Computing and Systems Technology Division Communications

Volume 18, Number 2, Summer 1995

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1995 Executive Committee

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Past Chair
W. David Smith, Jr.
E. I. DuPont deNemours & Co.
Experimental Station
P. O. Box 80269
Wilmington, DE 19880-0269
Email: smith@pscvax.dnet.dupont.com
Phone: (302) 695 1476
Fax: (302) 695 2645

Chair
Rudolphe L. Motard
Washington University
Dept. of Chemical Engineering
One Brookings Drive, Urbauer Hall 208
St. Louis, MO 63130-4899
Email: motard@wuche.wustl.edu
Phone: (314) 935 6072
Fax: (314) 935 7211

First Vice-Chair
Gary E. Blau
DowElanco
9330 Zionsville Rd. 306 Bldg.
Indianapolis, IN 46268-1054
Email: gblau@dowelanco.com
Phone: (317) 337 3137
Fax: (317) 337 3215

Second Vice-Chair
George Stephanopoulos
MIT
Room 66-444
Dept. of Chemical Engineering
Cambridge, MA 02139
Email: geosteph@athena.mit.edu
Phone: (617) 253-3904
Fax: (617) 253-9695

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H. Dennis Spriggs
Matrix 2000
P. O. Box 2356
Leesburg, VA 22075
Phone: (703) 779 0199
Fax: (703) 771 2146

Directors, 1993-95
Maria K. Burka
National Science Foundation
Chemical and Transport Systems Division
4201 Wilson Blvd.
Arlington, VA 22230
Email: mburka@nsf.gov
Phone: (703) 306 1371
Fax: (703) 306 0319

Stephen E. Zitney
Cray Research, Inc.
655-E Lone Oak Drive
Eagan, MN 55121
Email: sez@cray.com
Phone: (612) 683 3690
Fax: (612) 683 3099

Directors, 1994-96
Alan B. Coon
Aspen Technology, Inc.
Ten Canal Park
Cambridge, MA 02141
Email: coon@aspentec.com
Phone: (617) 577-0100
Fax: (617) 577-0303

Jeffrey C. Kantor
University of Notre Dame
Department of Chemical Engineering
Notre Dame, IN 46556
Email: Kantor.1@nd.edu
Phone: (219) 631 5797
Fax: (219) 631 8366

Directors 1995-97
Yaman Arkun
Georgia Institute of Technology
School of Chemical Engineering
Atlanta, GA 30332-0100
Email: yaman_arkun@chemeng.gatech.edu
Phone: (404) 894 2871
Fax: (404) 894 2866

Christos Georgakis
Lehigh University
Dept. of Chemical Engineering
Bethlehem, PA
Email: CG00@NS.CC.LEHIGH.edu
Phone: (610) 758 5432
Fax: (610) 758 5057

Ex-Officio Members
Programming Board Chair
Jeffrey J. Siirola
Eastman Chemical Company
Research Laboratories - B95
Kingsport, TN 37662-5150
Email: siirola@emn.com
Phone: (615) 229 3069
Fax: (615) 229 4558

Area 10a: Systems and Process Design
Mike Malone, Chair
University of Massachusetts
Chemical Engineering Dept.
Amherst, MA 01003
Email: mmalone@ecs.umass.edu
Phone: (413) 545 0838
Fax: (413) 545 1647

Michael L Mavrovouniotis, Vice-Chair
Northwestern Univ.
Chemical Eng. Dept.
Evanston, IL 60208-3120
Email: mlmavro@nwu.edu
Phone: (708) 491 7043
Fax: (708) 491 3728

Area 10b: Systems and Process Control
James B. Rawlings, Chair
University of Texas
Dept. of Chemical Engineering
Austin, TX 78712-1062
Email: jbraw@che.utexas.edu
Phone: (512) 471 4417
Fax: (512) 471 7060

Babatunde A. Ogunnaike, Vice-Chair
E. I. Dupont de Nemours
Experimental Station, E1/104
Wilmington, DE 19880-0101
Email: ogunnaike@esspt3.dnet.dupont.coı
Phone: (302) 695 2535
Fax: (302) 695 2645

Area 10c: Computers in Operations and Information Processing
Joseph F. Pekny, Chair
Purdue University
School of Chemical Engineering
West Lafayette, IN 47907-1283
Email: pekny@ecn.purdue.edu
Phone: (317) 494 7901
Fax: (317) 494 0805

Scott E. Keeler, Vice-Chair
DowElanco
9330 Zionsville Rd. 306 Bldg.
Indianapolis, IN 46268-1054
Email: skeeler@dowelanco.com
Phone: (317) 337 3138
Fax: (317) 337 3215

Area 10d: Applied Mathematics and Numerical Analysis
H. C. Chang, Chair
University of Notre Dame
Dept. of Chemical Engineering
Notre Dame, IN 46556
Phone: (219) 631 5697
Fax: (219) 631 8366

Kyriacos Zygourakis, Vice-Chair
Chemical Engineering Department
Rice University
Houston, TX 77251
Email: kyzy@rice.edu
Phone: (713) 527 3509
Fax: (713) 524 5237

AIChE Council Liaison
H. Scott Fogler
University of Michigan
Dept. of Chemical Engineering
Ann Arbor, MI 48109-2136
Email: sfogler@engin.umich.edu
Phone: (313) 763 1361
Fax: (313) 763 0459

Other Members
Publications Board Chair
Peter R. Rony
Dept. of Chemical Engineering
Blacksburg, VA 24061
Email: rony@vtvm1.cc.vt.edu
Phone: (703) 231 7658
Fax: (703) 231 5022

Bjorn Tyreus - Dupont

EDITORIAL NOTES

About This Issue

by Peter R. Rony, Jeffrey J. Siirola and Scott E. Keeler

The CAST Executive Committee extend congratulations to our 1995 award winners--**Thomas Edgar**, **Herbert Britt**, and **Evilio Hernandez**. CAST Communications is proud to provide the details of the basis for their nomination and selection. In doing so, we remind our readers of something that we wrote in the Winter 1995 issue: *"Readers will observe the extensive write-ups for our 1994 CAST Division award winners, a tradition that we have followed in CAST Communications for several years. In culling paragraphs, statements, citations, and so forth, the editor has noted how the honored work focuses on fundamental, long-lasting contributions to computer theory and practice in chemical engineering (and in other fields). For CAST Division members who are not familiar with our honorees and their respective contributions, the extensive statements from the awards dossiers have educational value."*

Jeff Siirola directs readers to the fact that the entire CAST programming efforts at the AIChE Spring National and Fall Annual meetings in 1995 are being co-sponsored by the Society for Computer Simulation (SCS). In addition, the SCS is putting on a special session with CAST Area 10A at New Orleans on "Potential Applications of Power Plant Simulation Technologies in the Chemical Industry." The hope is that there might be some interesting exchange of ideas from apparently very different approaches to simulation in these two industries.

We also direct readers to the electronic submission of extended abstracts via email or the WWW for the 1995 Miami Beach Annual AIChE Meeting. As described by Dale Kirmse (see Communications in this newsletter), "this year, authors of accepted papers for the American Institute of Chemical Engineers Annual Meeting can electronically submit extended abstracts for distribution via an email list processor and the World-Wide Web. Although this is optional, each author is encouraged to do so."

In this issue, we publish the second part of the invited article, "Low-Cost Virtual Reality and its Application to Chemical Engineering, " by John Bell and H. Scott Fogler. John and Scott have updated Part II as of July 1, 1995.

This issue marks the transition to a new "virtual publishing" triumvirate for CAST Communications. Recall that a "virtual corporation" is one that has few permanent employees, and instead relies on a cadre of corporate associates -- perhaps distributed geographically -- whose services are employed and paid for on an as-needed basis. The CAST Division virtual publishing triumvirate consists of Gordie Ellis (AIChE headquarters, New York); Scott Keeler, and Angela Lewis (DowElanco, Indianapolis); and Peter Rony (Virginia Tech, Blacksburg). The editorial process starts with the transmission of editorial content – preferably in electronic form -- to Peter Rony, who edits and partially formats it. The process continues with the electronic transmission of files from Peter to Scott and Angela, who lay out and print the final original copy of the newsletter and mail it to New York. The process is completed with the printing and mailing of the issue of CAST Communications, managed by Gordie Ellis at AIChE headquarters. We each handle about 33% of the overall task, and therefore make it a manageable volunteer activity for the CAST Division.

We should point out that the transition to a new triumvirate was not without its problems, exclusively with the transmission of electronic files from Blacksburg to Indianapolis. To describe our travails, let us first digress to the procedure that we used between Blacksburg and Mississauga, Ontario (Xerox Research Centre of Canada). Files edited using Word 5.1 for DOS were stored in ASCII text format, then uploaded to an IBM mainframe at Virginia Tech in Blacksburg using PCTRANS software (which can only handle ASCII characters). Once on the mainframe minidisk, the files were emailed to Colette Totino and Joe Wright in Canada. Triple asterisks (***) were used to denote individual paragraphs. We can characterize all such Blacksburg-Xerox file transfers as being basically ASCII-text oriented.

To transfer files between Blacksburg and Indianapolis, we moved to the Windows operating system and the Internet. First we tried simple Microsoft Word for Windows .DOC or .RTF file "attachments" to an Eudora 1.4 for Windows Internet email message sent to Indianapolis. Such attachments were encoded into ASCII text using either MIME or BINHEX encoding, a capability available within Eudora 1.4. All our attempts at file transfer of an attachment failed; the encoded files could not be received correctly at the Indianapolis end.

Finally, we tested a World Wide Web HTML scripting technique to create a simple, WWW home page that allowed a reader to retrieve binary-coded files from an anonymous FTP file server in Blacksburg. This approach worked very well, and will be used by the CAST Communications editorial team to transmit files between Blacksburg and Indianapolis. To illustrate how we accomplished the task, the HTML code used is being published in this newsletter as Figure 1. It should be noted that this HTML script could immediately serve as the basis for providing CAST Communications, formatted, word-processor files in binary form to CAST Division members. The editorial board does NOT propose to make available either feature articles or some communications in this form; they will be only available in the printed version of the newsletter.

We must admit that it was exciting to finally succeed with our HTML, WWW file-transfer approach. The file-transfer protocol (FTP) of Internet can be a very useful tool for computer professionals.

