

The Winter Simulation Conference: The Premier Forum on Simulation Practice and Theory

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INTRODUCTION

The Winter Simulation Conference (WSC) is the premier international forum for disseminating recent advances in the field of system simulation, with the principal focus being discrete-event simulation and combined discrete-continuous simulation. In addition to a technical program of unsurpassed scope and quality, WSC provides the central meeting place for simulation practitioners, researchers, and vendors working in all disciplines and in the industrial, governmental, military, and academic sectors.

From another perspective, the Winter Simulation Conference is the result of a remarkable collaborative effort that has been led entirely by volunteers for four decades and that is based on a unique, longstanding cooperative arrangement among seven major professional organizations. In this article we discuss all these aspects of WSC, giving special emphasis to the highlights of WSC '10, which will be held December 5 - 8, 2010 in Baltimore, Maryland.

OVERVIEW OF THE CONFERENCE

The Winter Simulation Conference features tracks devoted to leading-edge developments in simulation modeling and analysis methodology together with a diversity of simulation application areas including: agent-based modeling; business process reengineering; computer and communication systems; construction engineering and project management; education; healthcare; homeland security; logistics, transportation and distribution; manufacturing; military operations; risk analysis; virtual reality; web-enabled simulation; and the future of simulation. Moreover, WSC offers an invaluable educational opportunity for novices and experts alike, with a large segment of each program devoted to introductory and advanced tutorials that are carefully designed to address the needs of simulation professionals at all levels of expertise and that are presented by prominent individuals in the field. Of particular interest to virtually all attendees are the software tutorials and the exhibits by software and hardware vendors, which cover a broad range of commercial simulation products and services. Provided to each registrant at the beginning of the conference, the Proceedings of the Winter Simulation Conference contains complete documentation of the full technical papers presented during the conference. Rounding out the attractions of WSC are several social gatherings as well as meetings of numerous professional societies and users' groups. All

these events give attendees the opportunity to get acquainted and to become involved in the ongoing activities of the international simulation community.

SCOPE AND LAYOUT OF THE PROGRAM

In recent years the WSC program has been organized into broad subject-area categories (or tracks) that reflect the current state of the simulation field as well as the mix of interests and professional orientations of conference attendees. Although the content and structure of these tracks will vary to some extent from year to year, generally each WSC contains tracks organized along the following lines:

- **Introductory and Advanced Tutorials** — These tracks feature expository presentations on current or emerging simulation practice. Introductory tutorials are designed for newcomers who are interested in the basics of simulation. Advanced tutorials are oriented toward more experienced professionals who do not necessarily specialize in simulation research but nevertheless seek the latest modeling and analysis tools and techniques for advanced applications in a particular industry or discipline. Special-focus sessions within the Advanced Tutorials Track give practitioners and researchers a survey of recent fundamental advances in the theory of simulation modeling and analysis.
- **Software/Modelware Tutorials (Vendor Track)** — The highlights of this track are expository presentations on simulation languages as well as software and hardware systems for specification, development, documentation, management, animation, and presentation of simulation models.
- **Modeling Methodology** — One of the mainstays of WSC, this track encompasses animation; artificial intelligence; concepts and techniques for general systems modeling; discrete-event and combined discrete-continuous simulation; high level architecture; knowledge-based simulation; model specification and development; object-oriented simulation; parallel and distributed simulation; support environments; software engineering; verification, validation, and testing; and web-based simulation.
- **Analysis Methodology** — Topics covered in this track include efficiency improvement (variance reduction) techniques; experimental design; metamodels; modeling, fitting, and generating stochastic input processes; optimization; output analysis; quasi-Monte Carlo methods; random number generation; ranking and selection procedures; rare-event simulation; start-up techniques; sensitivity analysis; and statistical graphics.
- **Risk Analysis** — Incorporating virtually every aspect of simulation-based analysis of the risks involved in decision making, this track provides a high-profile forum for presenting the latest developments in this burgeoning area of simulation research and practice. Applications of simulation to risk analysis include, but are not limited to, the following: derivatives pricing, energy trading, financial engineering, hedging, and weather derivatives.

