineering Design Grid

*Andrew Burkimsher, Iain Bate and Leandro Soares Indrusiak*

### Summary

Computer-aided engineering design uses simulations to explore a design space and identify promising regions. The hierarchical structure of the engineering design process suggests distinctive workload patterns that we believe are common in industry, yet have been little captured by previous characterisations. Selecting a scheduling policy that is ill-suited to the workload it serves may lead to poor performance. This paper characterises the workload run on the private grid of a large aircraft manufacturer over a period of 30 months. Cycles of load at daily and weekly scales are observed, and there are extended periods where the grid operates at saturation and work must queue. A method of creating workloads containing such cycles at a given total load percentage by adjusting inter-arrival times is given. Task execution times are demonstrated to be dis- tributed in a log-uniform way, and an algorithm is given to generate execution times following this distribution. Graphs of dependencies between tasks are shown to have variation in node degree greater than that of random graphs, and a process of constructing dependency graphs following the observed distribution is described.

## A High-Level Programming Model to Ease Pipeline Parallelism Expression on Shared Memory Multicore Architectures

*Nader Khammassi and Jean-Christophe Le Lann*

### Summary

Pipeline execution pattern is a recurrent execution configuration in many application domains involving stream processing such as digital signal processing and data compression. Unfortunately, low-level parallel programming models exacerbate the difficulties of expressing pipeline parallelism and require verbose restructuring of the code and complex scheduling techniques to perform efficient execution on modern multicore architectures. High-level programming models are in high-demand as they reduce the burdens of programmers, ease parallelism expression and handle transparently tasks scheduling and communication. XPU[20] is a high-level programming model which aims to ease parallelism expression through exploiting meta-programming capabilities of standard C++. In this paper we focus on pipeline parallelism expression, we present the programming model which allows pipeline construction. We describe its internal design and the run-time implementation of the pipeline execution pattern and finally we show an example of image processing application implementing real-time adaptive edge detection algorithm. We reuse an existing sequential implementation to implement a pipelined version using both XPU and TBB. We compare the two versions in term of expressivity and performance. We note that XPU version performs about 20% faster than TBB on a 16-threads multicore platform and requires 80% less extra-code than TBB to express pipeline parallelism. Our experiments show that our programming model provides both programmability and execution efficiency.

## American Basket Option Pricing on a multi GPU Cluster

*Michael Benguigui and Francoise Baude*

### Summary

This article presents a multi GPU adaptation of a specific Monte Carlo and classification based method for pricing American basket options, due to Picazo [1]. The first part relates how to combine fine and coarse grained parallelization to price American basket options. A dynamic strategy of kernel calibration is proposed. Doing so, our implementation on a reasonable size (18) GPU cluster achieves the pricing of a high dimensional (40) option in less than one hour against almost 8 as observed for runs we conducted in the past [2], using a 64-core cluster (composed of quad-core AMD Opteron 2356). In order to benefit from different GPU device types, we present a dynamic strategy to load balance GPU calculus which greatly improves the overall pricing time. An analysis of possible bottleneck effects demonstrates that there is a sequential bottleneck due to the training phase that relies upon the AdaBoost classification method, which prevents the implementation to be fully scalable, and so prevents to envision further decreasing pricing time down to handful of minutes. For this we propose to consider using Random Forests classification method: it is naturally dividable over a cluster, and available like AdaBoost as a black box from the popular Weka machine learning library. However our experimental tests will show that its use is costly.

## Fast Radix Sort for Sparse Linear Algebra on GPU

*Lukas Polok, Viorela Ila and Pavel Smrz*

### Summary

Fast sorting is an important step in many parallel algorithms, which require data ranking, ordering or partitioning. Parallel sorting is a widely researched subject, and many algorithms were developed in the past. In this paper, the focus is on implementing highly efficient sorting routines for the sparse linear algebra operations, such as matrix - matrix multiplication, or matrix factorization. We propose a fast and simple to implement variant of parallel radix sort algorithm, suitable for GPU architecture.
Extensive testing on both synthetic and real-world data shows, that our method outperforms other similar state-of-the-art implementations. Our implementation is bandwidth-efficient, as it achieves sorting rates comparable to the theoretical upper bound of memory bandwidth. We also present several interesting code optimizations relevant to GPU programming.

## Solving 3D incompressible Navier-Stokes equations on hybrid CPU/GPU systems

*Yushan Wang, Marc Baboulin, Karl Rupp, Olivier Le Maître and Yann Fraigneau*

### Summary

This paper describes a hybrid multicore/GPU solver for the incompressible Navier-Stokes equations with constant coefficients, discretized by the finite difference method. By applying the prediction-projection method, the Navier-Stokes equations are transformed into a combination of Helmholtz-like and Poisson equations for which we describe efficient solvers. This paper proposes a new implementation that takes advantage of GPU accelerators. We also present numerical experiments on a current hybrid machine.

## Tracking constrained clustering solutions with a probability-one homotopy map

*David Easterling, Layne Watson and Naren Ramakrishnan*

### Summary

Many algorithms for constrained clustering have been developed in the literature that aim to balance vector quantization requirements of cluster prototypes against the discrete satisfaction requirements of constraint (must-link or cannot-link) sets. A significant amount of research has been devoted to designing new algorithms for constrained clustering and understanding when constraints help clustering. However, no method exists to systematically characterize solution sets as constraints are gently introduced and how to assist practitioners in choosing a sweet spot between vector quantization and constraint satisfaction. A homotopy method is presented that can smoothly track solutions from unconstrained to constrained formulations of clustering. Experiments demonstrate how the new homotopy method helps identify better tradeoffs and reveals insight into the structure of solution sets not obtainable using pointwise exploration of parameters.

## Multi-GPU/CPU Deflated Preconditioned Conjugate Gradient for bubbly flow solver

*Rohit Gupta, Martin B. van Gijzen and Kees Vuik*

### Summary

We present a Multi-GPU/CPU implementation of Deflated Preconditioned Conjugate Gradient (DPCG) to solve a highly ill-conditioned linear system arising from the discretized Pressure-correction equation on GPUs and CPUs. We discuss the challenges and choices in such an implementation with respect to communication and data layout. We present results of our implementation for systems having up to $16$ million unknowns. Across $8$ GPUs (on distinct nodes connected via MPI) our code achieves atleast $2$ times speedup compared to $32$ cores (across $4$ distinct nodes connected via MPI). Comparing with $64$ CPU cores across $8$ nodes the same GPU version proves to be comparable in terms of wall-clock time.