Figure 1. Sample HTML script for transmitting CAST newsletter files over WWW from Blacksburg to Indianapolis. This script also can be used as a method for transferring CAST newsletter files to CAST Division members.

```
<!DOCTYPE HTML SYSTEM "html.dtd">
<HTML>
<HEAD>
<TITLE>Peter Rony ChE WWW Home Page</TITLE>
</HEAD>
<H1> CAST Communications, Summer 1995 Files </H1>
<p><h2>Rich Text Format Files:</h2>

<p><h3><a name = "95sum01.rtf"  href ="95sum01.rtf">95sum01.rtf , 49572 bytes, 8/17/95</a></h3>
<p><h3><a name = "95sum02.rtf"  href ="95sum02.rtf">95sum02.rtf , 64522 bytes, 8/17/95</a></h3>
<p><h3><a name = "95sum04.rtf"  href ="95sum04.rtf">95sum04.rtf , 6584 bytes, 8/17/95</a></h3>
<p><h3><a name = "95sum05.zip"  href ="95sum05.zip">95sum05.zip , 912640 bytes, 8/17/95</a></h3>
<p><h3><a name = "95sum06.rtf"  href ="95sum06.rtf">95sum06.rtf , 5615 bytes, 8/17/95</a></h3>
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<p><h3><a name = "95sum19.rtf"  href ="95sum19.rtf">95sum19.rtf , 2862 bytes, 8/17/95</a></h3>

<p><h2>GIF Files for Feature Article on Virtual Reality:</h2>
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<p><h3><a name = "bwreac2.zip"  href ="bwreac2.zip">bwreac2.zip, 71208 bytes, 8/17/95</a></h3>
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<p>This document is under continuous modification for the Summer 1995 CAST newsletter. For additional details, or if there are any problems with any part of the information provided, please contact Peter Rony at RONY @ VTVM1.CC.VT.EDU. Thank you for your interest in the department.
<p>Latest update of CAST Communications, Summer 1995 Files on Netscape: August 21, 1995.<p>
<HR>
<ADDRESS>Peter R. Rony &amp;lt;rony@vtvm1.cc.vt.edu&amp;gt;</ADDRESS>
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Chairman's Message

by Rudy Motard

This Summer, I had the privilege of attending the CACHE/CAST Intelligent Systems in Process Engineering (ISPE'95) conference at Snowmass, Colorado. At the session on Knowledge and CAD Environments that I chaired, there were impressive developments in engineering information systems that implied new directions from our traditional view. The traditions I think about are not old in themselves, perhaps 15 years, such as engineering databases, activity models, data models, and interactive simulation but, to paraphrase our local baseball announcer when the game gets exciting, "Abner Doubleday has done it again"; the computer has done it again. Possibly we are facing a "paradigm shift".

Having not yet digested the current "state-of-the art", I am invited to envision a design support environment which uses World-Wide-Web (WWW) technology to enhance collaborative design (Art Westerberg, CMU) and to think of the computer as an active assistant whose top-level entities are constraints, alternatives, models and rationale (Rene Banares-Alcantara, Edinburgh). I will not try to explain WWW other than say it is a hypermedia environment rather than simply hypertext. For those who haven't encountered MOSAIC and NETSCAPE, the WWW browsers, just wait a few months and Internet will catch up to you. If you are planning to upgrade to Windows 95 on your PC then all these wonders will be staring at you.

I had the notion of putting some course notes on the WEB but discovered that it is not possible to enter scientific notation with the early versions of authoring languages called HTMLs (hypertext markup language). There is a clumsy fix using graphics and storing images of the scientific equations as (.gif) files. In the near future we are promised SGML (standard generalized markup language) which has actually been standardized internationally (ISO 8879) as the

medium for the exchange of documents across various platforms. Anyway, a WEB document is a flat file with links to a wide variety of media and Prof. Westerberg proposes that we can then use this as an archive from which we build generalization by induction. That turns the data modeling process up side down.

Rene Banares' prototype is also impressive since it harnesses knowledge based processing on a higher level than simply an expert system. There is also induction built into that environment since the computer-based agents try to, 1) interpret the state of the design, 2) represent intention, decisions, methods and assumptions, 3) relate all of the latter and, 4) use them in a man-machine discourse.

Beyond ISPE'95 there is now a great wave of new technology growing out of the object-oriented paradigm and called component software. There are a number of names for these methodologies (COM, OLE, SOM, etc.) but their goal is the same; namely, a broad interoperablility of modules as distributed objects. The field presents opportunities in developing new generations of software systems that would span wide-areas or global enterprises of users, machines and data resources. We will be seeing these innovations soon. Organizations like Intergraph and Autodesk have already announced products and platforms for the Computer Aided Design field. Whether this development will lead to open systems software production remains to be seen. If it does, hang onto your hats. CAST should have at least one session on this subject at the Fall 1996 Annual meeting.

Thomas F. Edgar is the Recipient of the 1995 CAST Division Computing in Chemical Engineering Award

"For excellence in education and research in the field of process modeling, control, and optimization, and outstanding leadership in the computing and systems technology community," Professor Thomas Edgar -- George T. & Gladys H. Abell Professor of chemical engineering at the University of Texas at Austin -- is the recipient of the 1995 CAST Division Computing in Chemical Engineering Award. Tom will speak on "Modeling and Control: Back to the Future" at the Computing and Systems Technology Awards Dinner on Tuesday, November 14, 1995, at the Club Atlantic, Versailles Building, 1995 AIChE Annual Meeting, Miami Beach. Tickets are $44 per person; the event starts at 7:00 PM (cash bar) and the dinner at 8:00 PM.

Professor Edgar received his B.S.ChE from the University of Kansas in 1967, and the A.M. and Ph.D. degrees in ChE from Princeton University in 1968 and 1971, respectively. He has been a faculty member at the University of Texas at Austin since 1971 and is presently Associate Dean for Academic Affairs in Engineering. His list of technical and professional society memberships and offices is much too long to list in its entirety here, but instead will be referred to in excerpts from his nomination letters, which follow.

"The research contributions made by Thomas F. Edgar during the past 25 years have spanned many areas of interest in computing and systems technology: modeling, control, optimization, numerical analysis, statistical analysis, and artificial intelligence. Application areas covered include separations, reaction engineering, coal gasification, and most recently, microelectronic manufacturing, and the large impact he has had on industrial practice as indicated by support of over 25 companies at various times during his career. In addition, he has greatly influenced the CAST community through his textbook authorship, professional leadership, and training of over 90 M.S. and Ph.D. students at the University of Texas. His early research work was recognized in 1980 by receiving the Allan P. Colburn Award of AIChE. Dr. Edgar has published over 190 journal articles and conference proceedings, 16 book chapters, three books, and three monographs; he has edited four publications."

"Professor Edgar has been an outstanding professional and educational leader of the control and computing communities in chemical engineering. As detailed in the supporting letters, Tom Edgar has had a significant impact on the organizations he has led: CACHE, AIChE-CAST Division (Chair), American Automatic Control Council (President), the Council for Chemical Research (Chair), and Department of Chemical Engineering at Texas (Chairman). He was one of twelve Directors of AIChE during 1989-92, and secured the financing of the CPC Conferences (via American Control Conference income) while on Council. He has served on six advisory boards for government, industry, and universities as well as the editorial boards of six journals."

"Dr. Edgar has a strong commitment to education. The two books he co-authored on optimization and process control have had a major impact on the teaching of these subjects in chemical engineering as well as on professional practice. Both books have received excellent reviews and are the leading textbooks in their respective areas. 'Optimization of Chemical Processes' (McGraw-Hill, 1988) emphasizes the difficult task of formulating optimization problems and contains numerous

practical examples. 'Process Dynamics and Control' (Wiley, 1989) is now used at over 80 chemical engineering departments and won the ASEE Meriam-Wiley Award in 1989 as the top new engineering textbook. In addition, Dr. Edgar has received education awards from several national groups, namely ASEE (Westinghouse Award), ISA (Eckman Award), and the American Automatic Control Council."

"In the field of process control, Dr. Edgar's work has focused on multivariable control and more recently on adaptive control. The 1981 work with a Ph.D. student (E. F. Vogel) on an adaptive, dead-time compensator solved a long-standing problem inherent in many chemical processes, and has been cited or used by a large number of subsequent investigators. Dr. Edgar has made important contributions to the modeling and control of nonlinear systems. He pioneered the use of nonlinear programming in design controllers with one of the original references in this area (with T. H. Tsang, 1975), based on the combined use of collocation and optimization. This eventually led to the experimental demonstration of a new model-predictive control algorithm on a commercial-scale packed-bed distillation column, where conventional control techniques had failed (with A. Patwardham, 1993). Other recent contributions include a new algorithm for dynamic data reconciliation for nonlinear systems, also based on nonlinear programming and orthogonal collocation (with M. Liebman, 1992)."

"Dr. Edgar's research in coal gasification and combustion during 1975-1985 focused on developing fundamentals-based mathematical models in a field noted for empirical approaches. In underground coal gasification (UCG), the general thrust of his work was to determine those physical and chemical conditions that are conducive to application of UCG. The interdisciplinary group that he directed developed computer-based methods for scale-up, and experimental methods to characterize a given coal deposit for UCG. These techniques were used by several oil companies and by government laboratories, and included computer models and experimental correlations. Of his publications on UCG, the book chapter in "Chemistry of Coal Utilization" (1981) will stand as the key chemical engineering reference in the field for the next 10 years."

"Another major publishing activity has been editing five volumes of process control modules that have been published by AIChE (1981-86). Since 1979, seven out of the ten publications in the process control section of the AIChE Publications Catalog have been due directly to his editorship. During the past year, he has led a multi-author team in a major revision of the Process Control section of Perry's Handbook."

"He currently directs the Texas Modeling and Control Consortium, involving four faculty at UT-Austin, 25 graduate students, and 15 sponsoring companies. Since 1987, his research program has included modeling and control of electronic materials processing, where he has become a leading spokesman for advanced, real-time modeling and control in the microelectronics industry. He and his students have worked with SEMATECH, AG Associates, Texas Instruments, and Advanced Micro Devices to develop deposition and etch models and control strategies that have been implemented on commercial equipment."

"No educator in chemical engineering works harder to stay at the cutting edge of process control than Dr. Edgar. When chemical engineering educators want to know what they should teach in the rapidly changing area of process control, they look to Dr. Edgar for advice. His major goal since becoming an educator has been to do everything he can to advance his profession and, at the same time, help others to best utilize these advancements. He is a tireless worker of seeming unlimited energy, an inspiration to his many colleagues, and a servant to his profession. He is highly deserving of the Computing in Chemical Engineering Award."

Herbert I. Britt is the Winner of the 1995 CAST Division Computing Practice Award

For the second year in a row, the CAST Division Computing Practice Award -- sponsored by Pergamon Press -- goes to an employee of Aspen Technology, Inc. This year, Dr. Herbert I. Britt, Senior Vice President for Product Management and Managing Director, Aspen Tech UK Ltd., was selected "For pioneering development of technology for computer-aided process simulation, for vision in translating state-of-the-art technology to broadly usable products, and for leadership as a founder of Aspen Technology, Inc." The award will be presented at the Computing and Systems Technology Awards Dinner on Tuesday, November 14, 1995, at the Club Atlantic, Versailles Building, 1995 AIChE Annual Meeting, Miami Beach.

The nomination package in support of candidate Britt continued as follows:

"As Associate Project Manager for the ASPEN Project at MIT from 1977 to 1981, he was responsible for the design and implementation of the leading-edge system and architecture concepts underlying the ASPEN process simulation system. The basic concepts of a 'table-drive' architecture and flexible stream structures -- which were new in 1977 -- are still used today not only in the commercial ASPEN PLUS system, but also in other simulators as well."

"Throughout the 1980s, Dr. Britt's vision guided the evolution of the

technology through an era in which the computing environment underwent dramatic changes. He has demonstrated a remarkable ability to meld together advanced modeling technology, system architecture and state-of-the-art computing technology to create powerful simulation systems with an appeal to a broad base of users. His vision led to the development of the expert guidance system that is still a part of the ASPEN PLUS user interface. The concept was deemed to be sufficiently unique to be awarded a U.S. patent in 1991."

"In the 1990s, Dr. Britt's vision has extended to the more comprehensive integration of modeling, simulation and computing technologies, encompassing steady state and dynamic simulation, the modular and equation-based modeling approaches, object-oriented modeling, and graphical and interactive user interfaces. As a founder and former Vice Chairman of the AIChE Process Data Exchange Institute (PDXI), he has been a leading advocate of the development of the enabling standards required for the reduction to practice of the vision for integrated modeling."

"Dr. Britt has not only contributed the vision for what is feasible and broadly useable, as a Vice President of Aspen Technology, Inc. he has had the responsibility for leading and managing the technical teams engaged in developing and implementing the technology. He has also played a key role in gaining acceptance of the vision and the technology among users and managers in the process industries on an international scale."

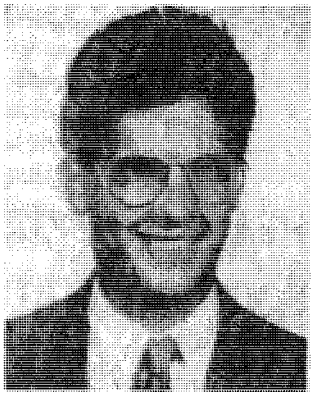
"In the research literature Herb was co-author with Joe Boston of the landmark paper, 'A Radically Different Formulation and Solution of Single-Stage Flash Problem' (Comp. Chem. Eng. 2 [109], 1978), which made a great impact in the area of process simulation. He has also been the author of a number of insightful papers on thermodynamic models and solution strategies for the convergence and optimization of process simulators. His papers on general reviews of process simulation have been invaluable in bridging the gap between academic research and industrial practice."

"Herb's major contributions have been in the development of modern computational tools for process engineering. In particular, he was pivotal in the development of the ASPEN simulator at MIT and in its subsequent commercialization in the form of the ASPEN PLUS system. In his current position as Senior Vice President for Product Management at Aspen Tech he has taken a leading role in a number of new areas, including the integration of ASPEN PLUS models with SPEED-UP."

"The criteria for receiving the CAST Practice Award are very general, stating only that the awardee must have made 'outstanding contributions in the practice or applications of chemical engineering to computing and systems technology.' So, let me be more specific. In my opinion, there are two key requirements: (1) That the person have a thorough understanding of a business need and simultaneously a vision of how to satisfy that need, and (2) The tenacity and passion to see it through into industrial practice. I believe that Herb fully meets both of these criteria."

"Herb Britt has been, in my estimation, at the heart of the development of chemical process simulation software for at least 18 years. He was one of the pioneers of the third generation of process simulators and, with the help of his colleagues (and the stimulus of his competition), is inventing the future in process simulation. He has nurtured the ASPEN PLUS system and its derivatives and expansions from conception in 1976 to the present day. Herb has an uncanny feel for the needs of industrial process engineers as users of commercial simulation and design software. The success of the Aspen Technology company in achieving a high share of the worldwide market for licensed process engineering software attests to the energy and creativity that he has brought to his job as the senior product development executive for the company."

Evilio Hernandez is Honored With the 1995 CAST Division Ted Petersen Award



The 1995 CAST Division Ted Petersen Award will be presented to Evilio Hernandez at the Computing and Systems Technology Awards Dinner on Tuesday, November 14, 1995, at the Club Atlantic, Versailles Building, 1995 AIChE Annual Meeting, Miami Beach. Dr. Hernandez, who received his B.S. and Ph.D. degrees at Georgia Institute of Technology in 1987 and 1992, respectively, is being recognized for "his work on identification, analysis and control of nonlinear dynamical systems using input-output plant information." His advisor at Georgia Tech was Professor Yaman Arkun. Dr. Hernandez currently is an Associate Research Engineer at Shell Development Company, Houston, where he is developing and testing productivity tools to assist field control engineers in the analysis and design of control systems.

Excerpts from the nominating letters that vigorously supported the candidacy of Dr. Hernandez include the following:

"His identification work appeared in 'Control of Nonlinear Chemical Processes Using Polynomial ARMA Models,' AICHE J., 1993 and 'A Study of Control Relevant Properties of Back-Propagation Neural Network Models of Nonlinear Dynamical Systems,' Computers Chem. Engng., 1992. In these two papers, he studied the use of nonlinear time series models described by neural nets and polynomial autoregressive moving average models. In particular, he provided valuable insights into input signal selection for

nonlinear identification and modal structure selection based on statistical methods. Also, using state-space realizations, he laid down a rigorous foundation to study the control relevant properties of nonlinear input-output dynamic models. These properties included the local stability of nonlinear maps and of their inverse dynamics at equilibrium points. In doing so, he established the connection between the stable inversion of nonlinear input-output models and the feedback linearization of discrete nonlinear systems. His nonlinear analysis results appeared in a recent paper, 'Stability of Nonlinear, Polynomial ARMA Models and Their Inverse,' Int. J. of Control, 1995. Here, using contraction mapping and robust control theory, he derived conditions that guarantee stability and invertibility in an 'extended neighborhood' around the equilibrium point, thus strengthening the local results presented earlier in the AIChE and Computers Chem. Engng. papers. The results are particularly useful for the analysis of closed loop stability when the model inverse or an extended-horizon-type controller is used."

"Under nonlinear control, after studying many seemingly different approaches he developed a unifying methodology to combine nonlinear input-output models with model-predictive control algorithms. This work appeared in 'Control of Nonlinear Chemical Processes Using Polynomial ARMA Models,' AIChE J., 1993 along with his identification studies discussed above. His model predictive control framework paralleled the recent linear MPC formulations, and included state and parameter estimation along with disturbance models. To the best of my knowledge, this work was the first of its kind. If I have to cite a single paper for his nomination, it will have to be this contribution. In a parallel paper, "On the Global Solution to Nonlinear Model Predictive Control Algorithms that Use Polynomial Models," Computers Chem. Engng., 1994, he showed, in a clever way, how the nonlinear MPC optimization can be solved globally for SISO systems by simply calculating the roots of a polynomial, thus reducing the computation time and guaranteeing the global optimum. This optimization algorithm then became an integral part of his nonlinear MPC implementation presented in the AIChE J. paper."

"These four publications have already made their impact on industry and academia. While addressing many control-oriented scientific issues, the results have proven useful for industrial applications, where nonlinear dynamic analysis and model building from input-output data are very much in demand due to a shortage of first-principle models. In our group, we have applied his research results to a polymerization reactor and a distillation column in collaboration with two major chemical companies. At the same time, his pioneering work on polynomial autoregressive models has spurred a big interest in this area in the process control community."

"The second point illustrated by these [four] papers is his focus on certain unifying themes of critical importance both in theory and in practice. For example, one theme that runs through all four papers is the use of polynomial ARMA models for approximating process dynamics. While other model classes have been proposed and continue to be investigated, the polynomial ARMA class appears to be one of the most flexible of these classes, a feature that is both a blessing and a curse. In particular, Evilio's AIChE Journal paper was one of the papers that made me keenly aware of some of the advantages of this class relative to the nonlinear moving-average classes (e.g., Volterra models) that I had been primarily interested in earlier. One of the results of this enhanced awareness was the emphasis I placed on polynomial ARMA (alternatively, NARMAX) models . . ."

