THE INSTITUTE OF MANAGEMENT SCIENCES

NEWSLETTER OF THE
TIMS COLLEGE on SIMULATION AND GAMING

BRUCE SCHMEISER and LEE SCHRUBEN, EDITORS VOL. 4, NO. 3 FALL 1980

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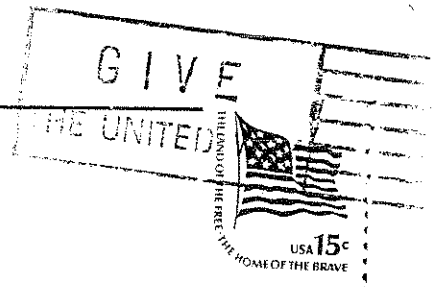

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OUTGOING CHAIRMAN'S COLUMN

As I write my last Chairman's Column, I first want to thank all of the individuals who helped me as Chairman of the College. Secondly, I would like to congratulate the new officers of the college on being elected. They are: Chairman, Professor Averill Law; Vice Chairman, Professor William Biles; and Secretary-Treasurer, Professor Bruce Schmeiser. The College will be in good hands with this set of officers, and I wish them success in their endeavors. Their term of office is from September 1, 1980 until August 31, 1982.

The College decided to undertake the awarding of a "Best Paper Award" to be given annually for the best paper published in MANAGEMENT SCIENCE on the practice or theory of simulation or gaming at the College meeting, held at the TIMS/ORSA Meeting in Washington, DC, in May 1980. I appointed a committee, composed of Professors William Biles, Chairman; Bruce Schmeiser; and Lee Schruben. They developed a set of Criteria and Procedures. The first award will be given for papers published in 1981. Details of this award is elsewhere in the Newsletter. The undertaking of this award is a major activity for the College, and should increase its prestige and visibility.

The College continues to sponsor many activities for the College membership and other professionals in Simulation and Gaming. This includes sponsoring sessions and holding mixers at the ORSA/TIMS National Meetings, having two newsletters yearly, and co-sponsoring the Winter Simulation Conference. There will be College meetings at the upcoming ORSA/TIMS Meeting in Colorado and at the Winter Simulation Conference. I hope you can attend one or both of these meetings to meet your new officers.

To help support your College on Simulation and Gaming, how about recruiting a new member for the College? This can be your "gift" to the new officers. Bibliographies are needed for the Newsletter. How about sending some to one of the Newsletter editors? Also, your new officers would welcome your help and any ideas for the College that you may have.

It's been a pleasure to serve you.

Robert G. Sargent

INCOMING CHAIRMAN'S COLUMN

I would like to thank Professor Robert Sargent for the fine job he has done as Chairman of the College during the past two years. I believe that the College has improved considerably during this period of time. Thanks also to Professors Bruce Schmeiser and Lee Schruben for their work as co-editors of the College Newsletter. They have developed the newsletter into a valuable source of information for the simulation community.

During my tenure as chairman, I hope to make additional improvements in the College. I would particularly like to increase the College membership. It would appear that there are considerably more people in TIMS with an interest in simulation than are currently members of the College. It has also been suggested that we might interface with ORSA in order to increase our membership; this has been done by at least one other TIMS College.

While I was Vice Chairman of the College in charge of meetings, I tried to schedule a session at each ORSA/TIMS meeting consisting of two 45 minute state-of-the-art talks on simulation methodology. Past (or scheduled talks) have dealt with simulation modeling, output data analyses, random number generators, generating continuous random variables, experimental design, and choosing input probability distributions. People attending these sessions have found them to be very informative because of the expository nature of the talks. College members who would like to see additional topics presented should contact the incoming Vice Chairman, William Biles, or myself.

The College will have meetings and also host mixers at both the Colorado Springs and Toronto ORSA/TIMS Meetings. I hope to talk to each of you about future College activities at these times.

Averill M. Law

NEW OFFICERS

New officers for the college have been elected. Terms are for two years.