## Fortran 95 Implementation of QNSTOP for Global and Stochastic Optimization

*Brandon Amos, David Easterling, Layne Watson, Brent Castle, Michael Trosset and William Thacker*

### Summary

A serial Fortran 95 implementation of the QNSTOP algorithm is presented. QNSTOP is a class of quasi-Newton methods for stochastic optimization with variations for deterministic global optimization. This discussion provides results from testing on various deterministic and stochastic optimization functions.

## A Performance Study Of InfiniBand Fourteen Data Rate (FDR)

*Qian Liu and Robert Russell*

### Summary

This paper evaluates the performance of Remote Direct Memory Access (RDMA) using the InfiniBand Fourteen Data Rate (FDR) Channel Adapter (CA). InfiniBand RDMA allows applications to move data directly between nodes without kernel intervention or extra data copying. While RDMA transfer is fast, this study shows that performance can be hindered by factors such as message buffer misalignment, inefficient work request signaling, a cache limitation in the CA, and inefficient CPU and NUMA memory access. This paper presents recommendations for achieving optimal performance when using the RDMA_WRITE_WITH_IMM verb. We are able to improve performance by up to 25% with no extra overhead added. In addition, we develop a formula to predict the best combination of user-level RDMA operational parameters which will generate the nearly-best performance and bypass the CA cache limitation. Verification of our formula reveals that our prediction is accurate within a 1% margin.

## Efficient Parallel Image Clustering and Search on a Heterogeneous Platform

*Dong Ping Zhang, Lifan Xu and Lee Howes*

### Summary

We present a parallel image clustering and search framework for large scale datasets that does not require image annotation, segmentation or registration. This work addresses the image search problem while avoiding the need for user-specified or auto-generated metadata. Instead we rely on image data alone to avoid the ambiguity inherent in user-provided information. We propose a parallel algorithm exploiting heterogeneous hardware resources to generate global descriptors for the set of input images. Given a group of query images we derive the global descriptors in parallel. Secondly, we propose to build a customisable search tree of the image database by performing a hierarchical K-means (H-Kmeans) clustering of the corresponding descriptors. Lastly, we design a novel parallel vBFS algorithm to search through the H-Kmeans tree and locate the set of closest matches for query image descriptors. To validate our design we analyse the search performance and energy efficiency under a range of hardware clock frequencies and in comparison with alternative approaches. The result of our analysis shows that the framework greatly increases the search efficiency and thereby reduces the energy consumption per query.

## Multiobjective Optimization Using Direct Search Techniques

*Shubhangi Deshpande and Layne Watson*

### Summary

A new Pareto front approximation method is proposed for multiobjective optimization in practical engineering and scientific computing problems. The proposed algorithm is one of the very few methods in the catagory of deterministic scalarization approches that can handle any number of objectives to produce well distributed Pareto fronts. A new adaptive weighting scheme is proposed for scalarizing a multiobjective optimization problem. Another contribution is the generalization of the star discrepancy based performance measure for problems with more than two objectives. A serial version of the algorithm is described and evaluated using three test problems from the literature with varying numbers of objectives. A possible extension of the proposed method to support high performance parallel and/or distributed computing is discussed.

## Autonomous Control of Issue Queue Utilization for Simultaneous Multi-Threading Processors

*Yilin Zhang and Wei-Ming Lin*

### Summary

Simultaneous Multi-Threading (SMT) is a technique that improves overall system performance by allowing concurrent execution of multiple independent threads with sharing of key datapath components and better utilization of the resources. Congested shared resources due to slower threads can easily lead to heavily under-used resources and thus an undesirable performance outcome. Most of existing resource allocation and distribution techniques adjust the resource allocation in real time based on certain pre-determined allocation parameter settings attempting to lead to better performance. Such an improved performance is contingent on the assumptions that the system environment parameters and workload characteristic remain unchanged. Once either is changed the same settings may no longer lead to the same performance gain. In this paper, we propose an adaptive technique to allow for a complete autonomous adjustment process to control the distribution of a critical shared resource -- Issue Queue (IQ) -- in an SMT system. The proposed process adjusts in real time the resource distribution based on the impact to performance caused by the previous adjustment, with a simple algorithmic guideline in constantly aiming to improve performance from one adjustment to the next. No a priori information in system environment parameters or workload characteristics is needed for this process to acquire beforehand for the autonomous adjustment. Our simulation results show that our proposed technique is able to improve the system's overall IPC by an average of 7.9% for a 4-threaded workload and 12.5% for an 8-threaded workload, as opposed other known adaptive techniques achieving similar performance under one condition but degrading poorly under another.

## Energy Measurement and Prediction for Multi-threaded Programs

*Thomas Rauber, Gudula Rünger and Michael Schwind*

### Summary

For many years, runtime performance has been the main concern in high-performance and parallel computing. However, power and energy consumption become more and more important, especially for large-scale supercomputer systems. Energy-saving methods, such as dynamic voltage frequency scaling, have been integrated in recent processor architectures. To estimate the effectiveness of techniques for energy-saving at application level, it would be advantageous to have a model for predicting the power consumption of program code before runtime without measuring the actual power and energy performance. In this article, we investigate the power and energy consumption for the execution of multi-threaded programs, considering the PARSEC and the SPLASH benchmarks on recent Intel processors as examples. In particular, we perform experiments for measuring the power and energy consumption and, based on these values, we investigate several power and energy models suggested in the literature as well as a new heuristic model. We show that especially the heuristic model is able to predict the power and energy consumption quite accurately for a wide range of frequencies.

## A Large-Scale Mobile Facial Recognition System using Embedded GPUs

*Ahmed El-Mahdy and Radwa Elsersy*

### Summary

With the rapid growth of mobile phones technology, there is a strong potential for porting server-class applications into the mobile platform. This paper considers the problem of face recognition, and proposes a system that exploits embedded GPUs for allowing for large scale, face recognition. The sys- tem provides a novel parallel Fischerface recogniser imple- mentation that allows for a configurable and scalable num- ber of parallel threads. The system also exploits the large secondary storage available, to further scale the recognition database. An initial prototype implementation allows up to 1024 face database size with a recognition time of 210ms on iPhone5 system. The GPU resulted in nearly 10x improve- ment in performance and 7x reduction in power.