"The third point clearly established by these papers is Evilio's attention to details that are ancillary to the empirical modeling problem per se, but that are of extreme importance in practice. This point is illustrated nicely in the International Journal of Control paper, in which it is demonstrated that sufficient conditions for model stability given earlier by Chen and Billings cannot be satisfied. Hernandez and Arkun then proceed to improve this earlier result to one that is applicable, and demonstrate it for a chemical process-oriented example. This theme -- a demonstrated understanding of both the underlying mathematics and its real-world implications -- is one that reappears in all four of these papers. In particular, issues of disturbance modeling, 'reasonableness' of both the identified process model and its inverse, the complexity of the model structures identified, and the computational difficulty of solving the model identification problem are all addressed in these papers."

ARTICLES

Low Cost Virtual Reality and its Application to Chemical Engineering, Part Two

Introduction and Update from Part One

This article has been subdivided into two parts, the first of which presented an introduction to virtual reality (VR) and a discussion of what low-cost hardware and software options are available.[3] This second part will cover some applications of virtual reality, including areas where VR is being or could be applied to chemical engineering, and in particular the work being done at the University of Michigan's department of Chemical Engineering to apply low-cost virtual reality to undergraduate education. First, it is necessary to address a few issues that have changed substantially since Part One was written. The fact that so much has changed in just six months is typical of this rapidly developing field.

Sourceless trackers improving and gaining in popularity:[15] Part one of this article discussed head trackers costing hundreds or thousands of dollars that utilize a transmitter-and-receiver combination -- either electromagnetic or ultrasonic -- to track the position and orientation of a user's head, and mentioned the existence of sourceless trackers. These latter devices, which incorporate gravimetric tilt sensors, compasses, gyroscopes,

and other self-contained sensors are termed "sourceless" because they are entirely self contained, which eliminates some of the clutter of a VR setup and avoids the interference problem when multiple sensors are used in close proximity. These sourceless sensors are much less expensive to produce, and have become quite popular, particularly as a 3- degree-of-freedom (rotation only) sensor for tracking head movements of a seated user, because the position of the head does not change appreciably in that environment.

HMDs available for $800 with built-in head tracker: In the first part of this article a low-cost head-mounted display (HMD) was one that cost only a few thousand dollars, such as the CyberEye from General Reality Company, which then also required the separate purchase of a head tracking device. While that solution is still available, and is a good quality device, a new product has recently hit the market which has won many awards and much praise from the virtual reality industry. That product is the *i-Glasses*, from Virtual I/O inc., which weighs in at just 8 ounces and fits in your pocket for color stereo viewing and built-in 3 DOF tracking for only $800. i-Glasses are the first product offered by this fledgling company, and other (e.g. VGA) products are expected within a year. Zwern[20] provides a good review of available head-mounted display devices.

New low-cost wired gloves available and others announced: Part one discussed the Nintendo Powerglove, a discontinued toy accessory that some homebrew VR enthusiasts have wired into their computers, and also mentioned the existence of more advanced gloves costing thousands of dollars based on fiber optics technology. Two announcements have been made within the last month regarding the availability of new, low-cost wired gloves. First of all, Arthur Zwern, of General Reality Company, announced the U.S. availability of a fiber-optic glove produced by Fifth Dimension, with an introductory price of $495, and a quality equivalent to the original fiber-optic gloves produced by the (now-defunct?) VPL corporation.

The second announcement was by Chris Gentile, of Abrams/Gentile Entertainment, the manufacturers and patent holders of the discontinued Nintendo PowerGlove. AGE announced the development of a "PC PowerGlove", to be available in 1996 for less than $120, with much higher resolution and better features than the Nintendo PowerGlove and pre-configured to connect to a PC serial port. Special options such as left-handed gloves, two-glove packages, and tactile feedback will be available at slightly higher cost.

WTK: New product replaces SPEA solution: WorldToolKit from Sense8 formerly had (a) a Windows 3.1 version which ran on ordinary PCs; (b) a DOS version which required a special graphics board, the SPEA Fire graphics board; and (c) a number of products running on higher-end platforms. The Windows 3.1 solution is still being sold, and is a popular product, but unfortunately the SPEA card is no longer available, which puts a damper (at least temporarily) on the DOS product. However, Sense8 now has an alternate product, using OpenGL and Windows NT. OpenGL is based upon the graphics language developed by Silicon Graphics for their high-end graphics supercomputers, and will be supported by the new Windows NT operating system. Because of the huge potential market for CAD applications and computer games, a number of companies have announced plans for OpenGL graphics accelerator cards, which will be expensive initially but will rapidly drop in price as volume sales and competition develops. Some systems available now from InterGraph corporation rival high-performance SGI workstations in performance for a fraction of the cost. The nice thing about it all is that Windows NT will support OpenGL applications whether or not a graphics accelerator is present -- they will just run faster with the special cards.

Current Applications of Virtual Reality, Including Possible Future Applications, and Their Extension to Chemical Engineering

Virtual reality has been applied to a wide variety of fields and problems, though very few have been specifically addressed to chemical engineering. Here are some of the current applications of virtual reality, with consideration of how they might be extended to chemical engineering, where appropriate. The few applications where VR is already being applied to chemical engineering problems are also covered here, along with some ideas as to how this technology might be applied to chemical engineering in the future. This section includes, but is not restricted to, low-cost implementations.

The first application of virtual reality was flight simulation conducted by NASA. This is still a major use of the technology, allowing potential pilots to "crash" million dollar simulators, with no real loss, rather than billion-dollar aircraft with considerable loss. In addition, much of the technology developed for flight simulators is now used in actual aircraft cockpits; examples are the head-mounted display (HMD) unit to show the pilot critical information without taking his/her attention away from the action in front of him/her, and 3D sound cues to provide the pilot with important information, with the "location" of the sound adjusted for optimal effect.

In an industrial setting, virtual reality has been applied to the training of assembly line personnel by Nina Adams and Art Paton at Motorola University.[18] In a carefully controlled study, they found that new employees trained using virtual reality were actually able to operate complicated machinery with fewer mistakes than similar employees who had been trained using the actual production equipment. Simulator training involving virtual reality is also used in several other fields, and could be applied in chemical engineering to the training of control room personnel in large, complicated chemical plants, or to other operating personnel where turning the wrong valve could lead to disaster. These simulators could also be used to de-

velop operational procedures, practice emergency shutdowns, and for re-enacting events leading to accidents or alarm conditions.

By far the most well-known and well-developed application of VR to date is the entertainment industry. Virtual reality gaming centers are popping up all across the country, with the most popular game being "Dactyl Nightmare" played on the Virtuality system from W Industries. This game allows from one to four participants to enter together into a virtual environment, where they attempt to find and kill each other before being killed by their opponents or by roving pterodactyls. VR has appeared as the main focus of a weekly TV game show in Great Britain, and has been idealized in several movies and television programs such as "Lawnmower Man", "VR5", and "Wild Palms," not to mention the Star Trek holodeck. The home gaming market has seen the introduction of home VR gaming equipment from Sega, Nintendo, and others; consumers can expect an explosion of new products and games within the next year. This application does not lend itself to practical engineering, but could be used to stir interest in the chemical engineering field if an appropriate chemical plant simulation game were to be developed.

The next biggest application is the architectural walk through (fly through). Using a program such as WorldToolKit, it is a simple matter to import anything drawn by a 3D CAD program, such as AutoCAD, into a virtual environment. (Some advanced CAD programs allow interactive rendering of their 3D constructions directly, bypassing the need for a separate rendering engine.) This allows users to view buildings and other constructions before they have actually been built. If the user does not like the results, it is a simple matter to enlarge a window, move a wall, or change the coloring, often from within the virtual environment. In Japan, where land is scarce and large showrooms prohibitively expensive, housewives can use VR to preview their new kitchens prior to remodeling. One research group has hooked up a wheelchair to a virtual display system in order to check designs for handicap accessibility.

Closer to our field, major construction engineering firms such as Bechtel, Fluor-Daniel, Parsons, Stone & Webster, and CADCentre have long used sophisticated CAD programs to keep track of large projects. As the years progressed, those programs have gone from 2D to 3D, have developed sophisticated rendering capabilities, and now allow dynamic viewpoint adjustment and interaction. Essentially the drafting programs have become VR engines, allowing engineers to walk through plants before they are constructed, to bring up project data on screen, and to discover problems and make modification before ground is broken or materials ordered. While not exclusively aimed at chemical engineering, this tool has been utilized in the construction of a number of chemical plants and refineries, such as ARCO's Cherry Point refinery, designed by the Ralph M. Parsons Company using Intergraph's "Plant Design System".

Medical imaging is another big application for virtual reality. By using collected data, doctors are able to visualize and interact with a virtual patient. This is useful for training purposes, for long-distance consulting, and for viewing the patient in ways that otherwise might not be possible. One application for this latter technique aids doctors in placing and aiming radiation sources so as to best affect cancerous tissue without affecting the neighboring healthy tissue. Prior to VR, most doctors used radiation projected only along x, y, and z axes, since that was the easiest to visualize and calculate. By experimenting with a see-through patient in a virtual environment, doctors are able to better determine optimal, often oblique radiation angles, yielding less damage to healthy tissue and faster recovery times. Biochemical engineers might apply VR to observe the diffusion and breakdown of drug and other molecules in the body's circulatory system, and their accumulation rate in various organs.

One very interesting medical application being developed at UNC Chapel Hill, allows doctors to view unborn fetuses in-situ.[1] Ultrasound data is fed into a computer, which then produces a 3D image of the fetus in real time. This image is then projected onto a half-silvered mirror located in front of the doctor's eye. Because of the half-silvering, the doctor can see not only the computer generated image, but also the patient and the rest of the "real" world. The net effect, known as augmented reality, allows the doctor to view the fetus in-situ, rather than on a computer screen. Difficulties currently being worked out include the alignment of the projected image with the real world. Chemical engineers could incorporate temperature, pressure, and other real-time sensor measurements in a computer simulation to generate an image of the conditions inside processing equipment.

Another application being developed at UNC is project GROPE[9], wherein pharmaceutical developers are using virtual reality and tactile feedback to determine docking sites for proposed drug molecules onto protein molecules. The researcher visualizes a room-sized protein molecule, and holds the proposed drug molecule in his/her hand. When (s)he tries to dock the drug in an unfavorable location, a robotic arm resists his/her movements in proportion to the intermolecular forces at work. This tactile feedback greatly increases the ability of these researchers to determine the correct docking sites, thereby speeding up the drug development cycle. This is one of many examples of the application of VR to chemistry/molecular modelling, that has been a field of development for close to thirty years.

Archaeologists are using virtual reality to model important historical sites. Their interests are many-fold. First is to present how important ancient cities looked during the height of their cultures' civilizations, thereby allowing researchers and students to "travel" to ancient times. Secondly, by modeling sites under current excavation, is to formulate better hypotheses of how the ancient buildings were laid out, thereby directing their digging efforts towards the most promising areas. Third is to allow wide access to archeological sites that are off limits to the general public because of the fragility of the artifacts.[8] Extensions to

chemical engineering would include the reconstruction of destroyed chemical plants in order to aid in accident investigations; courtroom litigations; and as an educational example for future plant designers and operating personnel.

The aircraft industry has embraced virtual reality in several applications. Boeing conducted all of the design, development, and testing of its new Boeing 777 airplane using virtual reality, and produced the first production plane directly from the plans, with no prototypes or physical mock-ups. (The automotive and other design industries are also using virtual reality extensively to reduce prototyping costs.) McDonnell Douglas Corporation used virtual reality to test mechanics' ability to change engines on the F18 before it was constructed, and to make design changes so that the engine could be replaced in 30 minutes or less. Another proposed application is to allow airline mechanics to view schematic drawings and maintenance manuals using a see-through head mounted display while performing maintenance operations. Extensions to the chemical engineering industry include the design and maintenance of chemical processing equipment.

There are several applications of virtual reality to database exploration, wherein the large amounts of data present and the complex relationships between different data items makes assimilation by human operators difficult. An example of this is the stock market, where analysts must keep track of thousands of stocks whose values are constantly changing, and where any competitive edge can be worth millions of dollars. Chemical engineering also has many large complex databases, which could be explored more intuitively if the appropriate VR implementation were developed.

Similar to this is the field of scientific visualization. Computer scientists working in the area of computer graphics have long been active in the visualization of complex scientific calculations, such as computational fluid dynamics (CFD). These applications have typically required tens or hundreds of hours of super computer time just to generate the underlying data, and almost as much effort to produce each beautiful 2D image of the results. As computer graphics capabilities have grown, these researchers have begun to develop VR- based representations of scientific data. Two examples related to chemical engineering are NASA's virtual windtunnel,[10,19] and an example problem regarding secondary oil recovery via chemical flooding developed at Lawrence Berkeley Laboratories in California.[5]

The former application allows NASA scientists to walk around a model of the space shuttle in a virtual windtunnel, and to view the flow patterns without disturbing the surrounding air. Another implementation of VR to display CFD results has been developed by the Matshusta Electric Works, a home heating and air-conditioning firm in Japan, to illustrate to potential clients the flow patters of heat and fumes through their new kitchens. (The CFD calculations still require many hours of supercomputer time; it is only the visualization of the results that is implemented using VR.)

The main focus of the Berkeley group is scientific visualization in general. They happen to have chosen a chemical example to illustrate their methods; this example allows petroleum engineers to move oil recovery and flooding wells by hand and view the resulting changes in the subterranean flow fields. Note that none of the scientific visualization applications mentioned above are being performed on low-cost hardware, but they give some indication of what may be possible in the future, or even today at a lower performance standard. Virtual reality also shows great promise for visualizing phenomena of dimensionality higher than three.

Teleconferencing is another useful application of virtual reality. This centers around the ability to have several participants simultaneously present in the same virtual world. These participants see the same environment, including each other, and can interact with each other as well. Since the actual participants can be physically located thousands of miles apart, teleconferencing provides a unique mechanism for group interaction. (One assumes the group members would take advantage of the opportunity more constructively than in Dactyl Nightmare!) In chemical engineering this technique would allow engineers from distant locations to meet in a virtual chemical plant to discuss a common problem. Even if only a single engineer was involved, telepresence could yield tremendous savings in the travel time and expense involved in "visiting" a remote chemical plant. And if the plant has already been rendered in the construction phase, then the use of the model after the plant is completed represents little additional cost.

Similar in name but not in function is telepresence. This is really more in the realm of robotics/remote manipulation than virtual reality. Telepresence involves the use of a remote mechanical device, including a camera and controllable hardware, connected to a user wearing goggles and utilizing a controller. The user sees what the camera sees, just as if (s)he were there, and the user's motions are transferred to the remote device. Examples would be exploring the bottom of the ocean, the surface of the moon, or the inside of a nuclear containment vessel.

Process synthesis is an area where an abstract virtual environment could prove useful to chemical engineers. There are an almost limitless numbers of production routes available for producing most chemicals, involving different combinations of raw materials, equipment, by-products, hazards, wastes, and chemical pathways. The "optimal" production route for any given chemical is a complicated trade-off involving considerations of cost, feedstock availability, safety, flexibility, investment capital costs, labor requirements, energy consumption, environmental impact, and many other concerns. An abstract virtual environment could be constructed that would allow the chemical engineer to explore different combinations of chemicals and processes, to see the impact of each different combination, and to develop new processes that are significantly better than other alternatives.

Process visualization can also be useful during developmental design phases, after the general process layout has been determined, but before final equipment specifications are available. The abstract representation developed during initial brainstorming sessions would gradually become more concrete as the design develops. The virtual chemical plant could be displayed so as to indicate areas of high cost, energy consumption, safety concerns, etc. through the use of color, relative sizing, or other techniques. (Objects in the virtual world do not have to be displayed in strict conformance with their actual physical appearance.) This differs from the architectural walkthrough, in that exact drawings would be unavailable and unnecessary during this phase of design. One possibility would be to develop a visualizer program that could simply read the results of a process simulation program such as AspenPlus or PROCESS, and then produce a virtual representation for the engineer to explore.

In process monitoring and control, the idea is to attach sensors (temperature, pressure, flowrate, pH, etc.) to actual chemical processing equipment, and to use the measured values as inputs to a virtual simulation of the process. This would allow the engineer to enter into operating equipment or other hazardous environments and monitor process conditions internally. The addition of virtual controls would further allow the engineer or operating personnel to control their processes from within. Simulations generated from recorded data could aid in the investigation of past performance, including disaster reconstruction.

Education is another area which holds great interest and potential for virtual reality researchers.[6,7,11,14] One reason for this is the power of experiential learning -- students learn and retain more from personal experience than they do from books, lectures, or other forms of less active and involved education.[16] Another benefit is the ability of virtual reality to provide tangible substance to intangible concepts, such as entropy and partial derivatives. Many educators are interested in using virtual reality to bring experiences into the classroom that would otherwise be impossible; however most published implementations so far only involve students in grade school and/or high school levels. The only known application of virtual reality to chemical engineering education is the work being done at the University of Michigan's Department of Chemical Engineering, as covered briefly in the following section, and in greater detail elsewhere.[2,4]