- **Manufacturing Applications** — A centerpiece of every WSC program, this track includes cellular systems; computer integrated manufacturing; facilities planning; flexible systems; materials handling; online control; production and inventory control; robotics; scheduling; semiconductor manufacturing; virtual manufacturing; and warehousing and distribution.
- **Military Applications** — A perennial high-visibility part of WSC, this track includes battlefield simulation; evaluation of strategies; distributed simulation; graphical techniques; and high level architecture.
- **Logistics, Transportation, and Distribution Applications** — Now one of the strongest and most comprehensive tracks in the WSC program, this track covers airport, airline, and air cargo operations; distribution systems; freight systems; intelligent transportation systems; intermodal facilities; logistics engineering; pedestrian movement; port operations and shipping; rail systems; rapid transit systems; street and highway traffic; and supply chain management.
- **General Applications** — As discussed in the brief history of the conference given in the next-to-last section of this article, the General Applications Track formed the nucleus from which the current WSC has evolved over the past four decades. This track encompasses simulation performed in a variety of areas that do not have a specific track in another part of the conference. Many topics in General Applications become tracks in later conferences.
- **Focused Minitracks and Tracks** — New and emerging trends or problem domains are highlighted in smaller, focused tracks, and each year the conference may include entire, full tracks in specific areas. MASM (Modeling and Analysis of Semiconductor Manufacturing), a conference within the conference, consists of a set of tracks focused on semiconductor manufacturing. The conference will also have focused mini-tracks in the areas of simulation education, simulation interoperability, health care, construction engineering/ project management, and business process modeling.
- **Poster Session** — This track consists of informal poster presentations on a variety of topics of current interest to the simulation community.
- **Ph.D.-Student Colloquium** — The INFORMS Simulation Society and ACM/SIGSIM invite doctoral students to present short research summaries and to participate in the Poster Session.

ADMINISTRATION OF THE CONFERENCE

From its inception, WSC has been distinguished by its broad base of interest and sponsorship. Currently, the following professional organizations are full financial sponsors for WSC, providing working capital for each year's conference, and sharing equally in conference surpluses or losses: Association for Computing Machinery/Special Interest Group on Simulation (ACM/SIGSIM); Institute for Operations Research and the Management Sciences Simulation Society (INFORMS-SIM); Institute of Industrial Engineers (IIE); and The Society for Modeling and Simulation International (SCS). The conference also has three technical sponsors: American Statistical Association (ASA);

Institute of Electrical and Electronics Engineers/Systems, Man, and Cybernetics Society (IEEE/SMCS); and National Institute of Standards and Technology (NIST). Each of the WSC sponsor organizations appoints a representative to serve on the WSC Board of Directors.

The WSC Board of Directors is responsible for long-term administration and policy making for the conference. The board's primary goal is to maintain a high-quality program with low registration fees while keeping WSC on a sound financial footing into the foreseeable future. Generally each board member serves for eight years, giving WSC stability and continuity. The board meets twice annually, in June and in conjunction with WSC in December. Minutes from the WSC board meetings are available from the WSC web site <<http://www.wintersim.org/minutes.htm>>.

Several years in advance of a particular conference, the board selects the leaders of the conference committee for that WSC, including the general chair, the program chair, and the business chair. Each conference committee consists entirely of volunteers drawn from the sponsoring organizations. The program chair forms an all-volunteer program committee that includes the proceedings coeditors, and the track coordinators. Within each track of the program described above, the assigned track coordinator is responsible for organizing a coherent set of sessions covering selected topics of current interest. Each track coordinator also recruits session chairs and arranges for referees to review the papers that are submitted (or invited) for inclusion in the corresponding track. Recently the acceptance rate for contributed papers has been about seventy-five percent, and the final program for each WSC has consisted of roughly equal numbers of invited and contributed papers.