## Accelerating Option Risk Analytics in R using GPUs

*Matthew Dixon, Sabbir Khan and Mohammad Zubair*

### Summary

Broadly, a major prerequisite for analytics applications is robustness to modeling idiosyncrasies. As a result, there is a demand for comprehensive model exploration and validation in high level statistical programming environments such as R. Many financial applications require on-demand processing, which in turn requires fast modeling and calibration computations. In this paper we describe our work on speeding up the calibration of a Heston stochastic volatility model, a financial application, on GPUs. The Heston volatility model is used extensively across the capital markets to price and measure the market risk of exchange traded financial options. However, a typical R based implementation of the Heston model calibration on a CPU does not meet the performance requirements for sub-minute level trading, i.e. mid to high frequency trading. The calibration of a Heston model is performed over M option data points which remains fixed during the calibration computation. The most computation intensive part of this computation is the error function which estimates the error between market observed and model option prices.

We have implemented the error function using a Map-Reduce design pattern leading to efficient implementation on various architectures including GPUs. In this paper, we describe the implementation of a GPU optimized kernel for this computation that can be called by the R script performing the calibration process. For M = 1024 we demonstrate a factor of 760x improvement in the overall calibration time over the R sequential implementation by off-loading Error Function on a system with an Intel Core i5 processor and NVIDIA Tesla K20c (Kepler architecture) consisting of 2496 cores. Note that not all the performance gain is due to the GPU- partly it is due to the reduction in the overhead of R for the Heston model calculation. For comparison we also implemented the calibration code using C/C++. We observed a speed up of 230x for the GPU based implementation over the C/C++ indicating that a factor of 3.4x improvement is due to avoiding the R overhead for the Heston model calculation. However, the overall calibration time using R based optimization routines combined with the GPU off-loaded error function is comparable to a C/C++ GPU based calibration code.

## Accelerated Design Space Pruning for CMP Memory Architectures (Work in Progress)

*Hadrien Clarke, Antoine Trouvé and Kazuaki Murakami*

### Summary

We propose an approach to help the design space pruning process of CMP memory architectures by making several simplification hypotheses. Mainly, we assume that performance mostly depends on data locality and the closer a datum is in the memory architecture from the core requesting it, the better. We therefore focus on tracking memory accesses and data localities. Also, we associate an access cost reflecting relative technology performance with each cache in the targeted architecture. By collecting the number of accesses made by each core under a given workload to the memory banks, and using their respective access costs on the other hand, a performance score can be computed. Architectures can then be compared by scores instead of using any concrete absolute metrics. The implementation of a trace-driven simulator incorporating these assumptions provided appreciable speedups at the expense of precision compared to other cycle-accurate simulators. Because of the limited accuracy, we try to identify under what conditions this method is adequate.

## Deterministic Partitioning Strategy to Parallelize the Constraint Programming Search Space

*Tarek Menouer and Bertrand Le Cun*

### Summary

This paper presents a deterministic parallelization to explore a Constraint Programming search space. This work is an answer to an industrial project named PAJERO, which is in need of a parallel constraint solver which always responds with the same solution whether using sequential or parallel machines. It is well known that parallel tree search changes the order in which the exploration of solution space is done. In the context where the first solution found is returned, using a different number of cores may change the returned solution. In the literature, several non deterministic strategies have been proposed to parallelize the exploration of Constraint Programming search space. Most of them are based on the Work Stealing technique used to partition the Constraint Programming search space on demand and during the execution of the search algorithm. Our study focuses on the determinism of the parallel search versus the sequential one. We consider that the sequential search algorithm is deterministic, then propose an elegant and simple solution introducing a total order on the nodes in which the parallel algorithm always gives the same solution as the sequential one regardless of the number of cores used. To evaluate this deterministic strategy, we ran tests using the Google OR-Tools Constraint Programming solver on top of our parallel Bobpp framework. The performances are illustrated by solving Constraint Programming problems modeled in FlatZinc format.

## Transit-oriented Development (TOD): Analyzing Urban Development and Transformation in Stockholm

*Todor Stojanovski, Tesad Alam and Marcus Janson*

### Summary

Transit-oriented development (TOD) is a policy to design and develop dense, attractive and walkable urban environments that enhance the use of public transportation. In a broader perspective, TOD deals with synchronizing urban life—its growth and development, its everyday activities and mobility patterns—with public transportation systems. Urban development is a product of negotiation, a political struggle between actors and stakeholders, their visions and interests, and their powers to induce urban change. In the background of urban politics, social and physical factors limit the potential to develop or transform. In this study, this potential for urban development and transformation is analyzed for three neighborhoods along the Tunnelbana, a subway line in Stockholm, with the help of geographic information systems (GIS) software. Two development scenarios are explored: one with TOD applied, the other with it dominating as a policy.

## Tensegrity Systems Acting as Windbreaks: Form Finding and Fast Fluid Dynamics Analysis to Address Wind Funnel Effect

*Panagiota Athanailidi, Ava Fatah gen Schieck, Vlad Tenu and Angelos Chronis*

### Summary

Wind speed in urban areas can create an unpleasant and dangerous environment, known as wind funnel effect, resulting in the non-use of urban spaces. This paper investigates a simulation-based method for designing tensegrity systems to mitigate the wind funnel effect in urban canyons, focusing on form finding of tensegrity systems. The following methodology was proposed: (1) modeling tensegrity structures accurately using Genetic Algorithms (GA) to find the most effective cubic units of struts and cables; (2) re-creating the wind funnel effect in a passage located between two parallel buildings; (3) finding the characteristics of the most porous windbreak structure that could effectively solve the funnel effect in the passage with the use of GA for optimization; (4) using tensegrity units acquired from step 1 to construct a windbreak with the characteristics found in step 3. All steps employed Fast Fluid Dynamic (FFD) simulations to test wind behavior in each environment. After this thorough investigation, the final results from the above steps showed that a proper combination of tensegrity units determined in step 1 is able to address the wind funnel effect effectively, creating a windbreak in a passage between parallel buildings.

# Symposium on Simulation for Architecture and Urban Design (SimAUD)

# Abstract

## Simulation Supported Precedent Analysis: Disclosing the Sustainable Attributes of Vernacular Structures in the Southern U.S.