Virtual Reality Development at the University of Michigan

Virtual reality holds great promise as an educational tool for undergraduate chemical engineering. However there are many aspects of this new technology which must be better understood before it can be applied effectively to technical education. These issues include not only the technical aspects of how to build a virtual world, but also representational issues (What does entropy sound like? What color is voltage?); interfacial issues (How do users interact with the world?); navigational issues (Which is more intuitive/effective, a mouse, joystick, keyboard, or HMD?); implementational issues (How should VR be integrated into course curriculum?); and hardware-related issues (How much does a head-mounted display or 3-D vision add to the experience, and is the benefit worth the cost in terms of both dollars and speed?).

In order to address some of these issues, we at the University of Michigan have developed a prototype virtual reality based educational module named Vicher. This is a natural extension to the interactive computing modules developed by Fogler and Montgomery,[12] and the multimedia applications currently under development by Montgomery. The following sections will describe our development efforts, including Vicher, followed by a discussion of what we have learned in the development process and the new modules under development as a result of this experience.

General Background

One of the primary goals in our development efforts is to put the finished product into the hands of as many students as possible as quickly as possible. To that end, we have chosen to develop software for the IBM PC platform. Specifically, we are developing on 90MHz Pentium based computers, which are slightly above the average student's home computer, but only slightly, as evidenced by several students who own similar systems. We are also using and investigating certain low-cost peripheral devices, such as General Reality's head-mounted display unit, Logitech's ultrasonic head tracker, and Crystal River Engineering's 3-D audio card, the Alphatron. While these latter devices are not yet commonly available to student budgets, they will become more accessible in the near future, and in any case are optional devices not required to run the programs.

We are also interested in future expandability to higher-end computing platforms, and have therefore chosen WorldToolKit from Sense8 as our primary software development platform. We are developing versions of our programs for both DOS and MS Windows, and plan to port the programs to other platforms at a later date. We also use Rend386, primarily for quick prototypes and preliminary proof-of-concept simulations.

Vicher -- Virtual Chemical Reaction Module

Vicher, (**V**irtual **Ch**emical **R**eaction module), is an educational application of virtual reality designed to aid in the instruction of undergraduate chemical reaction engineering, relating specifically to concepts covered in "Elements of Chemical Reaction Engineering" by H. S. Fogler.[13]

Users interface with Vicher using a joystick for movement, a mouse for "activating" objects and requesting information, and a keyboard for various other tasks, where "activate" takes on a meaning appropriate to the object, such as turning on the television or increasing the reactor feed temperature. When using the head-mounted display, the user may simply look where they want to go and push the joystick forward to move in that direction. This has been found to be the simplest and most effective navigation technique. Another strong benefit of the head-mounted display is the sensory-deprivation effect: When users

are unable to see the "real" world, they become much more immersed in the virtual one.

The virtual environment being modeled in Vicher consists of a small portion of a modern chemical plant, plus some microscopic exploration areas. The rooms consist of a welcome center, in which users learn how to use the program and receive other pertinent information, a transport reactor room where students can study the effects of catalyst fouling, and a non-isothermal packed bed reactor area for the study of energy effects on reaction kinetics and reactor design. All of the reaction equipment may be operated by the students at different operating conditions to observe the effects of changing feed rates, inlet temperatures, etc. on reaction conditions. The microscopic areas are the inside and the outside of a catalyst pellet, and a highly magnified section of a catalyst surface.

The Welcome Center

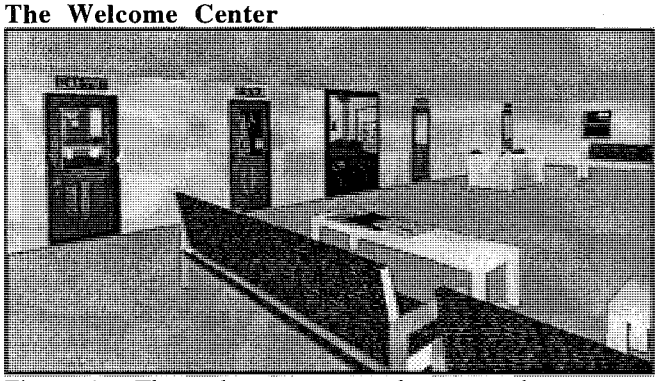


Figure 1: The welcome center, where users become accustomed to virtual reality and learn to navigate.

The welcome center provides two main functions in Vicher. First, it provides a familiar, comfortable environment in which the user can become accustomed to the virtual reality experience and equipment and learn how to navigate. We have found that this goes a long way to combat the disorientation effects that some users experience when first encountering virtual reality. Secondly, it provides a convenient base of operations from which to branch out and explore the other areas of Vicher. A large-screen virtual television in this room provides a preview of the other areas of the simulation. The other areas of Vicher will also have televisions, providing engineering information and other instructions appropriate to each area in the plant.

The Transport Reactor Room

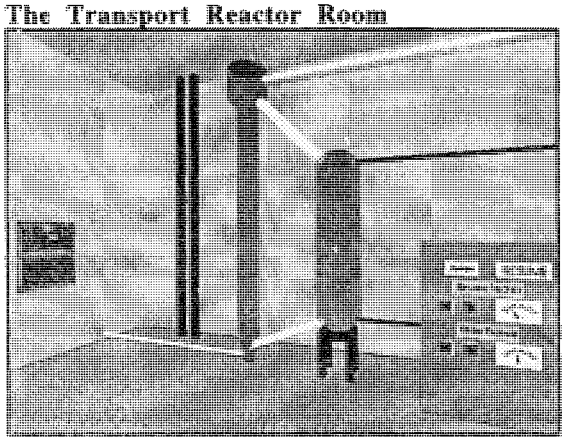


Figure 2: The transport reactor room, for the study of catalyst deactivation processes.

The transport reactor room contains a vertical straight-through transport reactor, (STTR), and its associated catalyst regenerator and control panel. The engineering principles being illustrated in this room are: (1) What does an industrial reactor look like, and how does it operate? (2) The effects of flowrates on coking and decoking of catalyst pellets, and (3) The shrinking-core model of catalyst decay and regeneration. By turning the equipment transparent, (or by simply stepping inside), students can observe the coking and de-coking of the catalyst pellets as they move through the equipment, and how the process changes as various flowrates are adjusted. Gauges on the control panel indicate current operating conditions, and students can teleport into the microscopic worlds described below, either by "activating" or by stepping into the pellets within the reaction equipment. This room also contains a three-foot diameter model of a catalyst pellet, sliced in half and linked to one of the pellets in the reactor, the purpose of which is to illustrate the shrinking core model of catalyst decay and regeneration.

Microscopic Areas

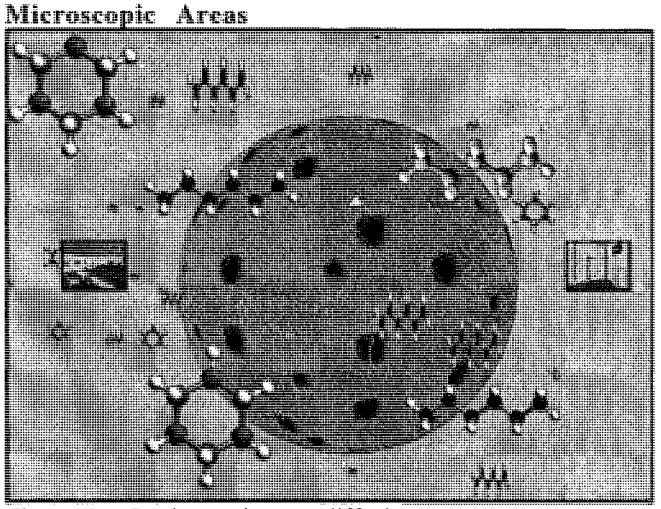


Figure 3: Students observe diffusional effects surrounding a porous catalyst pellet.

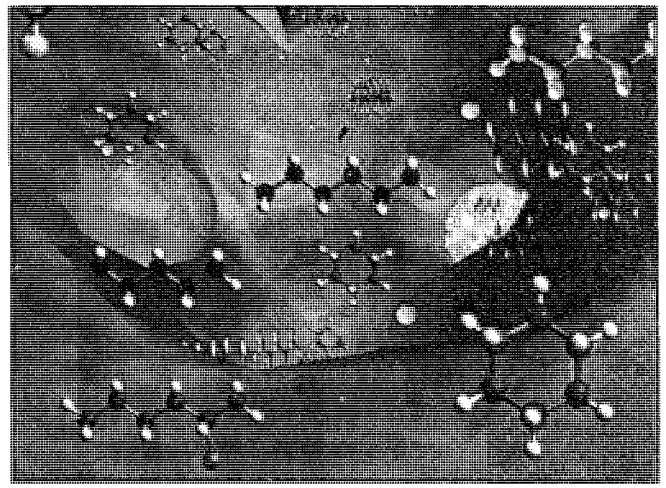


Figure 4: Catalytic reactions occurring inside a catalyst pore.

In addition to the macroscopic worlds, students can also observe catalyst activity on a microscopic scale, in the form of a single, highly detailed, catalyst pellet. From the outside of this pellet, students observe external diffusion. On the inside, students witness internal diffusion and the mechanism of catalytic reaction on a molecular level, including undesired side reactions and coke production. A recent refinement to this area is to reduce the light levels inside the pore as the pellet cokes up, thereby making the world progressively darker. Conversely while the user rides the pellet through the regenerator, the light levels increase as the pellet cleans up. Students may observe reactions either by following random reactants until they absorb and react, or by observing "staged" reaction sites, which are rigged so that there is constantly reaction activity to be observed. Stepping through these staged areas transports the user to a more highly magnified view, where the catalyst surface appears nearly flat and there is a single reaction that occurs repeatedly, and is labeled for easier viewing.

Non-Isothermal Reaction Area

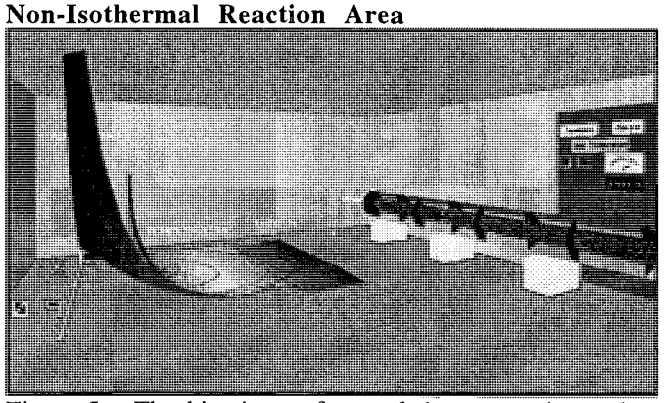


Figure 5: The kinetics surface and the reactor internals are color coded to indicate temperature.

The most recently developed room in Vicher is the non-isothermal packed bed reactor exploration area. In this area, students examine an exothermic reaction occurring in a packed-bed reactor surrounded by a cooling jacket. In addition to the reactor itself and the associated control panel, this room also contains a mathematical surface, which describes the reaction kinetics as a function of temperature and fractional conversion. Overlaid on top of the surface are a number of lines, indicating reactor conditions along the length of the reactor, with different lines corresponding to different reactor operating conditions. Both the mathematical surface and the reactor internals are color coded, from blue to red, to indicate the temperature at any given point. This temperature indication mechanism allows students to quickly and easily determine where the hot spots are within the reactor, and to observe how those hot spots change in both intensity and location as reactor operating conditions are varied. The interaction between the kinetics surface and the physical reality of the reactor goes a long way to bring "meaning " to the mathematics, by showing students a tangible link between the equations, formulas, and mathematics and the physical situations being modeled by those equations.

Lessons Learned From the Development of Vicher

Much has been learned during the development of and subsequent testing of the Vicher prototype program. Some examples of this knowledge can be broken down into a number of categories:

Technical: The worlds that we are developing now are more complex and require less development time than the worlds developed for Vicher. This reflects the experience and examples developed during that earlier work.

Navigational: Vicher originally contained hallways that users had to traverse in order to move from room to room. The replacement of these structures with teleports has greatly eased user navigation, and has provided the added benefit of flexibility in the interconnection of rooms. Results are mixed on the usefulness of the joystick as a navigational device.

Once users become accustomed to the joystick, it is an effective navigational method; however, some users experience some initial difficulty. The head-mounted display is also effective for navigation once the learning curve has been overcome. The keyboard is a poor navigational tool.

Interfacial: Vicher uses the mouse for user actions, which is generally effective, but has some drawbacks. The keyboard is also used during program development, but makes a poor input device for users, particularly when the head-mounted display is being used. One area where we have found virtual reality to be limited is in the presentation of text-based materials, such as written descriptions, formulas, or equations. We have had some limited success using various methods of presenting text in virtual worlds, and will be working on this area further, but in the meantime have concluded that VR is not an appropriate medium for large amounts of printed information. Auditory narration, on the other hand, as well as other auditory input, adds a great deal to the overall impact of VR, and should be used extensively.

Representational: Students particularly like the mathematical surface in the heat effects room, and the use of color to indicate temperature and show the relationship between the mathematics and the physical reactor. Alternate color schemes are being explored, as well as other applications of data presentation (thermodynamic properties, fluid flow velocities.) The molecule portrayal is quite effective, but the catalyst pore interior is an area of difficulty because of its unfamiliar nature. (A familiar environment, such as a room, can be rendered quite crudely and still be recognizable, whereas unfamiliar environments may be unrecognizable even if rendered perfectly.)

Implementational: One of the difficulties we have encountered is that although the IBM PC platform is widely available in general, the University of Michigan engineering network is primarily a Macintosh environment. This meant that the only way for students to experience Vicher was to schedule an appointment during normal business hours, which was inconvenient for many students. This limited access, coupled with the heavy course load taken by most students in

the related course, yielded a lower-than-expected participation rate when Vicher was offered as a voluntary activity. In order to see significant student usage of any program, (computer or otherwise), it must be a required activity, or at least convenient for students to perform at their leisure.

Hardware related issues: We have identified a number of key trade-offs involved in the choice of hardware platforms. For example, the head-mounted display adds greatly to the immersion and thereby the impact of the experience; however, HMDs have lower resolution than computer monitor screens, which results in loss of details when using HMDs, and their cost and fragility inhibits their widespread use in undergraduate computing labs. Hopefully the next generation of high-quality, low-cost head-mounted displays will alleviate some of these problems. Another trade-off involves 3-D vision, which adds a lot to certain worlds, but reduces the display speed by 50%. In our case, we are also somewhat constrained by our choice to support multiple hardware platforms. Not only are we limited to a software platform that runs on all of the hardware chosen, (e.g., WorldToolKit), but we are further limited to using only features that are implementable on all platforms, or else dealing with multiple versions of the programs.

Continuing and Future Developments

Much has been learned during the development of Vicher; however, further progress must be made before the module is ready for widespread classroom use. For one thing, Vicher has grown to about the limit of what will run well on 16 megabytes of memory. (The executing program requires about half of that, but we are also utilizing 8 MB of memory as a RAMdisk to allow for faster access to data files at run time.) In order to add additional areas to the simulation without requiring users to purchase large amounts of memory, it has been decided to split Vicher into two new modules -- one dealing with catalyst decay issues and the other covering non-isothermal effects in chemical reactor design. Progress has been rapid on these two modules, and it is hoped that preliminary classroom testing can commence this fall. Additional student testing, program refinements, and supplemental materials development will be required before widespread distribution can commence.

In addition, a series of small, simple modules are being developed, relating to other areas of chemical engineering, to determine how VR can best be applied in different contexts. For example, a fluid-flow module has been developed with a moving, color-coded, velocity profile, and similarly colored flow tracers. Another application explores thermodynamic properties and the best ways to represent partial derivatives, relationships between variables, and intangible properties such as entropy. The lessons learned from these and other mini-applications can then be incorporated into larger, more complex simulations, or the best of the small applications may be expanded, as appropriate. Some of the other topics of interest include safety studies, crystal structures, unit operations, heat transfer mechanisms and equipment, phase equilibrium, and semiconductor fabrication (both microscopic and clean-room environments).

Summary and Conclusions

Virtual reality is a powerful tool, growing in popularity and ease of access. Prices are coming down and capabilities are improving for entry-level systems. Simple virtual reality can be implemented using public domain programs on an ordinary PC with no special hardware. A few hundred dollars adds 3D vision and a powerglove. To add a true head-mounted display with tracker, sound, and a toolkit for development costs more – starting at $1300 for minimal quality, up to $15,000 and more for higher quality. These prices will continue to drop as VR gains in popularity. A reasonable approach is to start developing virtual reality solutions now using low-cost, low-tech equipment, and then applying the knowledge learned to more advanced implementations once the equipment becomes financially accessible.

There are many ways in which virtual reality can be applied profitably to chemical engineering problems. Several of the ideas presented here are realizable today with little or no new development required. Others will require some effort but are still attainable. At this point there is little use of virtual reality in chemical engineering, but this is expected to change rapidly as engineers realize the potential of this new technology and as prices continue to drop.

The application of virtual reality to chemical engineering education is making rapid strides at the University of Michigan. The first virtual reality based educational application has been developed and extensively beta-tested, and is currently being split into two modules, hopefully to be used in a few classes by this fall. Additional educational applications are developing rapidly, as the knowledge base grows. Some of these applications include safety studies, crystal exploration, mathematical function visualization, thermodynamics, and process design related projects.

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COMMUNICATIONS

Electronic Submission of Extended Abstracts via Email or the WWW for AIChE Meetings

by Dale Kirmse
<webmaster@che.ufl.edu>

This year, authors of accepted papers for the American Institute of Chemical Engineers Annual Meeting can electronically submit extended abstracts for distribution via an email list processor and the World-Wide Web. Although this is optional, each author is encouraged to do so.

Procedures

The procedures to follow for submitting and retrieving abstracts can be obtained by sending the following email message,

get miami95-abstracts abstract_procedures

to **listproc@www.che.ufl.edu** . Instructions for submitting and retrieving extented abstracts via World-Wide Web forms are located at,

http://www.che.ufl.edu/~aiche/annual_meeting/1995/abstracts/

A summary of the abstract submittal procedures are given below.

Submitting Abstracts

Abstracts can be submitted either via email or via World-Wide Web forms. (If you have access to a WWW forms compatable browser, this is the recommended method.)

Email Submission: Obtain a copy of the extended abstract email form and the instructions for completing the email submittal form by sending the following email message,

get miami95-abstracts submittal_form
get miami95-abstracts submittal_instructions

to **listproc@www.che.ufl.edu** .

Complete the email abstract submittal form and email the completed form to,

miami95-abstracts@www.che.ufl.edu

WWW Submission

A World-Wide Web form,

http://www.che.ufl.edu/cgi-bin/aiche/submit_form.pl

is available for entering and submitting the abstract. Instructions and entry descriptions are obtained through hyperlinks on the WWW form. NOTE: These forms are for submitting abstracts of papers that have already been accepted for presentation.

ALSO NOTE: Abstracts submitted using these forms will be used only for creating the abstract virtual library archive -- the abstracts will not be forwarded to the session chairs. This is an experiment to illustrate the use of the Information Superhighway as a method of distributing chemical engineering related information. Hopefully for future meetings these network based information technologies will be integrated with the current hard copy based methods of communication.

Retrieving and Viewing Abstracts

Two ways for retrieving and viewing the abstracts have been established - via email and via the World-Wide Web. Instructions for email retrieval are given in the Procedures mentioned above and the extended abstract virtual library archive is being created on the World-Wide Web at

http://www.che.ufl.edu/~aiche/annual_meeting/1995/abstracts/

Copies of the extended abstracts can also be received as their authors submit the abstracts. To do so, subscribe to the miami95-abstracts mailing list by sending the message,

subscribe miami95-abstracts [your_name]-[your-affiliation]

to **listproc@www.che.ufl.edu** .

Any Questions?

The Miami 1995 Annual AIChE Meeting abstract virtual library has been established as an Internet information service by the University of Florida Chemical Engineering Department. The objective is to promote the exchange of chemical engineering related information for educational and professional purposes. Enjoy!

If you have any questions, suggestions, or other feedback, please send them to,

Dr. Dale W. Kirmse -- aiche@www.che.ufl.edu or Dr. Tim Anderson -- miami95@www.che.ufl.edu

The Broad Beans That Became Criminal

by Christopher Booker (The Sunday Telegraph, London, July 23, 1995)

[NOTE: Your friendly newsletter editor was grading unit operations laboratory reports for five weeks at the University College of London during June and July, 1995. In addition to following the machinations of both Prime Minister John Major (after his resignation from the leadership of the Tory party) and the trials and tribulations of Hugh Grant and Liz Hurley, your editor came across the following Sunday comment on the day of his scheduled departure from Heathrow. The point is the multiple digits of precision that were enacted into British Law; seventeen digits of precision are simply awesome.]

"One of the hardest things to grasp about the EC is the sheer range of petty inanities with which it is now engulfing us. So many new examples pour over my desk each week it is impossible to do justice to them all."

"Readers may, for instance, have been puzzled to see that the Prince of Wales was having to launch a scheme whereby for 12.50 British pounds Sterling one can 'adopt' one of the thousands of traditional varieties of fruit, flowers and vegetables which it is now illegal to sell under 'EC rules.' Brussels has issued nearly 450 'directives,' 'regulations' and 'decisions' on seed varieties. Since it costs 2000 pounds to register any variety of seed, and 250 pounds to keep it registered, almost all the old, non-commercial, cottage varieties have been withdrawn from the market. They can now only be 'preserved' by schemes like the one launched under royal patronage by the Henry Doubleday Research Association."

"A typical example cited by the Association's Jeremy Cherfas is a variety of broad bean dating back to Elizabethan times, which he was given in 1978 by 'a Miss Cutbush of Kent.' Apparently it tastes delicious. But now, under the EC rules, it is a criminal offence to sell this bean if it is to be grown for eating -- although it can still be sold if it is used only 'for ornamental purposes'."