President	Averill Law Department of Industrial Engineering University of Wisconsin Madison, Wisconsin (608) 262-9927
Vice President	Bill Biles Department of Industrial & Management Systems Engineering 207 Hammond Building The Pennsylvania State University University Park, PA 16802 (814) 865-7601
Secretary/Treasurer	Bruce Schmeiser School of Industrial Engineering Purdue University West Lafayette, IN 47907 (317) 494-6266

The duties of the vice president are primarily to arrange the college sponsored sessions at the national meetings. Bruce Schmeiser and Lee Schruben continue as newsletter editors.

COLLEGE MEETING

As listed in the bulletin which you should have just received for the Colorado meeting, the College will have a business meeting beginning at 5:30 PM, Monday November 10, in the Green Room in the Broadmoor. All members are encouraged to attend.

MIXER AT COLORADO SPRINGS

The mixer at the Washington meeting in May went well. The mixer at Colorado Springs will be Tuesday, November 11 from 8PM to whenever. The location will be announced at the college sponsored sessions on Monday and Tuesday, as usual. All members of the college are invited, as well as their guest and anyone else interested in meeting others with simulation interests.

PAPER AWARD

At the college meeting in Washington, D.C. in May, it was decided to create an award for the best paper published in *Management Science* in simulation. The purpose is to encourage submission of simulation papers to the journal, since the submission rate has been low. We felt that having lobbied for the creation of the department, we should now support it. The following criteria, rules, and procedures for the selection of the "best paper in simulation and gaming" have been established by the college.

ELIGIBILITY. All papers and technical notes published in a given annual volume of *Management Science* that have a major focus on the theory or practice of simulation or gaming are eligible for this award. Letters to the editor are not eligible.

CALL FOR NOMINATIONS. A "call for nominations" will be published in the Newsletter of the TIMS College on Simulation and Gaming and in OR/MS Today as soon as possible after the publication of the last issue in the annual volume of Management Science. A closing date for nominations will be specified, at least 60 days after the expected publication of the "call for nominations."

NOMINATIONS. Anyone is eligible to nominate a paper. Nominations will be sent to the Chairman of the TIMS College on Simulation and Gaming. After the specified closing date for nominations, the Chairman (or a designated Award Chairman) will compile the bibliography of nominated papers, excluding any papers that fail to satisfy the above eligibility criteria. This bibliography will be sent to the Newsletter Editor, who will immediately publish the list of nominated papers and a ballot in the next issue. In the event that fewer than three eligible papers are nominated, no award will be offered; the nominated papers, however, will remain eligible for the next year's award.

BALLOTING. Validated ballots from members of the TIMS College on Simulation and Gaming will be sent to the Chairman of the College or the designated Award Chairman, who will tally the vote on the day after the specified closing date for receipt of the ballots.

AWARD PRESENTATION. The award for the Best Paper on Simulation and Gaming will be presented at the Business Meeting of the College on Simulation and Gaming held at the FALL TIMS/ ORSA Conference following the close of the Management Science volume year. An engraved plaque will be presented to the author(s) of the best paper, and a $500 cash prize will be divided among the authors.

EDITORIAL POLICY FOR THE SIMULATION DEPARTMENT OF *MANAGEMENT SCIENCE*

The college successfully lobbied for a Department of Simulation for *Management Science.* George S. Fishman, department editor, has established the following editorial policy.

The Simulation Department of *Management Science* is interested in receiving papers in simulation that describe:

a. Innovative ideas for modeling flow (state change) logic in simulated systems.

b. New probabilistic representations of underlying stochastic structures.

c. New and improved methodologies for analyzing simulation output and increasing statistical efficiency in estimation.

d. Unusual applications using existing or new methodological procedures.

In addition to a clear and concise account of a newly proposed technique in topics a, b and c, a paper should describe the merits of the technique relative to currently employed techniques, if such exist, and should include revealing comparisons.