*Tim Frank*

### Summary

Environmental case study analysis has long served the design profession in describing complex building behavior, putting architectural design strategies to task in order to offset the need for supplemental high-grade energy systems. Knowledge of these strategies becomes crucial for designers practicing in the Southern United States, a region that demands effective low-cost strategies that perform well within a fully humid climate marked by distinct variations. However, traditional case study methods rely heavily upon methods of approximation, basing results on commonly held assumptions with little regard for the particular characteristics of place, people, and purpose that animate building performance. Rather than relying upon rule-of-thumb conjecture, low-resolution simulation platforms offer a highly interactive and diverse toolset to designers, facilitating testing sequences which acutely disclose how a range of geometric building configurations intensively shape the behavior of light, heat, and airflow present within the extensive environment. This paper explores the role of building simulation tools in the analysis of Southern vernacular structures, with emphasis on the tool's capacity to support heuristic procedures. Through multi-domain functionality, these tools enable iterative analysis across numerous time frames, producing and advancing crucial knowledge about the performance of vernacular building attributes. The findings from simulation supported precedent analysis underscore this role, expanding upon the inventory of passive architectural devices highlighted by James Marston Fitch to include permeable enclosures, centralized wind chambers, and narrow floor plates (Fitch, 1961).

## SAFEgress: A Flexible Platform to Study the Effect of Human and Social Behaviors on Egress Performance

*Mei Ling Chu, Paolo Parigi, Kincho Law and Jean-Claude Latombe*

### Summary

Studies of past emergency events have revealed that occupant behavior, local geometry, and environmental constraints affect crowd movement and govern evacuation. Occupants' social characteristics and the unique layout of buildings should be considered to ensure that egress systems can handle evacuee behavior. This paper describes an agent-based egress simulation tool, SAFEgress, which is designed to incorporate human and social behaviors during evacuations. Simulation results on two scenarios are presented. The first scenario illustrates the effects of the exiting strategies adopted by occupants on evacuation. The second scenario shows the influence of social group behavior on evacuations. By assuming different behaviors using this prototype, engineers, designers, and facility managers can study the important human factors during an emergency situation and thereby improve the design of safe egress systems and procedures.

## Towards Visualization of Simulated Occupants and their Interactions with Buildings at Multiple Time Scales

*Simon Breslav, Rhys Goldstein, Alex Tessier and Azam Khan*

### Summary

While most building simulation tools model occupancy using simple 24-hour profiles, researchers are applying machine learning and other advanced modeling approaches to simulate individual occupants and their interactions with buildings. For building designers to fully benefit from these increasingly advanced occupant models, visualizations must ultimately reveal subtle yet informative patterns contained in the simulation results. As a step in this direction, we focus on 3D animation and the challenges that arise when multiple time scales are involved. Specifically, we explore the use of stylized computer animation to clarify occupant movement, the use of cueing to draw attention to key events, and an original clock widget to consolidate time-related information.

# Symposium on Simulation for Architecture and Urban Design (SimAUD)

# Abstract

## Acacia: A Simulation Platform for Highly Responsive Smart Facades

*Daniel Cardoso Llach, Avni Argun, Dimitar Dimitrov and Qi Ai*

### Summary

Recent advances in material science and high-precision digital manufacturing methods, as well as the increased availability of low-cost sensing technologies and processing power, are making programmable responsive surfaces viable alternatives to traditional building materials. These advances bring about opportunities to redefine building skins as interactive components with significant impact on the environmental and aesthetic dimensions of architecture. However, current modeling and analysis software systems largely consider building materials as static entities, making the design and assessment of programmable responsive surfaces (such as surfaces of variable optical transmittance) considerably difficult. Expanding on our previous innovative research on organic electrochromic smart windows as architectural components (Cardoso Llach et al. 2009), we report on a new simulation environment, Acacia, for the design and analysis of highly responsive building facades. Unique to Acacia is its capacity to enable the modeling and assessment of façade behaviors in response to both environmental and human inputs.

## Typologies of Architectural Interaction: A Social Dimension

*Seoug Oh, Veronica Patrick and Daniel Cardoso Llach*

### Summary

Interactive architecture is concerned with exchanges between humans, environmental factors, and the built environment. These systems are commonly presented as instruments to a) maintain adequate levels of interior lighting and temperature adapting to occupants' needs, and b) reduce building energy consumption by autonomously regulating solar intake in response to environmental factors (Cardoso et al. 2011). While these approaches have yielded promising questions and applications, in this paper we are more interested in exploring interactive architecture's potential role as catalyst for social activity. First, we analyze a selection of contemporary, interactive architecture projects, proposing a set of typologies of architectural interaction driven by the kind of exchanges each project establishes with both occupants and the environment. Second, we test these typologies through a controlled experiment with a responsive artifact that we use as a platform to investigate different types of interactivity and their effects on social activity. In one study, for instance, our responsive artifact is programmed to respond solely to environmental factors. In the second study, it is programmed to respond exclusively to human input. By presenting the typologies, the prototypes, and our observations about the interactions they enable, this paper proposes a new way of thinking "socially" about interactive systems, expanding on a crucial ongoing discussion about the relationship between interactive buildings, humans, and the environment.

## Experimental Design of Energy Performance Simulation for Building Envelopes Integrated with Vegetation (WIP)

*Xiao Sunny Li, Ultan Byrne and Ted Kesik*

### Summary

Green façades have many benefits, yet few software tool and methods for architects have been developed to assess the quantitatve energy performance of green façades. This work-in-progress paper explores the methodologies of modeling and simulating the effects of green façades on wall surface temperatures. It proposes a partially parameterized workflow to compute the thermal performance of green façades, within a Rhinoceros®-based platform and its plug-ins (Robert McNeel & Associates, Seattle, WA). By calibrating the computed results with field measurements, the paper is able to identify the importance of accurate information about vegetated cover and growth rates in modeling a green façade's performance. Also, the paper identifies evaporative cooling by vegetation's transpiration as a key component contributing to cooling.