"Again, a File fisherman, Foster Cammish, has been found guilty on criminal charges of catching undersize lobsters. A fisheries inspector who diligently rummaged through a large pile of crabs and lobsters found three which were below the minimum 85 mm size permitted by EC rules. Two were small by 'one millimetre,' the other by 'half a millimetre' (one fiftieth of an inch). The magistrates gave Mr. Cammish a conditional discharge, but he still had to pay 308.85 pounds costs."

"Then again, our sheep-like MPs have just nodded through the latest in the stream of statutory instruments implementing EC directives enforcing the use of the metric system."

"The aim of the Units of Measurement Regulations 1995, implementing directive 80.181, is to ensure metrication of all measures used for 'economic, public health, public safety or administrative purposes.' Wherever any imperial measure is referred to in a public document of any kind, from local bylaws to court records, from leases to planning applications, this must now be amended to its metric equivalent."

"A schedule to the regulations helpfully provides these equivalents. For instance, any reference to an ounce must now be changed to '**28.349523125** grams.' A ton is now '**1.060469088** tonnes.' An acre is '**4046.8564224** square meters.' One horsepower must from now on be given as '**0.74569987158227022** kilowatts.' A knot is now '**0.51477** metres per second.' Measurements of pressure related to an inch of water must now be translated as '**249.08891** pascals'."

"It is somehow appropriate that the minister who signed this phantasmagoria into British law was Jonathan Evans, whose claim to fame is that he succeeded Neil Hamilton as minister for 'deregulation.' But faced with such diktats from Brussels, all our ministers and MPs are reduced to a bemused jelly."

"Kind readers have now sent replies from more than 60 MPs (members of Parliament) to the two questions on metrication recently suggested in this column. These are remarkably revealing. I hope to report in full next week."

MEETINGS, CONFERENCES, CONGRESSES, SHORT COURSES, AND WORKSHOPS

To submit a paper for consideration at any event listed below, please contact the symposium coordinator or session chair directly. For further information or details about each of the four CAST Division programming areas, contact the appropriate Area Chair as noted in the masthead. For general information concerning CAST Division sessions and scheduling, or to correct errors in this listing, please contact Jeffrey J. Siirola (CAST Division Programming Chair), Eastman Chemical Company, PO Box 1972, Kingsport, TN 37662-5150, 423-229-3069, 423-229-4558 (FAX), siirola@emn.com. Many of these postings are archived on the World Wide Web (WWW) with URL http://control.cheg.nd.edu/cast10/.

Proceedings of the 1995 American Control Conference

The 1995 American Control Conference, held in Seattle, Washington on June 21-23, was a resounding success with over 1000 papers presented and 1100 attendees. The six-volume, 4483-page proceedings (ISBN 0-7803-2445-5) from that meeting are available for purchase from:

IEEE Service Center
445 Hoes Lane
P.O. Box 1331
Piscataway, New Jersey, USA
08855-1331
(908) 981-0060 or (800) 678-4333

The cost is $231 for members of the co-sponsoring societies (AIAA, AIChE, AISE, ASME, IEEE, ISA, and SCS) and $462 for non-members. Call or write to purchase. Please refer to IEEE Catalog Number 95CH3573-6. Payments by credit card, check, money order, or purchase order are acceptable.

1995 European Control Conference (ECC) --Rome, Italy-- September 5-8, 1995

The European Control Conference (ECC) is an event that is organized every two years with the aim to stimulate contacts between scientists active in the area of Systems and Control. The first two conferences took place in Grenoble in 1991 and Groningen in 1993. The third ECC will be held in Rome in 1995. The scope of the conference includes all aspects of Systems and Control, and ranges from subjects within the framework of fundamental research to engineering applications. Topics of interest include multivariable control, system modeling, system identification, adaptive control, optimal control, filtering, robotics, aerospace systems, neural networks applied to control, and control of chemical processes.

For further information concerning sessions related to chemical process control, contact Frank Allgower, Institut fur Systemdynamik und Regelungstechnik, Universitat Stuttgart, 70550 Stuttgart, GERMANY, 49-711-685-6193, 49-711-685-6371 (FAX), allgower@rus.uni-stuttgart.de.

Control of Industrial Processes: Synthesizing the Statistical and Engineering Approaches -St. Albans, United Kingdom- Sept. 19-20, 1995

Historically there have been two distinct approaches to the control of industrial processes: that of the statistician and that of the engineer. Statistical Process Control techniques were developed by statisticians for use in the discrete parts industries while Automatic Process Control techniques were developed by engineers for use in the process industries. This conference, organized by the University of Hertfordshire Business School, the City University School of Mathematics, and the University of Newcastle Department of Engineering Mathematics, aims to provide control engineers and statisticians an opportunity to exchange ideas about integrating the two approaches to Process Control. Sessions will include overview, process modeling, process control, and new thinking. Each half-day session will include a keynote talk and invited and contributed case studies. For further information, contact the Control of Industrial Processes Conference Secretary, Business School Development Unit, 45 Grosvenor Road, St. Albans, Hertfordshire, UNITED KINGDOM, 44-1727-813611, 44-1707-284649 (FAX).

Fifth IFAC Symposium on Automated Systems Based on Human Skill --Berlin, Germany-- Sept. 25-28, 1995

As the previous four symposia of the same name, this symposium will bring together researchers, developers, and users of automated systems. The areas of discussion are manufacturing, process control, traffic control, and administrative processes. Emphasis will be on how to design such systems integrating developers and users in the design process. It means joint engineering of production processes, information technology, and work organization. It may lead to redefining the roles of human operators in process automation. Half of the symposium will be structured by presentation of papers and discussions. The remaining time will be dedicated to on-site workshops given in factories, service organizations, and public administrations in Berlin. For further information, contact Dietrich Brandt, HDZ/IMA, RWTH Aachen, Dennewartstrasse 27, D-52068 Aachen, GERMANY, 49-241-9666-25, 49-241-9666-22 (FAX).

Fourth IEEE Conference on Control Applications --Albany, New York-- Sept. 28-29, 1995

The fourth IEEE Conference on Control Applications (CCA) is being sponsored by the IEEE Control Systems Society in cooperation with ASME. The theme of the conference is power and energy systems. Papers are solicited on all aspects of the application of control techniques including adaptive control, artificial intelligence, decentralized control, fuzzy logic, neural nets, modeling and diagnosis, optimization, robust and nonlinear control, simulation, and system identification. Topical areas of interest include alternative energy systems, combined cycles, cogeneration, distribution systems, environmental aspects, energy management, non-utility generation, power electronics, power system stability, protection systems, space power applications, and turbine and generator control. For further information, contact the conference cochairs Joe H. Chow, ECSE Department, Rensselaer Polytechnic Institute, Troy, NY 12180-3590, 518-276-6374, 518-276-6261 (FAX), chowj@rpi.edu or K. Dean Minto, GE Corporate R&D Center, Schenectady, NY 12309, 518-387-6760, 518-387-5164 (FAX), minto@crd.ge.com.

Workshop on Verification and Control of Hybrid Systems --New Brunswick, New Jersey-- Oct. 22-25, 1995

The fifth in a series of workshops on hybrid systems will be organized at Rutgers University in New Brunswick, New Jersey with the purpose of bringing together researchers from both computer science and control theory to advance the theory of hybrid systems and applications to real life problems. The workshop will be organized as part of the DIMACS Special Year on Logic and Algorithms. DIMACS is a NSF Technology Center of Rutgers and Princeton Universities, AT&T Bell Laboratories, and Bellcore. The workshop will pertain to formal verification and control of hybrid systems (systems with digital devices interacting with continuous objects). Topics will include formal models and specification languages, algorithmic and deductive verification, control and optimization, simulation and testing, design and synthesis, complexity and decidability issues, probabilistic systems, automatic and interactive tools, experimental results, and applications. For more information, contact Rajeev Alur, AT&T Bell Laboratories, 600 Mountain Avenue, Murray Hill, NJ 07974, alur@research.att.com.

Operations Research and Engineering Design --St. Louis, Missouri-- Oct. 24-27, 1995

The International Federation Operational Research Societies (IFORS) is sponsoring a specialized international conference on Operations Research and Engineering Design in St. Louis, Missouri, on October 24-27, 1995. The meeting should appeal to researchers and practitioners from operations research, engineering design, and related areas. The conference will include invited and contributed papers, tutorials and panel discussions. Conference objectives include: promotion of an interdisciplinary approach to optimal design; introduction of operations research to several distinct engineering design areas, and communication to design engineers the value of incorporating operations research techniques into engineering design; and stimulation of additional interest in the application of operations research methods to engineering design. There will be a special track of sessions on operations research and chemical engineering. Papers are sought in all areas typically sponsored by CAST including, but not limited to, design and analysis, process synthesis, process planning, scheduling and control, computers in operations and information processing, statistics and quality control, optimization theory and applications, advanced computer systems, etc. One session in particular will be on genetic algorithms, simulated annealing, and other stochastic optimization applications in chemical engineering. Planned tutorial topics include Current Advancements in Nonlinear Programming Software, Current Advancements in Structural Optimization, and Effective Engineering Design Through Simulation. For further information, contact James Campbell, IFORS SPC-4, School of Business Administration, University of Missouri - St. Louis, St. Louis, MO 63121-4499, 314-516-6125, 314-516-6420 (FAX), ifors.stl@shimsy.umsl.edu.

1995 AIChE Annual Meeting --Miami Beach, Florida-- Nov. 12-17, 1995

The CAST Division is sponsoring the following sessions at the Miami Beach Annual Meeting, which are also being cosponsored by the Society for Computer Simulation:

Area 10a: Systems and Process Design

1. New Topics in Process Synthesis.
2. Advances in Process Synthesis.
3. Design and Analysis.
4. Advances in Process Design.

Joint Area 10a and Area 10d Session

1.Computational Approaches in Systems Engineering.

Joint Area 10a and Area 12a Session

1. Modeling and Simulation in Pilot Plants.

Area 10b: Systems and Process Control

1-2. Advances in Process Control.
3. Nonlinear Process Control.
4. Model Predictive Control.
5. Control System Performance Monitoring and Diagnosis.
6. Control Relevant Identification and Estimation.
7. Batch Process Modeling, Monitoring, and Control.

Joint Area 10b and Area 10c Session

1. Issues in On-Line Optimization for Control.

Area 10c: Computers in Operations and Information Processing

1. Progress in Computer Integrated Manufacturing in the Chemical Process Industries. (Cosponsored

by the International Cooperation Committee of the Society of Chemical Engineers, Japan.)
2. Planning and Scheduling.
3. Computing for Plant Operations.
4. High Performance Computing for Process Engineering.
5. Issues in Process Operations.

Area 10d: Applied Mathematics and Numerical Analysis

1. Pattern Formation and Dynamics.
2. Parallel Computing Applications in Chemical Engineering.
3. Chemical Engineering Applications of Stochastic Processes.
4. Numerical Issues in Fluid Mechanics, Transport, and Materials Processing.

Joint Area 10d and Area 15d/e Session

1. Mathematical Modeling in Cellular Biology.

Division-wide Poster Session

1. Advances in Computing and Systems Technology.

In addition, CAST plans to again cosponsor Educational Computer Software demonstrations throughout the Annual Meeting.

International Conference on Computer Applications in Industry and Engineering --Honolulu, Hawaii-- Nov. 29-Dec. 1, 1995

The International Conference on Computer Applications in Industry and Engineering is sponsored by the International Society for Computers and Their Applications and will feature contributed as well as invited papers. Topics will include algorithm development (computer modeling, computer simulation, software development, multimedia applications, computer-aided design and manufacturing, computer-aided education, computer architecture, computer networks, and neural networks) and automation systems (intelligent systems, signal processing systems, VLSI, control systems, transportation systems, electrical circuits and systems, chemical engineering systems, energy systems, biomedical systems, and environmental systems). For further information, contact Mary Ann Sullivan, International Society for Computers and Their Applications, 8820 Six Forks Road, Raleigh, NC 27615-2969, 919-847-3747, 919-676-0666 (FAX), mas@isca.pdial.interpath.net.

Supercomputing '95 --San Diego, California-- Dec. 4-8, 1995

Supercomputing '95 will take place December 4-8, 1995 at the San Diego Convention Center. This will be the eighth conference in the series for the presentation and discussion of research in high-performance computing and communication. In addition, this conference will integrate fully with the capabilities of High Performance Computing and Communications (HPCC) and the National Information Infrastructure (NII). The conference will consist of technical sessions, educational sessions, panels, tutorials, computing center roundtables, workshops, exhibits, the NII Testbed, and the High Performance Computing Challenge for a teraflops application. For additional information, contact Sid Karin, San Diego Supercomputer Center, 619-534-5039, 619-534-5113 (FAX), sc95@sdsc.edu.

First World Conference on Integrated Design and Process Technology --Austin, Texas-- Dec. 7-9, 1995

The First World Conference on Integrated Design and Process Technology will be held at the IC2 Institute at the University of Texas. The conference will consist of invited and contributed papers emphasizing knowledge integration through the study of processes leading to the delivery of more robust high quality products and services. Topics of interest include design and process methodologies, theories, and applications; interdisciplinary approaches for product design and development; design for manufacturability, dependability, availability, reliability, maintainability, and quality; design tool development; computer integrated engineering, design, and manufacturing; concurrent engineering design; artificial intelligence in industrial engineering and production; neural networks; product and process simulation; and process control. For more information, contact Atila Ertas, Mechanical Engineering Department, Texas Tech University, Lubboch, TX 79409-1021, 806-742-3563, 806-742-3540 (FAX), meae@coe3.co3.ttu.edu.

Seventh Real-Time Optimization in the Process Industries Short Course --Burlington, Ontario, Canada-- Dec. 11-15, 1995

Real-time optimization (RTO) of process operating conditions is one of the fastest growing areas of process control. RTO systems select the best values for plant operating variables based on current economics, sales demands, process performance and equipment capabilities. Decisions can be implemented automatically or by the operator. The course is intended for university-educated engineers with experience in plant design, operation or control. The attendees should have a basic understanding of mathematical modeling and computers, but they need not have optimization experience.

Goals include to: Present the basic concepts of applied optimization; Highlight the unique issues involved in RTO; Present best available technology for RTO with strengths and limitations; Provide guidelines for successful selection and design of RTO applications; and Provide initial optimization experience through hands-on computer exercises.

The cost per person is ($CDN) 1500 or ($US) 1200 which covers copies of the lecture materials and GAMS software for each participant. Please return registration (Name, address, telephone and fax numbers) with either a check payable to "RTO Short Course" or a purchase order. The number of participants is limited. Please mail registration to: RTO Short Course, P.O. Box 20322, Upper James P.O., 858 Upper James St., Hamilton, Ontario, Canada L9C 7M8. Cancellations will not be accepted after Nov 1, 1995.

Each attendee receives a notebook with copies of all overheads, a workbook for the simulation exercises and an extensive reference list. Course princi-

ples are reinforced through numerous hands-on simulation exercises running on IBM-PC compatible computers. A fully functional GAMS package (Professional Demonstration Copy) which has limited problem size capability will be included in the course fee. Participants will be given copies of all the exercise files on diskettes.
The instructors, Dr. C.M. Crowe, Dr. A.N. Hrymak, and Dr. T.E. Marlin, are all in the Department of Chemical Engineering at McMaster University. They have over 40 years of experience in control and optimization and have published and consulted extensively. For additional information contact Dr. Tom Marlin by telephone (905) 525-9140 ext. 27125 or by fax at (905) 521-1350 or write to RTO Short Course, P.O. Box 20322, Upper James P.O., 858 Upper James St., Hamilton, Ontario, Canada L9C 7M8.

34th IEEE Conference on Decision and Control --New Orleans, Louisiana-- Dec. 13-15, 1995

The IEEE Conference on Decision and Control (CDC) is the annual meeting of the IEEE Control Systems Society conducted in cooperation with the Society for Industrial and Applied Mathematics (SIAM) and the Operations Research Society of America (ORSA). Papers are solicited in all aspects of the theory and applications of systems, including decision-making, control, adaptation, optimization, industrial automation, and manufacturing. Deadline for submission of contributed papers is March 1, 1995. For further information, contact the conference chair Panos J. Antsaklis, Department of Electrical Engineering, University of Notre Dame, Notre Dame, IN 46556, 219- 631-5792, 219 631-4393 (FAX), panos.j.antsaklis

Computer Process Control V (CPC-V) --Tahoe City, California-- Jan. 7-12, 1996

Co-sponsored by CAST Division and CACHE Corporation

The fifth Chemical Process Control Conference is scheduled for the second week of January, 1996 at Granlibakken Conference Center near Tahoe City, California. The goals of CPC-V are to promote a vital interactive discussion among a diverse group of experts regarding the state of the technology for chemical process control, assess current research, identify research opportunities for academics, government, and industry, and promote productive research collaborations. Main themes of the conference include robust and predictive control, modeling and identification, nonlinear and adaptive control, process monitoring and fault detection, sequence control PLCs and discrete event systems, surveys of control practice in industry, and the status of industry/academic research. Chairs for CPC-V are Carlos E. Garcia, Shell Development Company, PO Box 1380, Houston, TX 77251-1380, 713-493-8876, 713-493-8936 (FAX), Jeffrey C. Kantor, Department of Chemical Engineering, University of Notre Dame, Notre Dame, IN 46556, 219-631-5797, 219-631-8366 (FAX), jeffrey.kantor@nd. edu. The conference will be limited to 150 participants. Application for attendance should be made immediately to CACHE Corporation, PO Box 7939, Austin, TX 78713-7939, cache@utxvm.cc.utexas.edu.

Conference Program

Session 1: Opening Session (Sunday, January 7, 7:00 - 9:30 pm)~~Chair: Carlos Garcia (Shell Chemical Company)

Objectives and Agenda for CPC-V~~Carlos Garcia (Shell Chemical Company) and Jeffrey Kantor (University of Notre Dame)

Assessment of Process Control in the Petrochemical Industries~~George Birchfield (Solomon)

The Future of Advanced Control~~Brian Ramaker, Henry Lau, and Evelio Hernandez (Shell Development)

Session 2: Adaptive and Nonlinear Control - Fact or Fantasy? (Monday, January 8, 7:45 - 11:30 am)~~Chair: Yaman Arkun (Georgia Institute of Technology)

Certainty Equivalence Adaptive Control: Paradigms, Puzzles and Switching~~B. Erik Ydstie (Carnegie Mellon University)

Nonlinear Process Control - Which way to the promised land?~~Frank Doyle (Purdue University) and Frank Allgower (Universitat Stuttgart)

Industrial Applications of Nonlinear Control~~Babatunde Ogunnaike (Dupont) and Raymond Wright (Dow Chemical)

Session 3: Industrial Survey - II (Monday, January 8, 7:30 - 10:00 pm)

Computer Aided Process Engineering in the Snack Food Industry~~Mike Nikolau (Texas A&M University) and Don Strickert (Frito-Lay Technology)

Batch Food Processing: The proof is in the eating~~Sandro Machietto (Imperial College)

Session 4: New Directions for Academic Research (Tuesday, January 9, 7:45 - 11:30 am)~~Chair: Frank Doyle (Purdue University)

Monitoring and Diagnosis of Automated Controllers in the Chemical Process Industries~~Derrick J. Kozub (Shell Development)

Process Analytical Chemical Engineering~~Bruce Kowalski (University of Washington)

Analysis and Control of Combined Discrete/Continuous Systems: Progress and Challenges in the Chemical Process Industries~~Paul I. Barton and Taeshin Park (MIT)

Session 5: Industry Survey III (Tuesday, January 9, 7:30 - 10:00 pm)~~Dale Seborg (University of California, Santa Barbara)

Modeling and Control in Pulp and Paper Industries~~Ferhan Kayihan (Weyerhaeuser Company)

Case Studies in Equipment Modeling and Control in the Microelectronics Industry~~Stephanie W. Butler (Texas Instruments) and Thomas F. Edgar (University of Texas)

Session 6: Impact of Computer Science (Wednesday, January 10, 8:15

- 12 noon)~~Chair: Larry Biegler (Carnegie-Mellon University)

Numerical Analysis and Process Control~~Steven Wright (Argonne National Laboratory)

Real-time Economic Optimization (RTO) of Continuous Plant Operating Conditions~~Thomas E. Marlin and Andrew Hrymak (McMaster University)

DES for Processes~~Sebastian Engell and Stefan Kowalewski (University of Dortmund) and Bruce Krogh (Carnegie Mellon University)

Session 7: Past and Future Directions of Process Control Research (Wednesday, January 10, 7:30 - 10:00 pm)~~Chair: John Perkins (Imperial College)