Because several hundred libraries worldwide obtain the *Proceedings of the Winter Simulation Conference* online through the ACM Digital Library <<http://portal.acm.org/dl.cfm>> or the IEEE Xplore Digital Library <www.ieee.org/products/onlinepubs/pub/about_xplore.html>, the WSC *Proceedings* is well established as the primary archival outlet for rapid dissemination of leading-edge developments in system simulation. The proceedings coeditors perform all duties required for timely publication of the Proceedings. In 1997 a compact disk (CD) version of the WSC *Proceedings* was published in addition to the hard-copy (paper) version; and since 2000 the complete text of each full technical article in the latest WSC *Proceedings* has also been made freely accessible online via the INFORMS-SIM Web site <www.informs-sim.org> shortly after the close of each conference. Growing acceptance of electronic media for archival purposes meant that, beginning in 2005, hard-copy distribution of the *Proceedings* to conference attendees was discontinued; instead each attendee is now provided with a CD of the complete *Proceedings*. The extraordinarily high quality of the WSC *Proceedings* is a direct result of the intensive, closely coordinated efforts of the proceedings coeditors, the proceedings publisher, the program chair, the track coordinators, the referees, and the WSC webmaster as well as the authors.

HIGHLIGHTS OF WSC '10

WSC 2010 will be held in vibrant Baltimore, Maryland at the Marriott Waterfront Hotel, on December 5 – 8, 2010. The Marriott is located in the rejuvenated Inner Harbor area of this exciting city, a short stroll away from Baltimore's world-famous aquarium and many other attractions such as tall ships and submarines, Orioles Park at Camden Yards, the Maryland Zoo as well as the primary district for entertainment, shopping and dining. The hotel is easily accessible from all three airports in the region, namely BWI, Reagan National, and Dulles International. The Baltimore Marriott Waterfront features 490 luxurious rooms with views of the harbor and downtown Baltimore. Hotel amenities include high speed internet access, two restaurants, a bar and a coffee shop, and a full service health club and spa with a modern fitness center and pool.

KEYNOTE SPEAKER: Dr. Simon Bradley, *Vice President, Engineering, Physics, IT Security Services and Simulation, EADS Innovation Works*. As the head of a technical research division, Dr. Bradley focuses on Security, Information Technology, Systems/Software Engineering, Multi-Physics modeling and the use of Simulation. His team consists of 150 people, based in 6 countries – ranging from PhD students through to world renowned experts in their respective fields, working closely with organizations around the world to look at using simulation and technology innovations to help governments, regional organizations, and aid agencies to cope with the effects of geological and environmental change. He is currently responsible for reviewing the long-term research work required for EADS to continue its growth in the Homeland Security market, which is being done through expansion into the UK and US markets.

PROGRAM: WSC 2010 features a comprehensive program ranging from introductory tutorials to state-of-the-art research and practice. For the third consecutive year, WSC will incorporate the MASM (Modeling and Analysis for Semiconductor Manufacturing) Conference, the leading modeling and analysis conference specific to global semiconductor manufacturing and supply chain operations.

The theme of the WSC 2010 will be Global Integration and Collaboration. Our featured speakers will focus on the key role played by simulation in defining strategies as well as in assessing and managing risks in global projects requiring integration and collaboration. Our keynote speaker is Dr. Simon Bradley, Vice President of Engineering, Physics, IT Security Services and Simulation at EADS Innovation Works. As the parent company of Airbus, EADS lives this challenge on a daily basis in all aspects of their activities. Dr. Bradley will take us through this exciting journey.

In addition, as one of our Titans, Dr. Phil Heidelberger of IBM Watson Research Center will share with us the collaboration challenges encountered during IBM's Blue Gene project whose objective is to harness the power of a global network of computers to reach new heights in computing performance. Similarly, our second Titan, Professor Paul Kleindorfer of INSEAD and Wharton School will discuss the risks that global networked organizations must assess and manage.

For additional information, sponsorship opportunities, or to volunteer, contact the WSC'10 General Chair, Joe Hugan (email: jhugan@gmail.com), or the WSC'10 Program Chair, Enver Yücesan, INSEAD (email: enver.yucesan@insead.edu).

PLAN NOW FOR FUTURE WSCs

WSC 2011 will be held on 11-14 December at Grand Arizona Resort in Phoenix, AZ. For additional information, sponsorship opportunities or to volunteer, contact the WSC'11 General Chair, Preston White (e-mail: kpw8h@virginia.edu), or the WSC'11 Program Chair, Michael Fu (e-mail: mfu@rhsmith.umd.edu).