## Genetic Based Form Exploration of Mid-Rise Structures Using Cell Morphologies

*Omid Oliyan Torghabehi and Peter von Buelow*

### Summary

This research explores well-performing forms of mid-rise buildings which use cellular morphologies as perimeter bracing of the structure. The study is based on structural performance under earthquake loading. The geometry of the structure is created by parametric modeling following the principles of cellular space division. Optimization software is employed as a genetic based tool for exploration of design alternatives. The software combines parametric modeling, finite element performance simulation, and a genetic algorithm coupled with database storage. Externally braced frame structures consist of a braced load bearing system in the perimeter of the structure. In this study a parametric, vertical, spatially framed system is developed based on cellular morphology. The parametric model is used in a performance-oriented process of form generation guided by a genetic algorithm (GA). Using the database to store all of the evaluated design alternatives ,then exploration of desired solutions will be performed through data mining. A pallet of well performing design alternatives is generated as the exploration result.

## Optimizing the Form of Tall Buildings to Achieve Minimum Structural Weight by Considering Along Wind Effect

*Matin Alaghmandan, Mahjoub Elnimeiri, Anders Carlson and Robert Krawczyk*

### Summary

One of the most influential parameters in architectural and structural design of tall buildings, in addition to gravity loads, is the lateral load resulting from wind and earthquakes. Tall buildings have to be designed for a larger base shear resulting from wind forces rather than seismic forces; however, ductile detailing is used to account for seismic demands. The wind effect occurs primarily in two main modes of action: across wind and along wind. In this paper, a design method of tall buildings that considers integrated architectural and structural strategies to reduce the along wind effect in an effort to achieve the minimum weight of the structure is presented. This method creates an innovative computational workbench to design efficient tall buildings regarding the along wind effect by connecting an architectural parametric design procedure by AutoLisp (AutoCAD), a Computational Fluid Dynamics program (ANSYS), a structural analysis program (ETABS) and a genetic algorithm-based optimization procedure of ParGen.

## Comparison of Control Strategies for Energy Efficient Building HVAC Systems

*Mehdi Maasoumy and Alberto Sangiovanni Vincentelli*

### Summary

A framework for the design and simulation of a building envelope and an HVAC system is used to compare advanced control algorithms in terms of energy efficiency, thermal comfort, and computational complexity. Building models are first captured in Modelica [1] to leverage Modelica's rich building component library and then imported into Simulink [15] to exploit Simulink's strong control design environment. Four controllers with different computational complexity are considered and compared: a proportional (P) controller with time varying temperature bounds, a tracking linear quadratic regulator (LQR) controller with time varying tuning parameters, a tracking disturbance-aware linear quadratic regulator (d-LQR) controller with time varying tuning parameters which incorporates predictive disturbance information and a model predictive controller (MPC). We assess the performance of these controllers using two defined criteria, i.e. energy and discomfort measured with appropriate metrics. We show that the d-LQR and MPC, when compared to the P controller, manage to reduce energy by 41.2% and 46% respectively, and discomfort from 3.8 to 0. While d-LQR and MPC have similar performance with respect to energy and discomfort, simulation time in the case of d-LQR is significantly less than the one of MPC.

## Approximating Urban Wind Interference

*Samuel Wilkinson, Gwyneth Bradbury and Sean Hanna*

### Summary

A new approach is demonstrated to approximate computational fluid dynamics (CFD) in urban tall building design contexts with complex wind interference. This is achieved by training an artificial neural network (ANN) on local shape and fluid features to return surface pressure on test model meshes of complex forms. This is as opposed to the use of global model parameters and Interference Factors (IF) commonly found in previous work. The ANN is trained using shape and fluid features extracted from a set of evaluated principal (design) models (PMs). The regression function is then used to predict results based on shape features from the PM and fluid features from a one-off obstruction model (OM), context only, simulation. For the application of early-stage generative design, the errors (against CFD validation) are less than 10% centred standard deviation σ, whilst the front-end prediction times for the test cases are around 20s (up to 500 times faster than the CFD).

## Using Agent-Based Modelling to Simulate Occupants' Behaviours in Response to Summer Overheating

*Alaa Alfakara and Ben Croxford*

### Summary

This paper presents a pilot investigation of an ongoing research to model detailed occupants' behaviours when dealing with summer overheating in UK domestic buildings using agent-based modelling and a dynamic simulation model. The pilot model was built in REPAST to initially model the behaviours of two adults in a flat, controlling windows and mechanical cooling systems to achieve comfort. Two cases were considered; a base-case behaviour, and an improved-case behaviour. Thermal Analysis Simulation software (TAS) was used to model the flat, where hourly cooling and windows schedules produced by agents were fed into TAS to estimate cooling load and internal temperatures. Initial results showed a reduced usage of mechanical cooling and reduced cooling load under improved-case behaviour.

## Causality in Hospital Simulation based on Utilization Chains

*Gabriel Wurzer and Wolfgang E. Lorenz*

### Summary

The operation of complex buildings (e.g. airports, hospitals, industrial facilities, penitentiaries) is commonly simulated forward in time: Agents arrive and perform their prescribed tasks, utilizing resources and space as required. When trying to understand the model's state at a certain point in time, say, "why is this resource over-utilized", one must either guess or run the simulation again to determine what the cause is. Our contribution lies in the introduction of causal chains into the workflow of an agent-based simulation, so that an end user (in our case: process planner and hospital architect) can get a further insight into the intermediate simulation result at a certain point in time, without having to re-run it.

## Full-Automated Acquisition System for Occupancy and Energy Measurement Data Extraction

*Dimosthenis Ioannidis, Stelios Krinidis, Georgios Stavropoulos, Dimitrios Tzovaras and Spiridon Likothanassis*

### Summary

There is an ongoing research on reconciling the difference between predicted/simulated and actual energy consumption in buildings (either in design or in operational phase). In this paper a fully automated acquisition system for occupancy and energy measurement data is going to be presented. The proposed system comprises a depth camera cloud and RFID for occupancy extraction, a network of CO2 and temperature sensors and separate energy meters for HVAC, lighting, wall sockets and equipment. The extracted occupancy and energy consumption measurements of the proposed system could be utilized in a variety of applications, such as real-time control strategies, performance simulation analysis, high semantic occupancy and energy consumption information extraction, even business processes analysis and simulation. The proposed system has been evaluated to a large scale experiment, and its accuracy and robustness will prove its significance to the occupancy simulation processes, as well as to any kind of application that exploits occupancy.