Title TBA~~Manfred Morari (ETH-Zurich and Caltech)

The Future of Process Control - a UK Perspective~~Roger Benson (ICI and UK Ministry for Trade and Industry) and John Perkins (Imperial College)

Session 8: Predictive Control (Thursday, January 11, 7:45 - 11:30 am)~~Chair: James B. Rawlings (University of Wisconsin)

A Review of Recent Progress in Model Predictive Control~~Jay H. Lee (Auburn University)

Optimization in Model Based Control~~David Q. Mayne (University of California, Davis)

An Overview of Industrial Model Predictive Control Technology~~Joe Qin (University of Texas) and Thomas Badgwell (Rice University)

Panel Discussion~~Evelio Hernandez (Shell Development Company), Jay H. Lee (Auburn University), David Q. Mayne (University of California, Davis), Joe Qin (University of Texas), and Thomas Badgwell (Rice University)

Session 9: Contributed Poster Session (Thursday, January 11, 1:30 - 3:30 pm)~~Chairs: Richard Braatz (University of Illinois) and Karlene Kasonovich (University of South Carolina)

Contributions are invited that address the goals of this conference (no presentation of incremental results!)

Session 10: Leadership Issues (Friday, January 12, 8:15 - 12 noon)~~Chair: Carlos Garcia (Shell Chemical Company)

Panel Discussion on Technology Assessment of Process Control~~Facilitator: John MacGregor (McMaster University), David Smith (Dupont), Ferhan Kayihan (Weyerhaueser), and George Stephanopoulos (MIT)

CPC-V Assessment~~Carlos Garcia (Shell Chemical Company) and Jeffrey Kantor (University of Notre Dame)

1996 AIChE Spring National Meeting --New Orleans, Louisiana-- Feb. 25-29, 1996

Meeting Program Chair: David A. Rosenthal, Rohm and Haas Company, PO Box 219, Bristol, PA 19007, 215-781-4024, 215-785-8976 (FAX).

The CAST Division is planning the following program for the New Orleans National Meeting which has been approved by the Meeting Program Chair. A final call for papers for this meeting appears later in this issue. Deadline for submission of presentation proposals to Session Chairs is August 11, 1995. The entire CAST program in New Orleans is being co-sponsored by the Society for Computer Simulation.

Area 10a: Systems and Process Design

1. Process Synthesis for Industrial Applications. Oliver M. Wahnschafft, Aspen Technology, Inc. (Chair), and Lionel O'Young, Mitsubishi Chemical Corporation (Co-Chair).
2. Design and Analysis. Antonis C. Kokossis, University of Manchester Institute of Science and Technology (Chair) and Claudia Schmid, Simulation Sciences Inc. (Co-Chair).
3. Process Design for Waste Minimization. Paul I. Barton, Massachusetts Institute of Technology (Chair) and Srinivas K. Bagepalli, General Electric Company (Co-Chair).
4. Potential Applications of Power Plant Simulation Technologies in the Chemical Industry. (Developed by the Society for Computer Simulation.) Ariel Sharon, Computer Simulation Technologies, Inc. (Chair) and Reza Fakory, S3 Technologies (Co-Chair).

Joint Area 10a and Area 10b Session

1. Design and Control. Karen A. High, Oklahoma State University (Chair) and Richard D. Braatz, University of Illinois (Co-Chair).

Joint Area 10a and Area 10c Sessions

1. Design for Operability. Joseph F. Pekny, Purdue University (Chair) and Ryan C. Schad, Eastman Chemical Company (Co-Chair).
2. Engineering Databases and Data Management for Process Design. Carl F. King, E. I. du Pont de Nemours & Company (Chair) and H. L. Tomlinson, Chevron Research (Co-Chair).

Area 10b: Systems and Process Control

1. Applications of Control and Model Predictive Control. Jonathan E. Whitlow, Florida Institute of Technology (Chair) and Michael A. Henson, Louisiana State University (Co-Chair).
2. Control of Batch Processes. Srinivas Palanki, FAMU/FSU College of Engineering (Chair) and Surya N. Kavuri, Amoco Corporation (Co-Chair).
3. Distillation Column Control. James B. Riggs, Texas Technical University (Chair).

Area 10c: Computers in Operations and Information Processing

1. Modeling and Optimization. Claudia Schmid, Simulation Sciences, Inc. (Chair) and Robert L.

Clay, Sandia National Laboratories (Co-Chair).
2. Environmental Considerations for Process Simulation and Operations. Urmila M. Diwekar, Carnegie Mellon University (Chair) and Ajay K. Modi, Massachusetts Institute of Technology (Co-Chair).
3. On-Line Process Simulation. Stephen E. Zitney, Cray Research Inc. (Chair) and Chris Goheen, Aspen Technology, Inc. (Co-Chair).
4. Training for Process Operations. John C. Hale, E. I. du Pont de Nemours & Company (Chair) and Paul I. Barton, Massachusetts Institute of Technology (Co-Chair).
5. Component Software and Process Engineering Computing. Jaimin Mehta, UOP Inc., (Chair) and Rudolphe L. Motard, Washington University (Co-Chair).

International Conference on Identification in Engineering Systems --University of Wales, Swansea, United Kingdom--Mar. 27-29, 1996

Parameter estimation and system identification are used extensively to obtain dynamic models of engineering systems. A large number of methods have been developed and a huge amount of experience gained in their application, particularly in control engineering and structural dynamics. Although aspects of the methods are different there is a substantial overlap in the methodology and practice used in the identification. This conference will provide a forum for researchers and practitioners in the art and science of identification from a range of disciplines and provide further impetus for the cross fertilization of ideas in this area.

The following topics give an indication of the scope of the conference (other related topics may be included if they fall within the objectives of the conference): System identification, Parameter estimation, Inverse problems, Parameter estimation in nonlinear models, Validation of estimated models, Adaptive controllers, Recursive estimation, Self-tuning controllers, Excitation signals, Modal analysis, Finite element model updating, Error localization and damage location, Actuator/sensor location.

The deadline for the submission of Abstracts has already passed. For additional details, please contact the conference organizers:

Prof. J. E. Mottershead and Dr. M. I. Friswell
Department of Mechanical Engineering
University of Wales Swansea
Singleton Park
Swansea SA2 8PP, UK.
Tel: +44 (0)1792 295837 or +44 (0)1792 295217
Fax: +44 (0)1792 295674
E-mail: M.I.Friswell@swansea.ac.uk

Sixth European Symposium on Computer Aided Process Engineering (ESCAPE-6) --Rhodes, Greece-- May 27-29, 1996

ESCAPE-6 is the latest in the series of events initiated by the Computer Aided Process Engineering Working Party of the European Federation of Chemical Engineering. It follows previously successful conferences in Elsinore, Toulouse, Graz, Dublin, and Bled. The major aim of ESCAPE-6 is to review the latest developments in the use of computers as well as systems and information technology tools in the design and operation of processing plants. ESCAPE-6 will be held in Rhodes, Greece. The conference will focus on recent theoretical and practical developments in computer-aided process engineering in process design (process synthesis, optimization, static and dynamic simulation, control synthesis, energy integration, flexibility, etc.), process operations (modeling, identification, dynamics, controllability, operability, safety, reliability, fault tree analysis, process fault detection diagnosis and prevention, hazard and operability analysis, etc.), process and plant control (advanced control, on-line optimization, plant data analysis, large-scale control, integrated design operations and control, etc.), computer-integrated flexible manufacturing systems (scheduling and planning batch and semibatch operations, applications of computer aided engineering in small industries, specialty chemicals manufacture, management information systems, computer integrated manufacturing, etc.), use of computers in education, inclusion of environmental aspects and considerations, and industrial applications and case studies. For additional information, contact George Stephanopoulos, Massachusetts Institute of Technology 66-440, Cambridge, MA 02139, 617-252-1651 (FAX), geosteph@mit.edu or the Organizational Secretariat of ESCAPE-6, Hellenic Institution of Chemical Engineers, 36 3rd Septemvriou Street, 104 33 Athens, GREECE, 30-1-823-5877, 30-1-821-6242 (FAX).

International Conference on Computer Integrated Manufacturing in Process Industries (I-CIMPRO '96) --Eindhoven, The Netherlands-- June 3-4, 1996

The International Conference on Computer Integrated Manufacturing in Process Industries (I-CIMPRO '96) is being organized by the Industrial Engineering Department of Rutgers University and the Eindhoven University of Technology. AIChE, AIME, and AIIE are cosponsors. The conference is a forum for bringing together academic researchers and industrial practitioners to discuss current advances in operations management, automation, and computer integrated manufacturing in batch and continuous process industries. Topics include process design (engineering, project management, process re-engineering, etc.), production control (hierarchical distributed and inventory control, planning and scheduling, etc.), quality control (sensors, data acquisition, SPC, TQM, etc.), factory automation (real time control, AI, neural nets, robotics, machine vision, etc.), regulatory and environmental issues (software and process validation, regulatory changes, energy management and control, etc.), and information systems (CIM architecture, database design, decision support systems, etc.). The organizers are looking to AIChE and to CAST to provide industrial applications and other industry oriented papers. The CAST coordinator for this event is Michael T. Tayyabkhan, Tayyabkhan Consultants, 62 Erdman Avenue, Princeton, NJ 08540, 609-924-9174, miket@ins.infonet.net. For additional information, contact Mohsen A. Jafari,

Department of Indistrial Engineering, Rutgers University, Piscataway, NJ 08855-0909, 908-932-3654, 908- 445-5467 (FAX), jafari@princess.rutgers.edu.

The Ninth International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems (IEA/AIE-96) --ACROS Fukuoka, Tenjin Chuo-ku Fukuoka, Japan-- June 4-7, 1996

This conference has been held in Tennessee; South Carolina; Hawaii; Paderborn, Germany; Edinburgh, Scotland; Texas; Melbourne, Australia; and now visits the Orient for the first time. IEA/AIE-96 continues the tradition of emphasizing the application of Artificial Intelligence and Expert/Knowledge-based systems to engineering and industrial problems. Topics of interest include, but are not limited to:

Automated Problem Solving, CAD/CAM, Case-based Reasoning, Computer Vision, Connectionist Models, Dependability of AI/ES, Distributed AI Architectures, Expert Systems, Fuzzy Logic & Soft Computing, Genetic Algorithms, Heuristic Searching, Intelligent Computer Network, Intelligent Databases, Intelligent Interface, Intelligent Tutoring, KBS Methodologies, Knowledge Acquisition, Knowledge Representation, Machine Learning, Model-Based Reasoning, Natural Language Processing, Neural Networks, Planning & Scheduling, Practical Applications, Reasoning Under Uncertainty, Robotics, Sensor Fusion, Spatial & Temporal Reasoning, Speech Recognition, System Integration, Tools, Verification & Validation of KBSs.

Authors are invited to submit five copies of papers, written in English, of up to 10 single-spaced pages, presenting the results of original research or innovative practical applications relevant to one or more of the listed areas of interest. Practical experiences with state-of-the-art AI methodologies are also acceptable when they reflect lessons of unique value to the conference attendees. Shorter works, up to 6 pages, to be presented in 10 minutes, may be submitted as short papers representing work in progress or suggesting possible research directions. Submissions should be received by the program co-chair at IEA/AIE-96 conference office by November 8, 1995. All papers should include a key word list. Notification of the review process will be made by January 22, 1996, and final copies of papers will be due for inclusion in the conference proceedings by February 20, 1996. Referees will be asked to nominate papers for a Best Paper Prize to be announced at the conference. All papers, but particularly those nominated for Best Paper Competition, will be automatically considered for a place in the Journal of Applied Intelligence.

The general chair is Moonis Ali, Southwest Texas State University; the program chair Setsuo Ohsuga, Waseda University; and the program co-chair is Takushi Tanaka, Fukuoka Institute of Technology. Inquiries should be addressed to Professor Moonis Ali, IEA/AIE-96 General Chair, Dept. of Computer Science, Southwest Texas State University, San Marcos TX 78666-4616, Phone: (512) 245-3409; FAX, (512) 245-8750; and E-mail: ma04@swt.edu

INTERNET: http://www.fit.ac.jp/ieaaie.html

LaTek AND POSTSCRIPT VERSIONS AVAILABLE AT: http://control.cheg.nd.edu/cast10/

The proceedings will be published and will be available at the conference. Copies of the proceedings of earlier conferences are available from: Gordon and Breach Science Publishers, Customer Service, P.O.Box 786, Cooper Station, New York, NY 10276; Fax:(+1)212-645-2459. A color brochure of IEA/AIE-96 is available.

13th IFAC World Congress --San Francisco, California-- June 30-July 5, 1996

The 13th World Congress of the International Federation of Automatic Control will feature a Symposium on Industrial Applications of Chemical Process Control. Prospective areas to be addressed include dynamic modeling, identification, model based control, nonlinear control, statistical methods, fault detection and safety, process monitoring, and unit process control. For more information, contact Michael Peshkin, IFAC '96, Department of Mechanical Engineering, Northwestern University, Evanston, IL 60208-3111, 708-467-2666, 708-491-3915 (FAX), ifac96@ nwu.edu.

Fifth World Congress of Chemical Engineering --San Diego, California-- July 14-18, 1996

The World Congress of Chemical Engineering is held every five years in countries around the globe. 1996 will be the first time it has ever been held in the United States. The theme of this congress is "Technologies Critical to a Changing World". Technical areas of emphasis include Energy, Safety, and the Environment; Agriculture, Food, and Biotechnology; Products and Materials Process Technology; Technology Management and Transfer; and Advanced Fundamentals. Of particular interest may be the session on the implications of information technology, artificial intelligence and simulation on the future of the process industries which is being facilitated by the CAST Division. The CAST Division coordinator is Scott E. Keeler, DowElanco, 9410 Zionsville Road, Indianapolis, IN 46268-1053, 317-337-3138, 317-337-3215 (FAX), skeeler@dowelanco.com. For general information about the Fifth World Congress, contact AIChE at 212-705-7373, 212-752-3297 (FAX).

Third Workshop on Discrete Event Systems (WODES '96) --Edinburgh, Scotland-- Aug. 19-21, 1996

Discrete event systems has developed to be an interdisciplinary field of shared interest, methodologies, and applications between control and computer science. This workshop, sponsored by the Institution of Electrical Engineers (U.K.), aims to bring together control theoreticians, software engineers, and computer scientists with a view to integrate methodology, techniques, and tools. The workshop will focus on the control of discrete event systems (with emphasis on real time control), computer science (with

emphasis on hybrid systems, timed systems, Petri nets, process algebras, software verification, and design), and applications (with emphasis on manufacturing systems and software design). For more information, contact Rein Smedinga, WODES '96, Department of Computer Science, University of Groningen, NL-9700 AV Groningen, THE NETHERLANDS, 31-50-633800 (FAX), wodes96@cs.rug.nl.

1996 Portuguese Control Conference --Porto, Portugal-- Sept. 11-13, 1996

The Portuguese Society of Automatic Control will hold the 2nd Portuguese Conference on Automatic Control in Porto, Portugal. Held in cooperation with Instituto de Sistemas e Robotica, Instituto Superior Tecnico, and Faculdade de Engenharia da Universidade do Porto, this conference will bring together people working in the fields of control, automation, and related areas. Topics of interest include linear and nonlinear systems, adaptive control, robust control, modelling and simulation, systems identification, optimal control and optimization, stochastic control filtering and estimation, automation systems and control, algorithms and architectures for real-time control, robotics, manufacturing systems, process control, electrical and fluid power actuators, signal processing, artificial vision, fuzzy systems, and neural networks. For further information contact Maria Margarida A. Ferreira, Faculdade de Engenharia da Universidade do Porto, DEEC-ISR, Rua dos Bragas, 4099 Porto, PORTUGAL, 351- 2-2041847, 351-2-2000808 (FAX), control@fe.up.pt.

1996 AIChE Annual Meeting --Chicago, Illinois-- Nov. 10-15, 1996

Meeting Program Chair: Sangtae Kim, Department of Chemical Engineering, University of Wisconsin, Madison, WI 53706-1691, 608-262-5921, 608-262-0832 (FAX), kim@engr.wisc.edu.

The CAST Division is planning the following sessions at the Chicago Annual Meeting which have been approved by the Meeting Program Chair. A first call for papers for this meeting appears later in this issue. Deadline for submission of presentation proposals to Area Chairs is March 1, 1996. The entire CAST program in Chicago is being cosponsored by the Society for Computer Simulation.

Area 10a: Systems and Process Design

1. Design and Analysis - General Papers. Costas D. Maranas, Princeton University (Chair) and Srinivas K. Bagepalli, General Electric Company (Co-Chair).
2. Synthesis and Analysis of Separation Systems. Sophie Ung, E. I. du Pont de Nemours & Company (Chair) and Oliver M. Wahnschafft, Aspen Technology, Inc. (Co-Chair).
3. Process Synthesis - General Papers. Vivek Julka, Union Carbide Corporation (Chair) and Matthew J. Realff, Georgia Institute of Technology (Co-Chair).
4. Special Topics in Design and Analysis. Stratos Pistikopoulos, Imperial College (Chair) and Michael L. Luyben, E. I. du Pont de Nemours & Company (Co-Chair).
5. Synthesis and Analysis for Safety and Environmental Concerns. Karen A. High, Oklahoma State University (Chair) and Lionel O'Young, Mitsubishi Chemical Corporation (Co-Chair).

Area 10b: Systems and Process Control

1. Nonlinear Control. Francis J. Doyle, Purdue University (Chair) and Yaman Arkun, Georgia Institute of Technology (Co-Chair).
2. Advances in Process Control. Oscar D. Crisalle, University of Florida (Chair) and M. Nazmul Karim, Colorado State University (Co-Chair).
3. Applications of Process Control. Jorge A. Mandler, Air Products and Chemicals, Inc. (Chair) and Thomas A. Badgwell, Rice University (Co-Chair).
4. Integrated Estimation and Control. Fred Ramirez, University of Colorado (Chair) and Michael A. Henson, Louisiana State University (Co-Chair).
5. Plantwide and Decentralized Control. Richard D. Braatz, University of Illinois (Chair) and S. Joe Qin, Fisher-Rosemont Systems, Inc. (Co-Chair).
6. Process Performance Monitoring. George N. Charos, Amoco Research Center (Chair) and Masoud Soroush, Drexel University (Co-Chair).

Joint Area 10b and Area 10c Session

1. On-Line Optimization for Control. Karlene A. Kosanovich, University of South Carolina (Chair) and Iauw-Bhieng Tjoa, Mitsubishi Chemical (Co-Chair).

Area 10c: Computers in Operations and Information Processing

1. Optimization Methodology and Fundamentals. Christodoulos A. Floudas, Princeton University (Chair) and Mark A. Stadtherr, University of Illinois (Co-Chair).
2. Computer Integrated Manufacturing in the Chemical Process Industries. (Cosponsored by the International Cooperation Committee of the Society of Chemical Engineers, Japan). Bhavik R. Bakshi, Ohio State University (Chair) and Shinji Hasebe, Kyoto University (Co-Chair).
3. Process Monitoring and Data Interpretation. Lyle H. Ungar, University of Pennsylvania (Chair) and Miguel J. Bagajewicz, Simulation Sciences, Inc. (Co-Chair).
4. Large Scale Dynamic Modeling. Paul I. Barton, Massachusetts Institute of Technology (Chair) and Thanos Tsirukis, Air Products and Chemicals, Inc. (Co-Chair).
5. Intelligent Systems for Process Operations. Ajay K. Modi, Massachusetts Institute of Technology (Chair) and James F. Davis, Ohio State University (Co-Chair).

Area 10d: Applied Mathematics and Numerical Analysis

1. Nonlinear Dynamics and Pattern Formation. Hsueh-Chia Chang, University of Notre Dame (Chair) and Vemuri Balakotaiah, University of Houston (Co-Chair).

2. General Papers in Applied Mathematics. Doraiswami Ramkrishna, Purdue University (Chair) and Fernando J. Muzzio, Rutgers University (Co-Chair).
3. Novel Numerical Methods. Marios Avgousti, Stevens Institute of Technology (Chair) and Pedro Arce, FAMU/FSU College of Engineering (Co-Chair).
4. Inverse Problems and Methods in Chemical Engineering. Andrew N. Hrymak, McMaster University (Chair) and B. Erik Ydstie, Carnegie Mellon University (Co-Chair).

Division-wide Poster Session

1. Advances in Computing and Systems Technology. Michael L. Mavrovouniotis, Northwestern University (Co-Chair), Babatunde A. Ogunnaike, E. I. du Pont de Nemours & Company (Co-Chair), Scott E. Keeler, DowElanco (Co-Chair), and Kyriacos Zygourakis, Rice University (Co-Chair).

Educational Computer Software Demonstrations (Joint Effort with Group 4) Douglas J. Cooper, University of Connecticut (Coordinator) and Susan M. Montgomery, University of Michigan (Coordinator).

CALL FOR PAPERS

Final Call for CAST Sessions
1996 AIChE Spring National Meeting
-New Orleans, Louisiana-
Feb. 25-29, 1996

The names, addresses, and telephone numbers of the session chairs are given on the next several pages, as are brief statements of the topics to receive special emphasis in selecting manuscripts for these sessions. Prospective session participants are encouraged to observe the following deadlines which have been established, but may be changed, by the Meeting Program Chair, David A. Rosenthal:

August 11, 1995: Submit a proposal to present and an abstract (camera-ready) for use in the Meeting Abstract Booklet to the SESSION CHAIR and a copy also to the co-chair.

September 1, 1995: Session content is finalized; authors are informed of selection.

December 15, 1995: Authors submit, if desired, any revision of their abstract (camera-ready) to AIChE for the Meeting Abstract Booklet.

January 15, 1996: Authors submit final manuscript to AIChE.

February 25, 1996: Speakers bring 100 hard copies of visual aids to be distributed to the audience at the presentation. (This is a CAST Division policy, intended to improve the quality of the presentations and the benefit to the audience.)

Please note that there is an AIChE limitation that no person may author or co-author more than four contributions at any one meeting nor more than one contribution in any one session.