Appropriate subjects under topic a include modeling formulations that are alternatives to the well-established event-scheduling and process-interaction methods. Also appropriate are comparisons of the relative success with which established and, possibly, newly proposed techniques perform computationally for different classes of simulation problems. Such a comparison ordinarily would cover discussions of ease of conceptualization, ease of implementation, language adaptability and computational efficiency.

Topic b is aimed at making available to readers new probabilistic conceptualizations for simulating processes with special characteristics for which an established literature does not now exist. For example, there are at present no standard procedures for generating interarrival times in a queueing simulation that have a particular marginal distribution and are *dependent*. In order to provide useful guidance to readers in resolving such problems, papers under topic b should, in addition to a technical description, include a description of the steps required to implement the concept, together with computation time assessments, as appropriate. The Department is not interested in papers that deal *exclusively* with sampling from standard distributions.

Papers under topic c should describe how the proposed technique compares with past proposals for solving a particular statistical or decision making problem. Here comparison would include considerations of statistical performance, degree of generality, computational efficiency, ease of implementation and simplicity of concept. A methodological paper is expected to demonstrate its proposed technique and evaluate its performance relative to competing techniques. This demonstration should be accomplished with simulation models for which theoretical solutions are known. In this way a reader can assess both absolute and relative performance. In cases in which a paper presents a new methodology in an area where no alternatives exist, the absolute standard will provide the basis for an evaluation. A description of the testing procedure should specify an experimental design for each theoretical model considered. For example, if one is using a queueing model as the basis for testing, one would expect the studying the performance of the propsed technique for a range of traffic intensities would be one element of the experimental design.

The Simulation Department is also interested in publishing papers that describe the successful use of simulation experimentation as an aid in decision making (topic d). A paper in this area should provide a clear, concise account of the simulation to a degree of detail that allows a reader, mildly familiar with the problem, to comprehend the structure and purpose of the simulation model and the related statistical analyses performed on input and output data. A key feature of a paper in this area should be an account of the way in which knowledge gained from simulation experimentation came to influence policy with regard to solving the problem at hand. Here a description of the successful interaction between modelers and decision makers would be regarded as an essential component of the paper.

SIMULATION '80

Simulation '80 was held in Interlaken, Switzerland on June 25-27. The third in a series of international symposia covering all aspects of simulation, this meeting followed a course in which invited presentations of both a tutorial and state-of-the-art nature were given.

The 28 sessions comprising the technical program were organized into three tracks: modeling methodology, technical applications, and non-technical applications. Two plenary sessions were devoted to major topics: "Computer-Aided Modeling Systems" by T. I. Oren and "The International Linkage of Open Exchange Models for World Food Supply" by D. Frohberg.

Among the sessions in modeling methodology, some of the titles were: Modeling Methodology, Distributed System Simulation, Numerical Methods, Statistical Aspects of Simulation, Bond Graph Modeling Techniques, Simulation Software, and Simulation Hardware. The technical applications track featured sessions entitled: Electrical and Mechanical Systems I-II, Control Systems Design, Simulation of Computer Systems, and Energy I-II-III. The non-technical track included Production Systems, Inventory Systems, Transportation, Public Systems, Economy, Social and Biological Systems, and Water and Air among the session listings.

Professors M. H. Hamsa (General Chairman) and Francois E. Cellier (Program Chairman) are to be commended for their hard work leading to the success of Simulation '80. Selected papers from the Symposium are to form the first two issues of the *International Journal on Simulation*, to be published late in 1980.

Richard E. Nance

SIMULATION STANDARDIZATION ACTIVITIES

Of potential interest to Technical Section members is the existence of two bodies considering standardization efforts that apply to modeling in general and discrete event simulation in particular. The first and oldest is the TC3 Committee (Simulation Software) of the International Association for Mathematics and Computers in Simulation (IMACS). The second group, the Committee for International Standardization of Model Oriented Languages (CISMOL), was formed at the Sorrento Workshop for International Standardization of Simulation Languages, held in September, 1979 in Italy.