## Parametric Spatial Models for Energy Analysis in the Early Design Stages

*Wassim Jabi*

### Summary

Much of the research into integrating performance analysis in the design process has focused on the use of building information models (BIM) as input for analysis engines. The main disadvantage of this approach is that BIM models are resource intensive and thus are usually developed in the later stages of design. BIM models are also not necessarily compatible with energy analysis engines and thus a conversion and export process is needed. This can lead to data loss, calculation errors, and failures.

Starting with the premise that energy analysis is more compatible with earlier design stages where simpler schematic models are the norm, this paper presents a software system that integrates non-manifold spatial topology, a parametric design environment and an energy analysis engine for a more seamless generate-test cycle in the early design stages. The paper includes a description of the system architecture, initial results, and an outline of future work.

## Visual Robot Programming – Linking Design, Simulation, and Fabrication

*Johannes Braumann and Sigrid Brell-Cokcan*

### Summary

In the creative industry, architects and designers have to realize complex, prototypical projects without the profit margins or the economy of scale of other industries. One of the core enablers of such processes are fluid and efficient workflows that allow a maximum of flexibility throughout the design process. However, rather than fully automating the design process, approaches are required that allow quick and intuitive changes of key parameters. Using visual programming tools, architects and designers are now able to create their own virtual simulation environments, where they can change key parameters with the push of a slider, and observe the results on their designs in real time. This research shows approaches how parametric environments can be extended beyond simple design iterations to directly link the design with robotic fabrication. Due to their inherent multifunctionality, robotic arms are of special interest to the creative industry and can profit from the similar versatility of visual programming environments.

## Scenario Modeling for Agonistic Urban Design

*Trevor Patt and Jeffrey Huang*

### Summary

This paper describes a method for incorporating computational scenario modeling for integrated urban agricultural projections as an aid to the design process and the formulation of urban design guidelines. This method involves unique solutions for simplifying the input and management of large quantities of location-based data and hybridized processes for decision making among diverse and distributed behaviors. The project utilizes commonly available 3d-modeling software (Rhinoceros with Grasshopper) to produce a responsively interactive simulation of urban potentials for given parameters as well as a contextualizing series of alternate scenarios using variable parameters.

## Design-Friendly Strategies for Computational Form-Finding of Curved-Folded Geometries: A Case Study

*Shajay Bhooshan, Mustafa El Sayed and Suryansh Chandra*

### Summary

The built-prototype described in this paper explores synergies between contemporary architecture, engineering and robotic fabrication technologies. The fabrication technology and process used is a scaled and numerically controlled version of the 'scoring-paper and manual folding' method used to find feasible geometries. The essential contribution of the paper is a case-study of a digital-design strategy that enabled multi-displinary and novel solutions to address the difficulties in the design and manufacture of architecture-scale assemblies of curve-crease-folded panels.

## A Freeform Surface Fabrication Method with 2D Cutting

*Andres Sevtsuk and Raul Kalvo*

### Summary

We introduce a method for creating free-form architectural structures out of 2D domain line networks. The resulting structure combines principles of thin shell and single-layer grid structures. The innovation lies in a three-dimensional geometrical arrangement, where all structural elements can be cut out of flat panels. The advantage of the proposed method is that structural support systems can be created for a wide variety of line networks using simple cutting technology (e.g. saws, laser-cutters, 3 axis CNC routers), making the construction of geometrically complex structures accessible to a wider audience at a significantly lower cost. We illustrate theoretical possibilities of the approach and demonstrate a full-scale application on a 200 square-meter pavilion built from plywood panels and clad with sheet-metal tiles at the Singapore University of Technology and Design. An analogous approach can be used with a high degree of flexibility to fabricate complex structures of different shape and pattern for various building applications.

## Designing Fluvial Sites: Digitally Augmented Physical Hydraulic Modeling

*Alexander Robinson*

### Summary

This video presents an urban river design methodology that employs high-resolution hydraulic physical models. The video augments the process with metric and spatial performance analysis to enhance the methodology and facilitate iterative design for multiple critical functions. Overall, the approach prototypes an enhanced methodological common ground between fundamental civil engineering and landscape architecture design tools.

## Prototyping Interactive Nonlinear Nano-to-Micro Scaled Material Properties and Effects at the Human Scale

*Jenny Sabin, Andrew Lucia, Giffen Ott and Simin Wang*

### Summary

The goal of the eSkin project is to explore materiality from nano to macroscales based upon an understanding of the dynamics of human cell behaviors. Immediately at hand, is the necessity to understand, speculate, test and simulate which nonlinear nano-to-micro scaled material properties are possible at the architectural scale. The synergistic, bottom-up approach across diverse disciplines, including cell-matrix biology, materials science & engineering, electrical & systems engineering, and architecture brings about a new paradigm to construct intelligent and sustainable building skins that engage users at an aesthetic level. In this paper, we present two human scale prototypes combining real-time presence detection with specialized display technology and interactive computer simulation. The prototypes probe the possible features and effects of eSkin at the scale of a building façade unit.

## Tangible 3D Urban Simulation Table

*Flora Salim*

### Summary

Design models for an urban landscape could simulate how design alternatives perform with regards to volatile environmental phenomena, human movements and social interactions in the city. This paper presents a low-tech markerless approach to designing and developing a tangible 3D urban simulation table, using an ordinary table, generic building blocks and fabricated urban models, a Kinect and a projector. The digital 2D scene was projected on the table, in response to the forms and configurations of physical 3D models on the table. The installation that was developed for a public exhibition was specifically designed for visualizing wind flows and speed on an urban site. Users can get their hands on the 3D tangible building blocks to change the configuration of the urban model on the table and get a sense how it influences the wind flow around the site.

## Design Agency: Prototyping Multi-Agent System Simulation for Design Search and Exploration

*David Jason Gerber, Rodrigo Shiordia, Sreerag Veetil and Arjun Mahesh*

### Summary

This work presents prototypes of multi-agent system simulation for design search and exploration. We describe an experimental approach in part based on a previously established multidisciplinary design optimization (MDO) framework. Here the work further explores the potential impact of MDO in conjunction with multi-agent systems on the early stages of design. Specifically, this paper addresses the potential of introducing agent based computing techniques into the multidisciplinary architectural design optimization and search workflow to tackle geometrically complex design problems and to facilitate early stage design exploration. To address these interests a series of prototyped workflows were studied inclusive of environmental performance and structural performance metrics and benchmarks. This paper presents a novel methodology for using simulation data in conjunction with multi-agent systems as a way for re-informing form and enhancing performance in a generative design environment. The methodology is based on the use of swarm algorithms and their integration with data generated by simulation software. The interaction between these two domains, the simulation data and swarm algorithms, generates the final outputs as a modified geometry that is then evaluated by comparison for enhanced design performance.