The proposal to present a paper at a CAST-sponsored session should include the professional affiliations and full contact information including postal address, phone, FAX, and E-mail address for all authors, and indicate the speaker. Also, indicate if the paper has been submitted for presentation at another session in this meeting or elsewhere. The camera-ready abstract for the Meeting Abstract Booklet may be submitted in any of three ways:

i. Using an AIChE "Proposal to Present" form which can be obtained from each session chair or directly from AIChExpress, 800-242-4363.
ii. An electronic "Proposal to Present" form for use with LaTeX is available by anonymous FTP from ftp.che.utexas.edu in the pub/tex/aiche directory.
iii. On a blank sheet of US letter size paper (8.5x11in), typed or computer printed as follows:

Margins--Top: 2.25in, Bottom: 1.75in, Left: 1.25in, Right:1.5in
Typing Area--Width: 5.75in, Height: 7in
Font--12 point Times Roman or similar
Layout--Title in boldface type on top line; blank line; authors, affiliations and addresses; blank line; abstract.

Area 10a: Systems and Process Design

1. Process Synthesis for Industrial Applications.

This session invites papers on industrial applications of process synthesis methods and tools, as well as presentations describing advances in this area that can be used to address common industrial problems.

Chair: Oliver M. Wahnschafft
Aspen Technology, Inc.
Ten Canal Park
Cambridge, MA 02141-2201
617-577-0100
617-577-0303 (FAX)
wahnschafft@aspentec.com

Co-Chair: Lionel O'Young
Mitsubishi Chemical Corporation
3-10, Ushiodori, Kurashiki
Okayama 712
JAPAN
81-86-457-2983
81-86-457-2027 (FAX)
lionel@seigi2.mt.m-kasei.co.jp

2. Design and Analysis.

Papers are solicited related to recent developments in process design and engineering analysis. The contributions can be new approaches or industrial applications and are expected to demonstrate useful and efficient methods in the context of process integration and optimization of chemical processes. Design methodologies based on short-cut design methods, conceptual design approaches, and algorithmic procedures are all welcome. Areas of potential application include, but are not limited to, process synthesis and retrofit problems, design of energy recovery networks, reaction and separation systems, and batch processes.

Chair: Antonis C. Kokossis
Department of Process Integration
University of Manchester Institute of Science and Technology
Manchester M60 1QD
UNITED KINGDOM
44-61-200-4384

44-61-236-7439 (FAX)
kokossis@umist.ac.uk

Co-Chair: Claudia Schmid
Simulation Sciences Inc.
601 S. Valencia Avenue
Brea, CA 92621
714-579-0412 x245
714-579-0113 (FAX)
cschmid@simsci.com

3. Process Design for Waste Minimization.

Papers are requested in the area of process design which target waste minimization and pollution prevention in the chemical process industries. The session will focus on systems engineering approaches towards designing cost-effective chemical processes with low environmental impact. Of particular interest are design techniques that facilitate source reduction of wastes, recovery/recycle and reuse of materials, and the integrated use of pollution prevention and end-of-pipe technologies. Reports on industrial experience with process design issues are encouraged.

Since the key issue in process design is understanding and defining the problem, papers on the following topics are sought: tackling a new class of problems, novel approaches and problem formulations, approaches based on physical insights, and conceptual design and targetting based approaches towards pollution prevention. The applicability of the design methodologies in generating cost-effective solutions should be demonstrated by case studies of industrial significance.

Chair: Paul I. Barton
Department of Chemical Engineering
66-464
Massachusetts Institute of Technology
Cambridge, MA 02139
617-253-6526
617-358-5024 (FAX)
pib@mit.edu

Co-Chair: Srinivas K. Bagepalli
General Electric Company
PO Box 8
Schenectady, NY 12301-0008
518-387-7676
518-387-7611 (FAX)
bagepask@crd.ge.com

4. Potential Applications of Power Plant Simulation Technologies in the Chemical Industry. (Developed by the Society for Computer Simulation.)

This session is being developed by the Society for Computer Simulation which is also cosponsoring the entire CAST program at this meeting. The purpose of this session is to examine simulation technologies that have been developed within the power plant industry and to discuss their applicability to chemical process simulation.

Chair: Ariel Sharon
Computer Simulation Technologies, Inc.
459 Quail Drive
Naperville, IL 60565
708-983-5195
708-983-5249 (FAX)
sharona@ecn.purdue.edu

Co-Chair: Reza Fakory
S3 Technologies
Columbia, MD

Joint Area 10a and Area 10b Session

1. Design and Control.

This session intends to bring together academics and practitioners with interests in the integration of process design and control. Papers highlighting industrial experience or comparisons between theoretical predictions and experimental observations are particularly welcome. The scope of the session will cover the design of chemical plants at different stages of detail, and different levels of control from plantwide to the specific unit level. Some areas of interest include, but are not limited to: simultaneous process and control system design; controllability analysis; design for flexibility, resilience, and operability; structure selection of the process control system; optimization of process design and operation; and sensor selection and location.

Chair: Karen A. High
School of Chemical Engineering
Oklahoma State University
Stillwater, OK 74078-0537
405-744-9112
405-744-6187 (FAX)
high@master.ceat.okstate.edu

Co-Chair: Richard D. Braatz
Department of Chemical Engineering
University of Illinois
Urbana, IL 61801-3792
217-333-5073
217-244-8068 (FAX)
braatz@mozart.scs.uiuc.edu

Joint Area 10a and Area 10c Sessions

1. Design for Operability.

The session will focus on systems engineering approaches towards incorporating operability issues in the early stages of design. Particular areas of interest include, but are not limited to, flexibility, controllability, reliability, and observability. Applications include continuous, batch, multipurpose plants and techniques for design of specific units. Novel approaches and problem formulations based on conceptual design as well as reports on industrial experience with process design issues are especially encouraged.

Chair: Joseph F. Pekny
School of Chemical Engineering
Purdue University
West Lafayette, IN 47907-1283
317-494-7901
317-494-0805 (FAX)
pekny@ecn.purdue.edu

Co-Chair: Ryan C. Schad
Eastman Chemical Company
PO Box 511
Kingsport, TN 37662-5054
615-229-8139
615-224-0453 (FAX)
rschad@emn.com

2. Engineering Databases and Data Management for Process Design.

Operating companies and engineering contractors are achieving lower capital costs and faster projects using computer-aided process engineering and engineering databases. This session will focus on industrial applications of data management in computer aided engineering. Papers are sought describing successful application of data management technologies. The ideal paper has the subtitle: "How we saved a million dollars and got the project done three months faster using computer aided process design." An update

on standard data communications and the PDXI project will be invited.

Chair: Carl F. King
Experimental Station E302/333
E. I. du Pont de Nemours & Company
Wilmington, DE 19880-0101
302-695-8113
302-695-4429 (FAX)
kingcf@esvax.dnet.dupont.com

Co-Chair: H. L. Tomlinson
Chevron Research
100 Chevron Way
Richmond, CA 94802-0627
510-242-3384
hlto@chevron.com

Area 10b: Systems and Process Control

1. Applications of Control and Model Predictive Control.

Papers focusing on process control applications are solicited. Industrial applications and/or applications of model predictive control are especially encouraged. Papers on batch process control, distillation control, and design/control should be submitted to the other CAST 10b sessions focusing on these areas.

Chair: Jonathan E. Whitlow
Department of Chemical and Environmental Engineering
Flordia Institute of Technology
Melbourne, FL 32901-6988
407-768-8000 x7354
407-984-8461 (FAX)
whitlow@roo.fit.edu

Co-Chair: Michael A. Henson
Department of Chemical Engineering
Louisiana State University
Baton Rouge, LA 70803-7303
504-388-3690
504-388-1476 (FAX)
henson@nlc.che.lsu.edu

2. Control of Batch Processes.

Papers are solicited in all areas of batch process control. Papers dealing with the following issues related to batch reactors and batch distillation columns are especially encouraged: Model Based Control Algorithms; System Identification; On-line Optimization Issues; Practical Implementation Issues and Experimental Case Studies; Optimal Operation; and Industrial Case Studies and Experiences.

Chair: Srinivas Palanki
Department of Chemical Engineering
FAMU/FSU College of Engineering
Tallahassee, FL 32316-2175
904-487-6163
904-487-6150 (FAX)
srinivas@palanki.eng.fsu.edu

Co-Chair: Surya N. Kavuri
Amoco Corporation
3700 Bay Area Blvd.
Houston, TX 77058
713-212-7155
713-212-1614 (FAX)

3. Distillation Column Control.

Papers concerning the various aspects of distillation control are solicited. Special emphasis will be given to papers concerning industrial applications.

Chair: James B. Riggs
Department of Chemical Engineering
Texas Technical University
Lubbock, TX 79409-3121
806-742-1763
806-742-3552 (FAX)

Area 10c: Computers in Operations and Information Processing

1. Modeling and Optimization.

Papers are requested which discuss large-scale modelling and optimization, with emphasis on process and plant-wide applications. Of particular interest is the incorporation of increasingly comprehensive models to yield better representation of true plant behavior, and the role and impact of these models on the decision support systems. The work should also address the development, implementation and application of more powerful simulation tools and advanced computer architectures with a focus on the needs of the future.

Chair: Claudia Schmid
Simulation Sciences, Inc.
601 S. Valencia Avenue
Brea, CA 92621
714-579-0412 x245
714-579-0113 (FAX)
cschmid@simsci.com

Co-Chair: Robert L. Clay
Sandia National Laboratories
Livermore, CA 94550
209-957-2578
209-472-9849 (FAX)

2. Environmental Considerations for Process Simulation and Operations.

Increased awareness and regulations are precipitating the need to incorporate more environmental considerations into chemical process simulation and operations. This session will focus on the applications, trends, and challenges in end-of-pipe treatment methods, and with the identification of innovative pollution prevention opportunities during the design of processes. Topics of particular interest include, but are not limited to: process-simulation tools and expert systems for considering environmental issues; dynamic simulation and stochastic modeling for solving environmental problems; handling of fugitive emissions and trace contaminants in simulation tools; process optimization with environmental objective functions; use of rate-based models for environmental calculations; improved costing methods for environmental processes; and the incorporation of life-cycle analyses into process simulation and operations.

Chair: Urmila M. Diwekar
Department of Engineering and Public Policy
Carnegie Mellon University
Pittsburgh, PA 15213-3890
412-268-3003
412-268-3757 (FAX)
urmila@cmu.edu

Co-Chair: Ajay K. Modi
Department of Chemical Engineering
66-365
Massachusetts Institute of Technology
Cambridge, MA 02139
617-253-6521
617-253-9695 (FAX)
akmodi@mit.edu

3. On-Line Process Simulation.

In the chemical and allied industries, companies are using on-line process simulation tools to improve process analysis and optimize plant performance in terms of resource utilization, safety, environmental impact, and eco-

nomics. On-line process simulation can serve either as a guide to plant operators, directly to provide set points to a distributed control system, or in other model-based control schemes. We are soliciting presentations highlighting on-line applications ranging from data reconciliation, parameter estimation, steady-state simulation and optimization to dynamic simulation. Papers may focus on single complex unit operations, groups of several units, or on entire plantwide simulations.

Chair: Stephen E. Zitney
Cray Research Inc.
655-E Lone Oak Drive
Eagan, MN 55121-1560
612-683-3690
612-683-3099 (FAX)
sez@cray.com

Co-Chair: Chris Goheen
Aspen Technology, Inc.
Ten Canal Park
Cambridge, MA 02141-2201
617-577-0100
617-577-0303 (FAX)
goheen@aspentec.com

4. Training for Process Operations.

Papers are requested which report new and improved ways to train personnel involved in process operations. All aspects of training are of interest – both computer based techniques (such as dynamic simulation and computer based training), as well as the role of people in the learning process. Reports of improved ways to present information, to test for understanding, and to reproduce process behavior accurately are sought. Insights on what subject materials, especially how to accomplish more complete process understanding, would be welcome. Papers will be considered which address training of operators, other manufacturing personnel, engineers, and chemical engineering students.

Chair: John C. Hale
E. I. du Pont de Nemours & Company
1007 Market St.
Wilmington, DE 19898
302-774-2355
302-774-2457 (FAX)
hale@pccvax.dnet.dupont.com

Co-Chair: Paul I. Barton
Department of Chemical Engineering
Massachusetts Institute of Technology
Cambridge, MA 02139
617-243-6526
617-358-5024 (FAX)
pib@mit.edu

5. Component Software and Process Engineering Computing.

Component Object Models (COM), Object Linking and Embedding (OLE), System Object Models and Dynamic System Object Models (SOM/DSOM), and Compound Documents are new paradigms of interoperability that affect users and developers of engineering, design, manufacturing, and office software for the chemical process industry. These extensions of object-oriented technology provide several new opportunities for users and vendors. We solicit from practitioners and experts in the user and vendor industry papers that describe their technical and management experience with these technologies.

Chair: Jaimin Mehta
UOP Inc.
PO Box 5017
Des Plaines, IL 60017-5017
708-391-3167
708-391-2758 (FAX)
jmehta@uop.com

Co-Chair: Rudolphe L. Motard
Department of Chemical Engineering
Washington University
St. Louis, MO 63130-4899
314-935-6072
314-935-7211 (FAX)
motard@wuche.wustl.edu

First Call for CAST Sessions 1996 AIChE Annual Meeting --Chicago, Illinois-- Nov. 10-15, 1996

The names, addresses, and telephone numbers of the session chairs are given on the next several pages, as are brief statements of the topics to receive special emphasis in selecting manuscripts for these sessions. Prospective session participants are encouraged to observe the following deadlines which have been established, but may be changed, by the Meeting Program Chair, Sangtae Kim.

SPECIAL NOTE TO AUTHORS SUBMITTING ABSTRACTS FOR ANNUAL MEETING SESSIONS SPONSORED BY CAST:

Because of the large number of anticipated presentation proposals for annual meetings and the limited symposia space available, and also to maximize the number of good proposals that can be accepted, and to generally improve the quality of CAST sessions, all proposals for Fall programming must be accompanied by an extended abstract and will be received directly by the corresponding Area Chairs and then rated by panels of session chairs for selection and allocation to specific sessions. The extended abstracts may include figures and tables that might help to better convey the content of the work. If the research work has been presented previously, the authors must include a paragraph stating how the proposed paper differs from previous presentations. This extended abstract is IN ADDITION TO the abstract required for the Meeting Abstract Booklet.

Because of this centralized review and selection process, the deadline for receipt of proposals for CAST-sponsored sessions at the Annual Meeting is ONE MONTH EARLIER than the generally published AIChE deadline:

March 1, 1996: Submit a proposal to present, an abstract (camera-ready) for use in the Meeting Abstract Booklet, and also an extended abstract of approximately 550 words for use by the CAST selection panel to the corresponding CAST AREA CHAIR.
May 1, 1996: Session content is finalized; authors are informed of selection.

September 1, 1996: Authors submit, if desired, any revision of their abstract (camera-ready) to AIChE for the Meeting Abstract Booklet.

October 1, 1996: Authors submit final manuscript to AIChE.

November 10, 1996: Speakers bring 100 hard copies of visual aids to be distributed to the audience at the pres-

entation. (This is a CAST Division policy, intended to improve the quality of the presentations and the benefit to the audience.)

Please note that there is an AIChE limitation that no person may author or co-author more than four contributions at any one meeting nor more than one contribution in any one session.

E-mail submission of the extended abstract is preferred. It is appropriate to indicate for which session the contribution might best fit. Include the professional affiliations and full contact information including postal address, phone, FAX, and E-mail address for all authors, and indicate the speaker. Also, indicate if the paper has been submitted for presentation at another session in this meeting or elsewhere.

Extended abstracts will receive anonymous reviews by three or four session chairs, co-chairs, and/or area chairs for technical content, novelty and style. Submissions may be shifted between sessions or other CAST areas as appropriate. Also, papers of acceptable quality will automatically be considered for the CAST Poster Session, unless requested otherwise. Authors may also submit abstracts specifically for consideration in the Poster Session only.

The camera-ready abstract for the Meeting Abstract Booklet may be a shortened version of the extended abstract and may be submitted in any of three ways:

i. Using an AIChE "Proposal to Present" form which can be obtained from each session chair or directly from AIChExpress, 800-242-4363.
ii. An electronic "Proposal to Present" form for use with LaTeX is available by anonymous FTP from ftp.che.utexas.edu in the pub/tex/aiche directory.
iii. On a blank sheet of US letter size paper (8.5x11in), typed or computer printed as follows:

Margins--Top: 2.25in, Bottom: 1.75in, Left: 1.25in, Right:1.5in
Typing Area--Width: 5.75in, Ht.: 7in
Font--12 point Times Roman or similar
Layout--Title in boldface type on top line; blank line; authors, affiliations and addresses; blank line; abstract.

Area 10a: Systems and Process Design

NOTE: PLEASE SUBMIT CAMERA-READY ABSTRACT AND AN ADDITIONAL EXTENDED ABSTRACT FOR ALL AREA 10A SESSIONS TO THE 1996 AREA 10A CHAIR:

Michael L. Mavrovouniotis
Department of Chemical Engineering
Northwestern University
Evanston, IL 60208-3120
708-491-7043
708-491-3728 (FAX)
mlmavro@nwu.edu

1. Design and Analysis -- General Papers.

Papers are sought in the general area of design and analysis of continuous and batch processes. The session will focus on fundamental as well as application-oriented issues. Topics may include, but are not limited to, conceptual design methodologies, novel techniques for the design and analysis of process alternatives, retrofitting of process plants, thermodynamic issues in chemical process/product design, molecular design. The applicability of the design and analysis techniques in generating cost-effective solutions should be demonstrated by case studies of industrial significance.

Submit extended abstract to Michael L. Mavrovouniotis, 1996 Area 10A Chair at address above.

Session Chair (For Information Only)
Costas D. Maranas
Department of Chemical Engineering
Pennsylvania State University
University Park, PA 16802
814-865-2574
814-865-7846 (FAX)

Co-Chair: Srinivas K. Bagepalli
General Electric Company
PO Box 8
Schenectady, NY 12301-0008
518-387-7676
518-387-7611 (FAX)
bagepask@crd.ge.com

2. Synthesis and Analysis of Separation Systems.

Process synthesis, a key step in chemical process design, is concerned with determining the best configuration of processing steps that can transform given raw materials into the desired products. Typically, the process synthesis step will elucidate a limited number of candidate schemes from among a typically quite large number of alternatives which will require more detailed analysis. The analysis step, complementary to process synthesis, involves calculating the outputs for a specified process and given feeds. This session will focus on the synthesis and analysis of separation systems. The process economics and a number of other quality measures, such as controllability, safety, compliance with environmental and other regulations, largely depends on the results of this conceptual design phase. Papers are sought on new developments and applications of process synthesis methodologies for separation systems, such as mathematical programming approaches, heuristic strategies, thermodynamic methods, etc.

Submit extended abstract to Michael L. Mavrovouniotis, 1996 Area 10A Chair at address above.

Session Chair (For Information Only)
Sophie Ung
Experimental Station E10
E. I. du Pont de Nemours & Company
Wilmington, DE 19880-0010
302-695-7244
302-695-2625 (FAX)
ungs@esvax.dnet.dupont.com

Co-Chair: Oliver M. Wahnschafft
Aspen Technology, Inc.
Ten Canal Park
Cambridge, MA 02141-2201
617-577-0100
617-577-0303 (FAX)
wahnschafft@aspentec.com

3. Process Synthesis - General Papers.

Papers are solicited for a general session on process synthesis (systematic methodologies/procedures for developing the basic flowsheet structure for chemical processes). Areas of interest include, but are not restricted to, over-

all process flowsheet synthesis, reaction path and reactor network synthesis, sequencing and scheduling of batch processes, advances in mathematical programming, heuristic, thermodynamic, and artificial intelligence based methodologies for process synthesis, integration of synthesis, operability and control, process synthesis under uncertainty, synthesis of multipurpose plants, heat exchanger networks, and future trends and challenges in process synthesis research. Industrial applications of process synthesis are particularly encouraged.

Submit extended abstract to Michael L. Mavrovouniotis, 1996 Area 10A Chair at address above.

Session Chair (For Information Only)
Vivek Julka
Union Carbide Corporation
PO Box 8361
South Charleston, WV 25303
304-747-5949
304-747-5448 (FAX)
vivek@medinah.atc.ucarb.com

Co-Chair: Matthew J. Realff
School of Chemical Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0100
404-894-1834
404-894-2866 (FAX)
matthew.realff@che.gatech.edu

4. Special Topics in Design and Analysis.

Papers are sought in process design and analysis. Topics may include such areas as the design of integrated plants, interaction between process design and process control, consideration of uncertainty and operability at the design stage, and strategies for the synthesis and optimization of entire flowsheets/plantwide systems.

Submit extended abstract to Michael L. Mavrovouniotis, 1996 Area 10A Chair at address above.