The TC3 seeks to include both discrete event and continuous models in the update of the 1967 Continuous System Simulation Language standard. The committee is chaired by Dr. Roy Crosbie of the University of Salford (UK) and the Vice-Chairman is Dr. F. E. Cellier of The Swiss Federal Institute of Technology - Zurich.

Professor M. S. Elzas of the Wageningen Agricultural University (Netherlands) chairs the CISMOL, which consists of three working subcommittees, chaired by Professor T. I. Oren of the University of Ottawa (Canada), Inge Troch of the Technische Universitaet Wien (Austria), and B. P. Zeigler of the Weizmann Institute (Israel).

Both committees welcome input from individuals interested in and willing to work on the standards tasks. Contacts can be made through the committee or subcommittee chairmen. Dr. Cellier has a mailing list for both committees, and his address is Institute for Automatic Control, The Swiss Federal Institute of Technology, ETH-Zentrum, CH-8092 Zurich, Switzerland.

Richard E. Nance

ABSTRACTS OF RECENT PAPERS

Note: For papers with multiple authors, write to an underlined author for copies of papers.

"Regression-Adjusted Estimates for Regenerative Simulations, with Graphics," P.A.W. Lewis and P. Heidelberger, Department of OR and Administrative Sciences, Code 55Lw, Naval Postgraduate School, Monterey, CA 93940. Report Number NPS55-80-019, April 1980.

The independent block structure of regenerative processes and the known convergence rates of the means of ratio estimators are exploited to produce bias-free regression-adjusted estimates (rare's) for regenerative simulations. Direct assessments of the variances of the estimates are obtained, as well as indications--both formal and graphical--of their normality or non-normality.

"The Time and State Relationships in Simulation Modeling," Richard E. Nance, Department of Computer Science, Virginia Tech, Blacksburg, VA. Written at the Naval Surface Weapons Center (Combat Ssytems Department), Dahlgren, VA, April 15, 1980. No abstract.

"Model Representation in Discrete Event Simulation: The Conical Methodology," Richard E. Nance, Department of Computer Science, Virginia Tech, Blacksburg, VA. October 15, 1980.

"Verification and Validation of Simulation Models," Robert G. Sargent, Department of Industrial Engineering and Operations Research, Syracuse University, Syracuse, NY 13210.

This is a tutorial paper on verification and validation of simulation models. Included in this tutorial paper are what is meant by verification and validation, a description of the various techniques used, and a general discussion on how one verifies and validates a simulation model.

"Batch Size Effects in the Analysis of Simulation Output," Bruce Schmeiser, School of Industrial Engineering, West Lafayette, IN 47907. Research Memorandum 80-05, June 1980.

This paper considers the effects of using fewer batches than are necessary to satisfy normality and independence assumptions. Using too few batches results in 1) correct probability of covering the mean, 2) an increase in expected half length, 3) an increase in the standard deviation of the half length, and 4) an increase in the probability of covering incorrect values of the mean (analogous to Type II error in hypothesis testing). These effects, quantified here, are shown to be small when at least eight to ten batches are used, with least effect on confidence intervals having low confidence values. With the effects of using too few batches quanitified, a simulation practitioner can make the trade-off between the ease of using very few batches with known independence and normality versus using

a batching algorithm to squeeze some remaining information from the data. For researchers developing batching algorithms, the results are useful in selecting initial batch sizes. The results may also be useful in the context of using independent replications to establish confidence intervals on the mean.

Finally, some criteria and a procedure are suggested for Monte Carlo comparison of confidence interval procedures. These suggestions are not restricted to batch mean algorithms.

"Random Variate Generation: A Survey," Bruce W. Schmeiser, School of Industrial Engineering, Purdue University, West Lafayette, IN 47907. Research Memorandum 80-06, August 1980.