## Sustainability Performance Evaluation of Passivhaus in Cold Climates (WIP)

*Kyoung-Hee Kim and Seung-Hoon Han*

### Summary

Buildings are one of the major sectors that contribute to significant environmental impacts and energy consumption in the USA. Building sustainability can be realized through enhancing energy efficiency and reducing energy demand. One sustainable strategy for meeting such goals is to adopt high performance building envelopes integrated with an energy efficienct HVAC system. Heat transmission (U-factor) and air infiltration of building envelopes are closely correlated to building energy conservation. The primary goal of this paper is to understand the energy implication of U-factor and air infiltration of building envelopes for energy conservation. The research is based on a case study project, a residential building in Calgary, Alberta, Canada designed based on Passivhaus (PH) criteria. In order to reduce the U-factor of the glazing façades of the case study building, a high performance glazing system is discussed and respective energy saving potentials are estimated using a building energy simulation tool. Air tightness of building envelopes is also discussed as it plays a crucial role in the heating energy consumption of buildings in cold climates. The study confirms that both enhanced U-factor and airtightness reduce energy consumption by 30~40%. The proper choice of window technologies and field quality workmanship that enhance U-factor and air tightness becomes essential in building sustainability in severely cold climates.

## Parameters Tell the Design Storey: Ideation and Abstraction in Design Optimization

*Erin Bradner, Francesco Iorio and Mark Davis*

### Summary

We report qualitative findings from interviews and observations detailing how professionals generate and evaluate design ideas using design optimization tools. We interviewed 18 architects and manufacturing design professionals. We frame our findings using the Geneplore model of creative cognition and classify examples of ideation and abstract design thinking arising from optimization workflows. Contrary to our expectations, we found that the computed optimum was often used as the starting point for design exploration, not the end product. We also found that parametric models, plus their associated parameters and simulations serve as an alternate, highly valued form of design documentation distinct from engineering schematics.

# Notes

## Decentralized K-Means for MANET Swarms

*Ryan McCune and Greg Madey*

### Summary

Swarm intelligent systems are efficient, decentralized multi-agent problem-solving systems that offer several advantages over centrally controlled systems. A swarm intelligent system self-organizes into a structure that is robust, scalable, adaptable, and computationally efficient. Swarm intelligent systems, or swarms, utilize emergence, where simple local behaviors distributed across many agents lead to complex global phenomena, yielding a whole greater than the sum of parts. However, the relationship between the lower level agent behavior and the higher level emergent behavior is non-linear and not well understood, challenging the development of artificial swarms for engineering problems. Improved understanding of swarms can be realized by further instances of artifical swarms utilized for emergent problem solving.

A swarm intelligent solution is presented to a computationally challenging problem with quantifiable results in support of future models of emergence. The swarm intelligent Decentralized K-Means Clustering system is introduced within the context of rechargeable Mobile Ad hoc Networks (MANETs). Through engineered emergent behavior, cluster centroids relocate to reduce the cumulative distance between sensors and the nearest centroid, similar to K-means clustering, an NP-hard problem. An agent-based simulation is developed to evaluate the technique, which quantitatively demonstrates the effectiveness of the system.

## N To P Portfolio Solver using a Learning Algorithm

*Tarek Menouer and Bertrand Le Cun*

### Summary

This paper presents a parallel Constraint Programming (CP) solver, based on the portfolio principle, which quickly solves constraint satisfaction and optimization problems. The principle of the Portfolio method is to run N search strategies using N computing cores and the first strategy to satisfy the needs of the user stops all other strategies. In the usual portfolio principle, the number of search strategies is limited compared to the current number of computing cores used by the parallel machines. Using an internal parallelization for each search strategy, it is possible to run N search strategies using P computing cores with P > N$ (N To P Portfolio), as all the search strategies are scheduled using the same parallel framework (Bobpp). So, we can schedule dynamically the N search strategies there between in order to favor the strategy that finds a solution quickly and we give more cores to this privileged strategy. This Portfolio model is called the Adaptive Portfolio. The Adaptive Portfolio is used when the user wants to solve different CP problems and can not know the best strategy. In some industrial projects, such as the PAJERO project, we always solve different instances of the same CP problem. The novelty is to use the N To P Portfolio using a learning algorithm to predicts the number of cores to assign to each strategy automatically from a database that stores the ranks of all strategies used to solve a number of instances.

## A Virtual Crowd-Sourcing Approach for Pedestrian Simulation

*Eric Kolstad*

### Summary

Simulating pedestrian behavior in large-scale facilities presents varied challenges in representing the inter-related processes that characterize real-world interaction. Assembling groups of human participants for controlled experimental trials to acquire positional measurements and behavioral feedback is typically an extended, time-consuming process. More generally, methods utilized to track and analyze individuals' movements tend to severely limit temporal and spatial resolution (e.g. via video camera footage or indoor signal-tracking akin to WiFiSLAM), and observations are often focused on pre-defined regions.

The dissertation work [in progress] suggests an advanced modeling strategy offering advantages vs. conventional practice as well as a novel approach for interactive simulation prototyping and evaluation. An interactive 3D pedestrian model is discussed where concurrent groups of live participants and simulated agents interact in a shared environment. This has the potential to enable direct acquisition of trial data at levels of detail, precision and correspondence not otherwise possible, within an existing or proposed building structure model. Human subjects may be drawn from vastly diverse sources without need for physical presence, and examined comparatively in-situ relative to simulated agents whose behavior, in turn, may be adjusted to correspond in context with the local environment – providing immediate and direct feedback for progressive model refinement.