Session Chair (For Information Only)
Stratos Pistikopoulos
Centre for Process Systems Engineering
Imperial College
London SW7 2BY
UNITED KINGDOM
44-171-594-6620
44-171-594-6606 (FAX)
e.pistikopoulos@ic.ac.uk

Co-Chair: Michael L. Luyben
Experimental Station
E. I. du Pont de Nemours & Company
Wilmington, DE 19880-0101
302-695-4820
302-695-2645 (FAX)
luybenml@esvax.dnet.dupont.com

5. Synthesis and Analysis for Safety and Environmental Concerns.

This session invites paper submissions in the area of process synthesis and analysis for safety and environmental concerns. Papers describing the latest synthesis and analysis techniques, methodologies, procedures, novel equipment related to safety and the environment are sought. Applications and industrial case studies relating to process safety concerns and/or environmental issues are encouraged.

Submit extended abstract to Michael L. Mavrovouniotis, 1996 Area 10A Chair at address above.

Session Chair (For Information Only)
Karen A. High
School of Chemical Engineering
Oklahoma State University
Stillwater, OK 74078-0537
405-744-9112
405-744-6187 (FAX)
high@master.ceat.okstate.edu

Co-Chair: Lionel O'Young
Mitsubishi Chemical Corporation
3-10, Ushiodori
Kurashiki, Okayama 712
JAPAN
81-86-457-2983
81-86-457-2027 (FAX)
lionel@seigi2.mt.m-kasei.co.jp

Area 10b: Systems and Process Control

NOTE: PLEASE SUBMIT CAMERA-READY ABSTRACT AND AN ADDITIONAL EXTENDED ABSTRACT FOR ALL AREA 10B SESSIONS TO THE 1996 AREA 10B CHAIR:

James B. Rawlings
Department of Chemical Engineering
University of Wisconsin
Madison, WI 53706-1691
608-263-5859
608-262-5434 (FAX)
jbraw@che.wisc.edu

1. Nonlinear Control.

Papers are solicited which describe new theoretical approaches and/or applications in the area of nonlinear process control. The main issues addressed by the paper should be clearly described in the abstract. Priority will be given to papers which describe new work, and work that is not covered in other sessions. Relevant topics include, but are not limited to: model predictive control, differential geometric control, robust control, nonlinear model identification for control, scheduled control, and nonlinear analysis tools.

Submit extended abstract to James B. Rawlings, 1996 Area 10B Chair at address above.

Session Chair (For Information Only)
Francis J. Doyle
School of Chemical Engineering
Purdue University
West Lafayette, IN 47907-1283
317-494-9472
317-494-0805 (FAX)
fdoyle@ecn.purdue.edu

Co-Chair: Yaman Arkun
School of Chemical Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0100
404-894-2871
404-894-2866 (FAX)
yaman_arkun@chemeng.gatech.edu

2. Advances in Process Control.

This session emphasizes papers that address recent advances in the control of chemical process systems. Priority will be given to papers that discuss novel theories, new and innovative strategies, novel applications or the definition of new problem areas. Papers which demonstrate the application of existing theory to new problem areas are also welcome. The contribution of the paper to the advancement of the state-of-the-art should be clearly stated in the abstract. The topic and research area are open; however, authors are strongly discouraged from submitting to this session papers that would be better suited for presentation in the following sessions sponsored by the Area 10b of CAST: Nonlinear

Control, Applications of Process Control, Integration of Estimation and Control, Plantwide and Decentralized Control, Process Performance Monitoring, and On-line Optimization for Control.

Submit extended abstract to James B. Rawlings, 1996 Area 10B Chair at address above.

Session Chair (For Information Only)
Oscar D. Crisalle
Department of Chemical Engineering
University of Florida
Gainesville, FL 32611-6005
904-392-5120
904-392-9513 (FAX)
crisalle@bitrun.che.ufl.edu

Co-Chair: M. Nazmul Karim
Department of Chemical and Biosource Engineering
Colorado State University
Fort Collins, CO 80523
303-491-5252
303-491-7369 (FAX)
karim@longs.lance.colostate.edu.

3. Applications of Process Control.

Submit extended abstract to James B. Rawlings, 1996 Area 10B Chair at address above.

Session Chair (For Information Only)
Jorge A. Mandler
Air Products and Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195-1501
610-481-3413
610-481-2446 (FAX)
mandleja@ttown.apci.com

Co-Chair: Thomas A. Badgwell
Department of Chemical Engineering
Rice University
Houston, TX 77251-1892
713-527-4902
713-285-5478 (FAX)
tab@rice.edu

4. Integrated Estimation and Control.

Submit extended abstract to James B. Rawlings, 1996 Area 10B Chair at address above.

Session Chair (For Information Only)
Fred Ramirez
Department of Chemical Engineering
University of Colorado
Boulder, CO 80309-0424
303-492-8660
303-492-4341 (FAX)
ramirez@rastro.colorado.edu

Co-Chair: Michael A. Henson
Department of Chemical Engineering
Louisiana State University
Baton Rouge, LA 70803-7303
504-388-3690
504-388-1476 (FAX)
henson@nlc.che.lsu.edu

5. Plantwide and Decentralized Control.

This session will focus on recent advances in the areas of plantwide and decentralized control. Papers highlighting industrial experience or comparisons between theoretical predictions and experimental observations are welcome. Some areas of interest include, but are not limited to, alternative formulations of the plantwide control problem, pairing of manipulating and measured variables, decentralized controller design, performance comparisons between decentralized and interacting control, computational difficulties associated with plantwide control, implementation issues: supervisory computer vs. DCS platform, and real time applications.

Submit extended abstract to James B. Rawlings, 1996 Area 10B Chair at address above.

Session Chair (For Information Only)
Richard D. Braatz
Department of Chemical Engineering
University of Illinois
Urbana, IL 61801-3792
217-333-5073
217-244-8068 (FAX)
braatz@mozart.scs.uicc.edu

Co-Chair: S. Joe Qin
Fisher-Rosemont Systems, Inc.
1712 Center Creek Drive
Austin, TX 78754
512-832-3635
512-834-7200 (FAX)
qin@fisher.com

6. Process Performance Monitoring.

Process Performance Monitoring is an extremely important function in the process industry. It provides the means to achieve process safety, product quality, process operability, process performance optimization, the economic viability and ultimately the profitability of a process. Various strategies and techniques have been devised for automatic process performance monitoring. Multivariate statistical methods have been shown to provide a mechanism for process monitoring and diagnosis. Neural networks have been utilized in fault detection. Artificial intelligence and fuzzy logic are some other alternative approaches. We solicit papers which address the theoretical and application problems associated with process performance monitoring and diagnosis. Industrial implementations and/or case studies are particularly welcome. Topics may include, but are not limited to: Multivariate Statistical Methods, Neural Networks, Process Chemometrics, Fuzzy Logic, Artificial Intelligence for Monitoring and Diagnosis, and Statistical Process Control.
Submit extended abstract to James B. Rawlings, 1996 Area 10B Chair at address above.

Session Chair (For Information Only)
George N. Charos
Amoco Research Center, MC-7
PO Box 3011
Naperville, IL 60566
708-961-7872
708-420-4678 (FAX)
gcharos@amoco.com

Co-Chair: Masoud Soroush
Department of Chemical Engineering
Drexel University
Philadelphia, PA 19104
215-895-1710
215-895-5837 (FAX)
masoud.soroush@coe.drexel.edu.

Joint Area 10b and Area 10c Session

1. On-Line Optimization for Control.

This session will focus on issues in the general area of real-time optimization for control. Areas of interest include, but are not limited to, large-scale modeling strategies, sparsity issues, gross error detection, data reconciliation, and optimization strategies. New developments in real-time MPC for challenging industrial problems (e.g. plant-wide control) are sought. Papers dealing with actual

applications (industrial or experimental) are strongly encouraged.

Submit extended abstract to James B. Rawlings, 1996 Area 10B Chair or Joseph F. Pekny, 1996 Area 10C Chair.

Session Chair (For Information Only)
Karlene A. Kosanovich
Department of Chemical Engineering
University of South Carolina
Columbia, SC 29208
803-777-0143
803-777-8265 (FAX)
kosanoka@sun.che.scarolina.edu

Co-Chair: Iauw-Bhieng Tjoa
Mitsubishi Chemical

Area 10c: Computers in Operations and Information Processing

NOTE: PLEASE SUBMIT CAMERA-READY ABSTRACT AND AN ADDITIONAL EXTENDED ABSTRACT FOR ALL AREA 10C SESSIONS TO THE 1996 AREA 10C CHAIR:

Joseph F. Pekny
School of Chemical Engineering
Purdue University
West Lafayette, IN 47907-1283
317-494-7901
317-494-0805 (FAX)
pekny@ecn.purdue.edu

1. Optimization -- Methodology and Fundamentals.

Contributions are sought describing new optimization methods and theory; for example, new algorithms for mathematical programming problems, parallel and distributed computing based approaches, tailored methods for specialized large scale problems, methods for solving optimization problems in real-time (e.g. for control applications), and new software engineering techniques for optimization systems. Presentations describing practical applications of optimization are also welcome but should focus on extensions in methodology required to address the application.

Submit extended abstract to Joseph F. Pekny, 1996 Area 10C Chair at address above.

Session Chair (For Information Only)
Christodoulos A. Floudas
Department of Chemical Engineering
Princeton University
Princeton, NJ 08544-5263
609-258-4595
609-258-0211 (FAX)
floudas@titan.princeton.edu

Co-Chair: Mark A. Stadtherr
Department of Chemical Engineering
University of Illinois
Urbana, IL 61801
217-333-0275
217-244-8068 (FAX)
markst@uiuc.edu

2. Computer Integrated Manufacturing in the Chemical Process Industries. (Cosponsored by the International Cooperation Committee of the Society of Chemical Engineers, Japan.)

Contributions are sought describing methodological developments, implementations, and experiences with all aspects of CIM in the process industries. Subjects of particular interest include integration of application areas such as plant information systems, monitoring, diagnosis, control, scheduling, planning, optimization, and design, as well as developments within application areas themselves that focus on integration issues. Presentations of industrial experiences with CIM technology and critical discussions of limitations/advantages of current approaches are also welcomed.

Submit extended abstract to Joseph F. Pekny, 1996 Area 10C Chair at address above.

Session Chair (For Information Only)
Bhavik R. Bakshi
Department of Chemical Engineering
Ohio State University
Columbus, OH 43210-1180
614-292-4904
614-292-3769 (FAX)
bakshi.2@osu.edu

Co-Chair: Shinji Hasebe
Department of Chemical Engineering
Kyoto University
Yoshida-Honmachi Sakyo-ku
Kyoto 606-01
JAPAN
81-75-753-5587
81-75-752-9639 (FAX)
hasebe@cheme.kyoto-u.ac.jp

3. Process Monitoring and Data Interpretation.

This session addresses recent advances in process monitoring and data interpretation. Topics of interest include fault detection and diagnosis; root-cause identification; fault compensation; statistical methods for data analysis; data-, model-, knowledge- based approaches; integration of process monitoring within high level decision systems; and industrial applications.

Submit extended abstract to Joseph F. Pekny, 1996 Area 10C Chair at address above.

Session Chair (For Information Only)
Lyle H. Ungar
Department of Chemical Engineering
University of Pennsylvania
Philadelphia, PA 19104-6393
215-898-7449
215-573-2093 (FAX)
ungar@cis.upenn.edu

Co-Chair: Miguel J. Bagajewicz
Simulation Sciences, Inc.
601 S. Valencia Ave.
Brea, CA 92621
714-579-0412
714-579-0113 (FAX)
71726.2353@compuserve.com

4. Large Scale Dynamic Modeling and Optimization.

In recent years dynamic simulation of entire chemical manufacturing systems has become widely demonstrated and practiced in the chemical processing industries. Modeling, simulation, and optimization of large-scale dynamic systems continue to pose many challenging problems, particularly as new and larger applications push and exceed the limits of existing technology. Papers are sought that address the modeling, simulation, and optimization of large-scale dynamic systems. Topics of interest include algorithms, modeling approaches, analysis tools, computational performance, computer and software architecture, integration of simulation and optimization, hybrid (combined discrete/continuous) systems, and on-line technology. Industrially relevant applications and exam-

ples are encouraged, in particular applications to non-traditional sectors of the chemical industry such as industrial gases, pharmaceuticals, semiconductors, forest products, or polymers.

Submit extended abstract to Joseph F. Pekny, 1996 Area 10C Chair at address above.

Session Chair (For Information Only)
Paul I. Barton,
Department of Chemical Engineering 66-464
Massachusetts Institute of Technology
Cambridge, MA 02139
617-253-6526
617-258-5042 (FAX)
pib@mit.edu

Co-Chair: Thanos Tsirukis
Air Products and Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195-1501
610-481-4452
610-481-2556 (FAX)
tsiruka@ttown.apci.com

5. Intelligent Systems for Process Operations.

Contributions are sought concerning all aspects of the construction and use of intelligent systems in process operations including automated problem solving, knowledge acquisition, knowledge representation, machine learning, model-based reasoning, connectionist models, neural networks, distributed AI architectures, practical applications, expert systems, fuzzy logic and soft computing, reasoning under uncertainty, genetic algorithms, heuristic searching, intelligent databases, intelligent interfaces, tools, knowledge based system (KBS) methodologies, and verification & validation of KBSs.

Submit extended abstract to Joseph F. Pekny, 1996 Area 10C Chair at address above.

Session Chair (For Information Only)
Ajay K. Modi
Department of Chemical Engineering
Massachusetts Institute of Technology
Cambridge, MA 02139
617-253-6521
617-253-9695 (FAX)
akmodi@mit.edu

Co-Chair: James F. Davis
Department of Chemical Engineering
Ohio State University
Columbus, OH 43210-1180
614-292-0090
614-292-3769 (FAX)
davis.64@osu.edu

Area 10d: Applied Mathematics and Numerical Analysis

NOTE: PLEASE SUBMIT CAMERA-READY ABSTRACT AND AN ADDITIONAL EXTENDED ABSTRACT FOR ALL AREA 10D SESSIONS TO THE 1996 AREA 10D CHAIR:

Hsueh-Chia Chang
Department of Chemical Engineering
University of Notre Dame
Notre Dame, IN 46556
219-631-5697
219-631-8366 (FAX)
hchang@bach.helios.nd.edu

Area 10d: Applied Mathematics and Numerical Analysis

1. Nonlinear Dynamics and Pattern Formation.

Papers are sought on nonlinear spatio-temporal patterns in chemical systems. Of specific interests are reaction-diffusion systems, wave dynamics, mixing kinematics and fluid dynamics and dynamics of systems under control. Experimental, computational and theoretical papers are all welcomed.

Submit extended abstract to Hsueh-Chia Chang, 1996 Area 10D Chair at address above.

Session Chair (For Information Only)
Hsueh-Chia Chang
Department of Chemical Engineering
University of Notre Dame
Notre Dame, IN 46556
219-631-5697
219-631-8366 (FAX)
hsueh-chia.chang.2@nd.edu

Co-Chair: Vemuri Balakotaiah
Department of Chemical Engineering
University of Houston
Houston, TX 77204-4728
713-743-4318
713-743-4323 (FAX)
bala@henri.chee.uh.edu

2. General Papers in Applied Mathematics.

Papers are solicited in the innovative application of mathematics to chemical engineering with an analytical or computational flavor. Preference will be given to those that deal with more current developments of applied mathematics.

Submit extended abstract to Hsueh-Chia Chang, 1996 Area 10D Chair at address above.

Session Chair (For Information Only)
Doraiswami Ramkrishna
School of Chemical Engineering
Purdue University
West Lafayette, IN 47907-1283
317-494-4066
317-494-0805 (FAX)
ramkrish@ecn.purdue.edu

Co-Chair: Fernando J. Muzzio
Department of Chemical and Biochemical Engineering
Rutgers University
Piscataway, NJ 08855-0909
908-932-3357
908-932-5313 (FAX)
muzzio@zodiac.rutgers.edu

3. Novel Numerical Methods.

The increasingly widespread use of non-traditional computational methods in the modeling of physico-chemical processes is becoming an attractive and powerful alternative to more traditional numerical techniques. Contributions related to applications of novel numerical techniques in Engineering and Science are welcomed. Some specific examples include but are not limited to: Cellular Automata, Random and Stochastic Methods (Monte Carlo), Brownian Dynamics, Multigrid Methods, Domain Decomposition, Global Optimization Techniques, Wavelet and Neural Network Applications and Sinc Methods. Selected applications may include, for example, Fluid Mechanics of one or more phases, complex and supermolecular fluids, Non-Newtonian fluids, porous media, advanced materials and their processing (ceramic and composites), and environmental and bioengineering problems. Authors are invited to present the advantages of their chosen methods over more traditional techniques. Discussions on the

applicability and extensions of specific methods to various classes of problems are also welcomed.

Submit extended abstract to Hsueh-Chia Chang, 1996 Area 10D Chair at address above.

Session Chair (For Information Only)
Marios Avgousti
Department of Chemistry and Chemical Engineering
Stevens Institute of Technology
Hoboken, NJ 07030
201-216-8015
201-216-8243 (FAX)
marios@olympus.ppi.stevens-tech.edu

Co-Chair: Pedro Arce
Department of Chemical Engineering
FAMU/FSU College of Engineering
Tallahasse, FL 32316-2175
904-487-6166
904-487-6150 (FAX)
arce@evex12.eng.fsu.edu

4. Inverse Problems and Methods in Chemical Engineering.

Many chemical engineering applications can be posed as inverse problems. They may be ill-posed if the outputs do not depend continuously on the input data. Applications of inverse methods include parameter estimation and domain identification from over-specified boundary data. Sources of models and data include partial differential equations, multivariate statistical models, process data, physical property measurements and imaging data. Common difficulties in solving the inverse formulation include non-existent or non-unique solutions, sensitivity of the output to the input conditions, and insufficient or inaccurate data. This session seeks contributions which pose novel inverse problem formulations, provide new developments into the numerical solution or provide an analysis to explain difficulties in the solution of inverse problem formulations.

Submit extended abstract to Hsueh-Chia Chang, 1996 Area 10D Chair at address above.

Session Chair (For Information Only)
Andrew N. Hrymak
Department of Chemical Engineering
McMaster University
Hamilton, Ontario L8S 4L7
CANADA
905-525-9140 x23136
905-521-1350 (FAX)
hrymak@mcmaster.ca

Co-Chair: B. Erik Ydstie
Department of Chemical Engineering
Carnegie Mellon University
Pittsburgh, PA 15213-3890
412-268-2235
412-268-7139 (FAX)
ydstie@andrew.cmu.edu

Division-wide Poster Session

1. Advances in Computing and Systems Technology.

Posters describing recent original results of interest in any of the areas of process design, control, operations, information processing, applied mathematics, and numerical analysis are solicited. In order to accomodate late-breaking news, submissions will be accepted up until September 1, 1996, although earlier submissions are helpful and welcome. Submit an extended poster abstract stating the new results to all of the CAST Area Co-Chairs listed below. Submissions with multiple authors should be made by the person who will present the work if accepted. It should be clearly indicated if this work has been submitted for consideration in another session. Electronic submissions are strongly preferred.

Michael L. Mavrovouniotis
Department of Chemical Engineering
Northwestern University
Evanston, IL 60208-3120
708-491-7043
708-491-3728 (FAX)
mlmavro@nwu.edu

Babatunde A. Ogunnaike
Experimental Station E1/104
E. I. du Pont de Nemours & Company
Wilmington, DE 19880-0101
302-695-2535
302-695-2645 (FAX)
ogunnaike@essptd.dnet.dupont.com

Scott E. Keeler
DowElanco
9330 Zionsville Road
Indianapolis, IN 46268-1053
317-337-3138
317-337-3215 (FAX)
skeeler@dowelanco.com

Kyriacos Zygourakis
Department of Chemical Engineering
Rice University
Houston, TX 77251-1892
713-527-3509
713-524-5237
kyzy@rice.edu

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Submission of articles:
November 1, 1995
Review and selection of articles:
January 15, 1996
Final articles due:
March 1, 1996
Publication date:
June 1996
Susan Montgomery, Chemical Engineering Department, University of Michigan, 3330 Dow Connector, 2300 Hayward St., Ann Arbor, MI 48109-2136. Phone: (313) 936-1890; FAX: (313) 763-0459; E-mail: smontgom@engin.umich.edu.

World-Wide Web: http://www.engin.umich.edu/labs/mel/Chemengin/montgom.html

Information for Contributors: Articles and Software

1. Prospective authors should submit five copies of the complete manuscript and/or two copies of any software being submitted to Dr. Susan Montgomery, Department of Chemical Engineering, University

of Michigan, Ann Arbor, MI 48109-2136, USA. Camera-ready illustrations (originals plus one copy) must accompany the manuscript, but be separate from it. Other correspondence should be sent to the Publisher, Professional, Reference, and Trade Group, John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158, USA.

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3. The language of the journal is English.

4. Manuscripts should be submitted typed double-spaced on one side only on standard 8 1/2 x 11-inch (21.5 x 28-cm) paper with 1-inch (2.5-cm) margins. An abstract of not more than 50 words should be included. Authors should supply up to five key words or phrases that characterize their manuscript.

Manuscripts should not be more than 25 pages long (11 typeset pages) including artwork. The paper should be reasonably subdivided into sections and, if necessary, subsections. The references should be numbered consecutively in the order of their appearance and should be complete, including authors' initials, the title of the paper, the date, page number, and the name of the journal or sponsoring society. Please compile references on a separate sheet at the end of the manuscript. See the examples below.

Reference Examples:

[1] P. D. Deshpande, "Improve quality control on-line with PID controllers," Chem. Eng. Prog., Vol. 88, No. 5, 1992, pp. 71-76.
[2] N. N. Rao, Elements of Engineering Electromagnetics. 3rd Ed. Prentice Hall, Englewood Cliffs, New Jersey, 1991, p. 45.

Where possible, material intended for footnotes should be inserted in the text as parenthetical material. Please supply numbers and titles for all tables. All table titles should have an explanatory heading. Please supply legends for all figures and compile these on a separate sheet.

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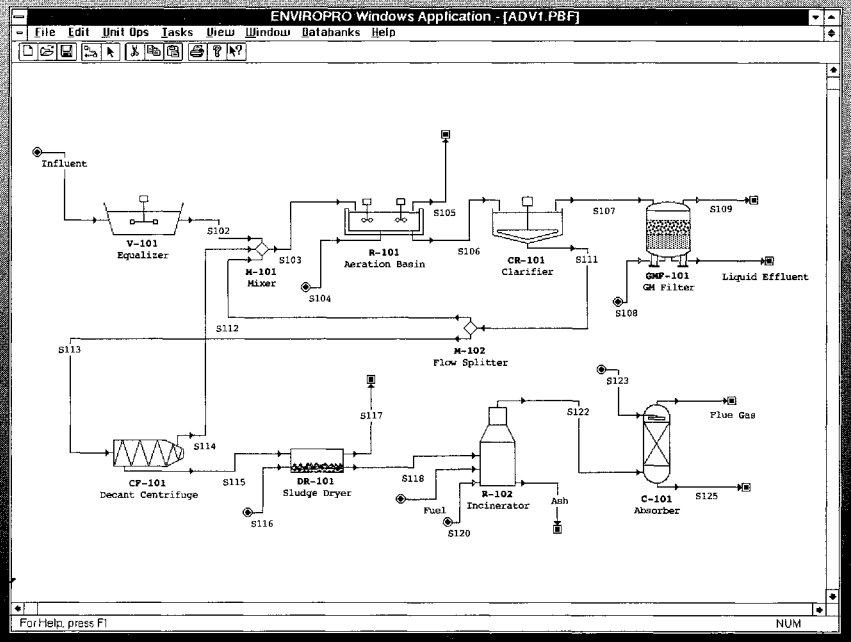

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