The state of the art of generating random variates on a digital computer is surveyed. General concepts are presented, followed by criteria for comparing algorithms. The literature is surveyed for continuous univariate, discrete univariate, continuous multivariate, and discrete multivariate distributions, as well as for point processes, time series, order statistics and geometrically inspired problems. An extensive list of references is provided.

"Control of Initialization Bias in Multivariate Simulation Response," Lee W. Schruben, School of Operations Research and Industrial Engineering, Cornell University, Ithica, NY. Technical Report 455, revised September 1980.

A procedure is proposed for controlling intialization bias in multiple response simulation output. The technique is an adaptation of multivariate quality control methods using a two-sample T^2 statistic for testing equality of means. An example, taken from an actual simulation study, illustrates how initialization bias can go undetected when an aggregrate scalar output is used to control initialization effects. A study of a simple computer time sharing model illustrates that the proposed bias control method can be effective and efficient.

"A Batching Approach to Quantile Estimation in Regenerative Simulations," Andrew F. Seila, University of Georgia, Athens, GA. *"Mathematics and Computers in Simulation,* 21 (1979), 376-384.

This paper presents a new method, called the batch quantile method, for estimating quantiles in regenerative simulations. The quantile estimator is consistent and asymptotically normal, and the method can be easily implemented and does not require prior knowledge of the range of values the data will assume. Empirical studies show adequate coverage of confidence intervals when batches of 50 cycles or more are used.

"A Stratified Regenerative Method for Estimating Mean Waiting Times in Queues With Multiple Renewal Input Streams," Andrews F. Seila, University of Georgia, Athens, GA.

This paper presents a method for estimating mean waiting times and other performance measures in regenerative queueing systems with multiple renewal input streams. This method, which is based upon a stratification of the waiting time data by the stream of origin for each customer, produces estimates of mean waiting times for customers from each stream, as well as overall mean waiting time for all customers. Computational results indicate that the method produces a modest variance reduction, compared to the usual regenerative method based upon aggregating the data over all strata. Since the method imposes no restrictions on the system being simulated, it can also be applied to regenerative service systems which possess a natural stratification scheme, such as priority queueing systems.

"The Use of Cutsets in Monte Carlo Analysis of Stochastic Networks," C. E. Sigal, A. A. B. Pritsker, and J. J. Solberg, School of Industrial Engineering, Purdue University, West Lafayette, IN 47907.

Monte Carlo methods utilizing a new network concept, Uniformly Directed Cutsets (UDCs) are presented for analyzing directed, acyclic networks with probabilistic arc durations. The procedures involve sampling arc values for arcs not on a UDC and utilizing known probability information for arcs on a UDC. This approach results in less sampling effort and less associated variance than a straightforward simulation approach. A proof of this variance reduction is offered. The procedures provide estimates for project completion time distributions, criticality indices, minimum time distributions and path optimality indices. All of these network performance measures are useful to decision makers in project planning. Application areas include PERT-type network planning, equipment replacement analysis, reliability modeling, stochastic dynamic programming problems and maximal flow problems.

"Proof of the Antithetic-variates Theorem for Unbounded Functions," James R. Wilson, Purdue University, West Lafayette, IN 47907. *Math. Proc. Camb. Phil. Soc.,* 86 (1979), 477. No abstract.

"Weighting Simulation Data to Reduce Initialization Effects," Mark Snell and Lee Schruben, School of Operations Research and Industrial Engineering, Cornell University, Ithica, NY. Technical Report 395, April 1979.

A popular method for reducing initialization bias in simulation output is to delay the collection of data until the model has "warmed up." This technique, called data truncation, is considered as a special case of observation weighting. Using a simple autoregressive model for the simulated series, several alternative weighting schemes are studied.

FORMAT FOR SUBMITTING ABSTRACTS

When submitting abstracts of papers, theses or technical reports to the TIMS newsletter please use the following format.

Paper Title _____

Author(s) _____

Address to write for copy

Name _____

Street & Number _____

City, State, Zip _____

Abstract (< 100 words)

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