## A Generic Layered Modeling for Cognitive Radio Networks

*Syed Rizvi and Nathan Showan*

### Summary

Cognitive Radio (CR) remains theoretical while new research developing the implementation of CR continues to be produced. In this paper, we present different components necessary for a design of a typical CR and classify them in the context of modeling and simulation. A design of a CR network (CRN) includes the software defined radio (SDR), spectrum sensing, and communication channels. In this paper, we construct a theoretical representation of a CR by specifying its unique characteristics needed for modeling and simulation. Furthermore, we show the mapping of these characteristics into a layered architecture framework which ease the model formalization and simplify the simulation of a complex CRN.

## A System-Theoretic Approach to Case Management

*Shaowei Wang and Mamadou Traoré*

### Summary

The Object Management Group (OMG) defined Case Management Model and Notation (CMMN) in early 2013, which is a modeling specification for case management processes. However, no supporting software tools exist for this novel concept. Besides, the capability of simulation is not taken into account. For this reason, in this paper we present a DEVS-based case management system, with which case workers are able to interact with their knowledge work in terms of (1) model representation (by using visual modeling notations), (2) model manipulation (by using simulation), (3) model verification and validation (by using formal methods), and (4) model implementation (by using object oriented paradigm). Functionality (1) is enabled by CMMN; (2), (3) and (4) are achieved by using a high level simulation modeling language for discrete event system, i.e., DDML (DEVS-Driven Modeling Language).

## Consideration for M&S in Africa

*Adedoyin Adegoke and Mamadou K. Traore*

### Summary

The focus of this work is on the use of modeling and simulation problem-solving techniques in resolving issues in different domains in the African region. From existing results (established from scientific papers), we propose two approaches namely System of Systems and the other we call Simulation of Simulations. For this work we deal mainly with Simulation of Simulations approach. Using System dynamics tool we build a model and perform both structural and behavioral analysis on it. Preliminary results are shown from structural analysis while direction is shown for behavioral analysis. Though this work has focused on Africa, the methodology can apply to similar cases in other regions or domains.

## Nondeterministic and Elapsed-Time-Sensitive DEVS

*Ji-Hyeon Yoon and Hae Young Lee*

### Summary

Discrete Event System Specification (DEVS) has been applied to the development of embedded systems, so that the necessity of formal verification for DEVS has arisen. This paper presents a verifiable subclass of DEVS, called nondeterministic and elapsed-time-sensitive DEVS (NES-DEVS). By mapping a state into an interval, NES-DEVS allows nondeterminism at the time advance function. It also provides a more intuitive way to describe systems whose transitions are affected by elapsed times, by imposing time constraints on external state transitions. While still verifiable, it is more expressive than finite and real-time DEVS that is another verifiable subclass of nondeterministic DEVS.

## Method of Ground Weapon Effectiveness Data Estimation for Generating Combat Samples

*Ahreum Kim, Youngjae Lim, Youngbo Suh, Chanwoo Park and Hyung-Kon Moon*

### Summary

The need for weapon effectiveness data is more emphasized along the increase in applying defense modeling and simulation (DM&S) tools. Still currently ROK army does not have sufficient preliminary data to evaluate effectiveness of weapon systems such as artillery, mortar and small arms. Hence, ROK is utilizing weapon effectiveness data from the United States. With recent increase in originally developed ROK weapon systems, requirements for M&S technologies have also increased in order to analyze the weapon effectiveness. For acquiring reliable weapon effectiveness data, experiments with maneuver weapon systems must be needed, but is limited due to man powers or cost. In this paper, we developed methods to estimate weapon effectiveness for both vulnerability and lethality not requiring any experiments. For estimating vulnerability, we analyze the physical characteristics of the weapon system that has directly impact on vulnerability. Then we categorize and group by casualty types and apply weighted value in order to calculate the vulnerability multiplier. Approach for estimating lethality is based on a set of rule associated with critical variables related to ability of making losses against target.

## Development of Correlated Terrain Databases for Simulation and Command and Control Systems

*Maher Ali, Cody Kester, Stuart Topp and Wesley Trumbauer*

### Summary

Our team is assessing the value of creating and using computer generated, high-resolution, “geo-referenced,” terrain databases in Army modeling and Simulation. Our team has successfully produced a terrain database using the Rapid Unified Generation of Urban Databases (RUGUD) program through the use of provided elevation, imagery, and shape-file data. Our team also developed value measures which we are currently using to assess the value of RUGUD and its outputs to Army simulations and provide feedback to the Simulation and Training Technology Center (STTC) on our findings. Our in-progress-reviews and engagements with the STTC have allowed us to alter our value modeling as the project progresses to allow for mutual benefit from the work of our team. Our team regularly provides the STTC with our findings to provide them with active feedback

## Development of Smart Micro-Grid in Energy Efficiency Technologies on Workplace Level

*Shahryar Habibi*

### Summary

Commercial buildings have a great energy saving potential. To present an in-depth investigation, this research will be narrowed down to a particular workplace. The analysis will also be centred on user oriented energy reduction on workplace level. Nevertheless, this approach and some of the results can be extrapolated to other locations and types of building. The aim of this paper is to introduce a "how-to" method to realize building energy consumption and building energy management plans, to guide a building energy reduction from the point of view the micro Grid. It is in contention that there is no universally agreed method in optimizing Energy Management System (EMS) at the workplace and room. This research is concentrated in addressing EMS to make it more efficient for occupants by including users' requirements and comfort conditions.

## Simulation Analysis for Squad Technologies

*Nolan Anderson, John Burk, Nicholas Miles and Charles Tobin*

### Summary

The Defense Advance Research Projects Agency (DARPA) looks to achieve infantry squad overmatch through the incorporation of advanced technology in their Squad-X Program. In terms of an infantry squad, overmatch is the ability to immediately overwhelm an opposing force and continue on with its mission. Furthermore, DARPA is seeking specific technological information and innovative ideas that can be used to inform a potential new program focused on demonstrating the advantages of an organically digitized and interconnected dismounted squad. Our team is engineering simulation solutions for analysis of the effectiveness of potential technologies. Through use of simulation programs, such as IWARS, OneSAF, COMPOSER, and VBS2 simulation programs, the team is able to incorporate Squad-X technologies into battlefield simulations in order to target specific gaps in a squad's ability to achieve overmatch.

# SCS Membership Meeting


THE SOCIETY FOR
**MODELING & SIMULATION**
INTERNATIONAL

## Annual Membership Meeting

**Tuesday, April 15, 2014**

**12:00 pm**

The meeting will be held
in the Pelican Room Lunch snacks will be
provided