BRIEF HISTORY OF THE CONFERENCE

Although in some sense the origins of the Winter Simulation Conference can be traced to certain computing seminars held in the late 1940s, the impetus to hold a national conference on the scale of the current WSC took shape in the spring of 1967. The Conference on Applications of Simulation Using the General Purpose Simulation System (GPSS) was held November 13-14, 1967, at the Hilton Hotel in New York City. The general chair was Harold G. Hixson, an operations research analyst with the Air Force Logistics Command and the system simulation project manager of SHARE (the IBM scientific users' group). The program chair was Julian Reitman, a prominent user of GPSS in the Norden Division of United Aircraft Corporation and a leader in IEEE. The publicity chair was Arnold Ockene, an IBM employee responsible for marketing and support of GPSS. Acting entirely on their own initiative, these individuals arranged for ACM, IEEE, and SHARE to cosponsor the conference, which had a planned attendance of 225 and an actual attendance of 401. To provide a permanent record of the 1967 conference and to set the stage for a follow-up conference in 1968, Julian Reitman edited a special issue of the *IEEE Transactions on Systems Science and Cybernetics* (Volume SSC-4, Number 4, November 1968) that contained some of the papers presented at the 1967 conference.

Because of the technical and financial success of the 1967 conference, a second conference was held December 2-4, 1968, at the Hotel Roosevelt in New York City. Julian Reitman served as general chair and Arnold Ockene served as program chair for the Second Conference on Applications of Simulation. In addition to the original sponsors, the 1968 conference gained sponsorship from Simulation Councils, Incorporated (SCi, now known as SCS). The scope of the 1968 conference was expanded to include papers on any simulation language or any aspect of simulation applications; and as a result, the 1968 conference grew to twenty-two sessions with a total of eighty papers. Sessions on statistical considerations, development of new languages, and tutorials on new languages complemented the applications sessions; and attendance jumped to 856. To provide a complete record of the papers presented at the second

conference, the 1968 conference committee published a 368-page *Digest of the Second Conference on Applications of Simulation*.

Much of the structure and traditions of what is now known as the Winter Simulation Conference crystallized during the period 1969-1974. The Third Conference on Applications of Simulation was held December 8-10, 1969, at the International Hotel in Los Angeles. In addition to the previous sponsors, the 1969 conference also gained sponsorship from the American Institute of Industrial Engineers (now known as IIE) and The Institute of Management Sciences/College on Simulation and Gaming (TIMS/CSG, now known as INFORMS-SIM). The *Proceedings of the Third Conference on Applications of Simulation* totaled 513 pages, and it established the basic proceedings format followed in all subsequent years. In 1971 the official conference title was changed to 1971 Winter Simulation Conference: Fifth Conference on Applications of Simulation. Although there are no surviving records of conference attendance for the period 1969-1973, it is widely believed that the attendance at WSC '71 was approximately twelve hundred - the largest attendance of any WSC to date. The Operations Research Society of America became a sponsor of the conference in 1974, but in that year conference attendance dropped to 463.

It should also be noted that WSC shares a common heritage with the Summer Computer Simulation Conference (SCSC), which has traditionally concentrated on continuous system simulation. Timed to minimize competition with the 1969 predecessor of WSC, the Conference on Applications of Continuous System Simulation Languages was held June 30-July 1, 1969, at the Sheraton Palace Hotel in San Francisco with sponsorship from ACM, IEEE, SCi, and SHARE. Harold Hixson, one of the "founding fathers" of WSC and an active member of SCi, also served as the general chair of this predecessor of SCSC. Whereas multiple sponsorship quickly became a distinctive feature of WSC, the development of SCSC followed a completely different path; and ultimately SCSC became the sole sponsor of what Hixson called WSC's "twin sister" conference.

By 1975 the ad hoc nature of WSC's administration had completely broken down, and the conference with multiple sponsorship planned for that year did not take place. The rebirth of WSC in 1976 was largely due to the initiative of Robert G. Sargent and the work of Paul F. Roth, Harold Joseph Highland, and Thomas J. Schriber. Sargent, a professor at Syracuse University and then the IIE liaison to WSC, advanced the idea of reviving and stabilizing the conference by enlisting the National Bureau of Standards (NBS, now known as NIST) as an additional cosponsor of a 1976 Bicentennial Winter Simulation Conference. Roth was then an NBS employee and chair of ACM/SIGSIM; and he convinced his superiors at NBS of the merits of Sargent's proposal. Highland, then a professor at the State University of New York at Farmingdale, agreed to be general chair for WSC '76. Schriber, a professor at The University of Michigan, agreed to be program chair for WSC '76; and Sargent agreed to be associate program chair. With a Board of Directors and a set of bylaws in place to ensure timely planning and continuity in the operation of future conferences, the Winter Simulation Conference was given a new lease on life in 1976.

Throughout the 1980s, WSC grew and evolved to address the constantly changing interests of the simulation community. Since 1984 each WSC has featured an exhibit area in which vendors may demonstrate their software products to interested attendees. Instead of the traditional two-volume, softbound format for the *WSC Proceedings*, beginning in 1984 the *Proceedings* was published in a one-volume, hardbound format. In 1985 the American Statistical Association became a WSC sponsor. In 1986 the program was substantially expanded with the addition of two tracks devoted to software tutorials as well as a track devoted to manufacturing simulation. TIMS/College on Simulation (now INFORMS-SIM) began sponsoring the Ph.D.-student colloquium in 1988.

Since the early 1990s, the pace of innovation and change in WSC has accelerated substantially. To provide a timely forum for rapidly developing areas in the simulation field, recent conference committees have added the following new tracks and minitracks to the program:

- 1992—Construction Engineering and Health Systems;
- 1998—Future of Simulation and Logistics, Transportation, and Distribution;
- 1999—Business Process Modeling and Semiconductor Manufacturing;
- 2000—Simulation Education;
- 2001—Telecommunications;
- 2002—Risk Analysis and Simulation-Based Scheduling;
- 2004—Homeland Security/Emergency Response, Biological/Environmental Simulations, Agent Based Modeling, Virtual Reality/3D Visualization, Simulation Case Studies, and Titans of Simulation;
- 2005—Six Sigma & Simulation and one-day Introduction to Simulation for Management program;.
- 2006—Computational Systems Biology, Dynamic Data-driven Simulation, Simulation-based Scheduling, and the preconference "Simulation 101" short course.
- 2007 - Cross-Fertilization
- 2008 – MASM (Modeling and Analysis of Semiconductor Manufacturing), and “Simulation Around the World”
- 2009 – Introduction of an expanded education track

Many of these new tracks and minitracks have attracted a sufficiently large constituency to become a permanent part of the WSC program.

Beyond the expansion of the WSC program in recent years, other innovations have improved both the scope and quality of virtually every aspect of the conference. Since 1990 the review process for contributed papers has been strengthened and formalized, with written referees' reports being provided to the author(s) for every contributed paper. The poster session was introduced in 1993. The conference Web site <www.wintersim.org> made its debut in 1995; and the Web site has rapidly become the primary vehicle for dissemination of information about the conference - including electronic versions of the Call for Papers, the Author Kit, and the Preliminary Program as well as an online registration facility. Although the *WSC Proceedings* was published in

both hard-copy and CD versions beginning in 1997, the increased size of the hard-copy *Proceedings* forced a return to a two-volume, softbound format beginning in 1998, and the hard-copy *Proceedings* was discontinued in 2005. Traditionally the WSC *Final Program* simply provided the locations and times of all technical presentations and other events of interest to attendees. In 1999, however, the content of the *Final Program* was substantially expanded to include abstracts not only of all *Proceedings* papers but also of all presentations in the Ph.D.-Student Colloquium and all posters in the Poster Session; and this was achieved without sacrificing the convenience of the *Final Program* as a pocket-size guide to the conference. A major milestone in the development of WSC was also reached in 1999, when the conference gained corporate sponsorship for the first time.

With the advent of the new millennium, WSC introduced a totally web-based system for submission, review, revision, and final delivery to the publisher of all technical articles handled by the *Proceedings* Editors. Moreover, since 2000 the complete text of each technical article in the latest *Proceedings* has been freely accessible on-line via the INFORMS-SIM Web site <<http://www.informs-sim.org>> shortly after the conference; and currently this website contains the contents of the *Proceedings* for the years 1997–2008 in the form of Portable Document Format (PDF) files from the corresponding CDs. Beginning in 2002, the contents of the latest WSC *Proceedings* have been available on the web on the day after the close of the conference, with full search capability over all *Proceedings* articles back to 1997. These developments have significantly enhanced the attractiveness of the *Proceedings* to authors who seek the broadest, most timely dissemination of their work to the worldwide simulation community. As one measure of the growing stature and global scope of the conference, we note that in 2005 approximately 30% of WSC authors were based outside the United States, whereas in 1992 the comparable figure was only 10%.

In the year leading up to WSC '03, the WSC Board of Directors undertook in April a fund-raising effort titled "Patrons of WSC". The donated funds were dedicated to the establishment of an independent WSC Foundation <www.wscfoundation.org> whose trustees will manage the fund. During 2003, the board also established the Board of Directors' Award to recognize individuals or organizations for longstanding, distinguished service to the conference; and the first such award was presented to Dr. C. Dennis Pegden. The award has since been given to Richard E Nance (2004), James R. Wilson (2005), Thomas J. Shriber (2007), and Deb Sadowski (2009). Completing a busy year, the National Institute of Standards and Technology (NIST), which had been an unofficial sponsor of WSC since the 1976 Winter Simulation Conference, became recognized as an official sponsor of the conference in 2003.

In 2004 WSC emerged from a period of severely constrained budgets and limited growth that began shortly after the attacks of September, 11, 2001. The WSC '04 program featured a presentation-only "Case Studies" track designed to showcase leading-edge examples of simulation practice. WSC '04 also introduced the "Titans of Simulation" minitrack to provide leaders of the field with a high-visibility forum in an extended

luncheon session that would complement the addresses given by the keynote and military keynote speakers.

In 2005, the WSC program was further expanded with the addition of a one-day "Simulation for Managers" workshop designed to introduce simulation modeling to business decision makers. WSC '06 featured "Simulation 101," an intensive preconference workshop for newcomers to Monte Carlo and discrete-event simulation. WSC '07 introduced a 'Cross Fertilization' track, where leading researchers in disciplines closely related to simulation presented on critical topics.

For the first time in 2008, the Winter Simulation Conference incorporated another conference. MASM (Modeling and Analysis for Semiconductor Manufacturing) Conference, the leading modeling and analysis conference for global semiconductor manufacturing and supply chain operations, ran as two complete tracks within WSC '08.

In addition to attaining a high level of maturity and professionalism over the past four decades, the Winter Simulation Conference has grown steadily in attendance. Over the past five years, conference attendance has averaged about 675. For more information on the history of WSC, see the articles on the conference website that are titled "[The Winter Simulation Conference: Celebrating Twenty-Five Years of Progress](http://www.wintersim.org/wsc92keynote.pdf)" (<http://www.wintersim.org/wsc92keynote.pdf>, a 3.3-megabyte PDF file) and "[The Winter Simulation Conference: Perspectives of the Founding Fathers](http://www.wintersim.org/wsc92panel.pdf)" (<http://www.wintersim.org/wsc92panel.pdf>, a 2.8-megabyte PDF file), which have been extracted from the *Proceedings of the 1992 Winter Simulation Conference* (Swain et al. 1992). For a comprehensive picture of the recent state of WSC and the field of discrete-event and combined discrete-continuous simulation, see the *Proceedings of the 2008 Winter Simulation Conference* (Mason et al. 2008) which is freely accessible online via < <http://www.wintersim.org/prog08wsc.htm> >. For a table summarizing all Winter Simulation Conferences held to date, see the on-line document titled "[WSC: Dates, Locations, Leaders, and Attendance](http://www.wintersim.org/wschistory.htm)" (<http://www.wintersim.org/wschistory.htm>).

CONCLUSION

Further advances in system simulation will require coordinated improvements in education, methodology, and software and hardware development together with innovative, intelligent applications of simulation technology. By providing a common, broad-based forum for the diversity of professional interests held by the members of its sponsoring organizations, the Winter Simulation Conference will continue to serve as a catalyst for the interactions between simulation professionals in academia, government, and industry that are essential to future progress of the field. With the preservation and extension of its long-standing traditions, WSC should also provide a model for other conferences that are based on collaboration among several large professional societies.

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