Computing and Systems Technology Division Communications

Volume 18, Number 1, Winter 1995

Table of Contents

Editorial Notes

Communications

Articles

Meetings, Conferences, Congresses, Short Courses, and Workshops . . . 20

Calls for Papers

Advertisements

CAST Division of AIChE
1995 Executive Committee

Elected Members

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
Rodolphe 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
Dow Elanco
306 Bldg.
9330 Zionsville Rd.
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

Secretary/Treasurer
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.com
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 Keeler, Vice-Chair
Dow Elanco
306 Bldg.
9330 Zionsville Rd.
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
Email:
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

Editorial Notes

About This Issue

by Peter Rony and Jeff Siirola

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. Above all, these statements provide appropriate and well deserved tribute to our 1994 award winners--**Ignacio Grossmann**, **Joe Boston**, and **Peter Piela** -- and serve as a continuing baseline for the nomination of future award candidates.

With the publication of "On the Scope and Future of Mathematical Programming in Chemical Process Systems, " the Computing in Chemical Engineering award address (at the San Francisco AIChE meeting) by Professor Ignacio Grossmann, we continue a tradition of the Winter issue of CAST Communications. Some of the figures in this article have appeared in Ignacio's prior work, and others are in the public domain as best as we can discern.

We are very pleased to publish the first part of the invited article, "Low-Cost Virtual Reality and its Application to Chemical Engineering, " by John Bell and H. Scott Fogler. John exhibited virtual reality technology at the San Francisco AIChE meeting; your editor had an opportunity to try it. Quite interesting, even amazing. The breakpoint for Part II of the article was determined by restrictions on the page count of this issue, which is overflowing with photos, figures, and meeting announcements.

Jeff Siirola, our hard working Programming Chairman, pointed out in December 1994: "The list of meetings and conferences in CAST Communications is getting pretty long. I try to put in almost everything I receive (from Jeff Kantor's email system and other sources). I wonder if it might be appropriate if we use one of our little "filler boxes" (assuming that we figure out how to do them again) to seek feedback on whether all these announcements are of any value to the readership."

Rather than use a filler box, we would like to address this issue directly in this "About This Issue" section. Jeff Sirola's point is well taken. Jeff Kantor, with his superb Internet operation, has substantially surpassed the ability of CAST Communications to keep up, in a timely manner, with meeting announcements posted almost daily over WWW or (to Area 10b members) by email.

Are "all these announcements of any value to the readership?" Several thoughts immediately come to mind. First, two

arguments in favor of continuing the "Meetings, Conferences, . . " section as it presently exists: (a) It is always useful to advertise a meeting anywhere and everywhere; and (b) The CAST Communications "Meetings..." listing is free and targeted to a demographic market, namely, all members of the CAST Division. Second, three arguments in favor of reducing the Meetings, Conferences, . . " section as it presently exists: (a) By early 1996, most members of the CAST Division will have access to WWW as an educational or business necessity; (b) The titles, locations, and dates of meetings, conferences, congresses, short courses, etc. could continue to be published in CAST Communications, *with the reader referred to WWW pages for further details*; and (c) Prudent management of CAST Division financial resources requires a reasonable limitation on the page count -- approximately 40-45 pages -- for each issue of the newsletter. Third, two arguments directed toward expanding the publication scope of CAST Communications are worth serious consideration: (a) By late 1996, most members of the CAST Division will have a CD-ROM drive associated with their personal computers; and (b) CAST Communications could cease publication as a *printed* newsletter in favor of a CD-ROM based newsletter distributed to all members of the CAST Division. Such a CD-ROM disc could contain color images, sound, and digital video, in addition to text. Adobe Acrobat Reader for Windows 2.0 could be supplied at no cost. Meeting organizers could provide electronic files that advertise their meetings in a more compelling manner than the printed word. A downside aspect is that the creation of a CD-ROM disc is more time intensive.

Please communicate your thoughts concerning the size of the "Meetings, Conferences, Congresses . . . " section in CAST Communications to either the Publications Board Chair (*rony@vtvm1.cc.vt.edu*) or the Programming Board Chair (*siirola@emn.com*) soon. It is possible and likely that the second alternative, described above, will be tested either for the Summer 1995 or the Winter 1996 issue.

Jeff Siirola also noted, in passing, that "proposals to present" may be submitted electronically, but gave no details. This matter was discussed at the San Francisco AIChE meeting in November, 1994. The details of such electronic submission, courtesy of Jim Rawlings, are contained in this issue. The CAST Division Executive Committee strongly encourages electronic submissions from this point forward.

Jeff Siirola has produced "the latest version of CAST Programming Guidelines -- dated January 12, 1995 -- which outline our expectations for speakers, session chairs, area chairs (and vice chairs), and the division program chair (currently me)." We shall serialize these Guidelines in several issues of CAST Communications. In this issue, we provide the Guidelines for Speakers.

This issue was both edited and produced in Blacksburg. Microsoft Word for Windows 6.0 was employed to layout the 2-column editorial notes, articles, communications, meetings, and calls for papers. Photographs were scanned in the Virginia Tech Multimedia Lab into BMP file format, then imported into the Word document. BMP files provided by Ignacio Grossmann were

also imported in the same manner. The original photos and figures were sent to New York; at the time of writing of this paragraph, the editor does not know whether or not the originals were used in place of the scanned versions. The editor, who is familiar with Word for Windows, had a substantially easier time to perform this task than he did using Pagemaker for Windows 5.0 for the Summer 1994 issue of CAST Communications.

For the next issue, Summer 1995, the CAST Communications editorial triumvirate will be restored to full strength as the *virtual publishing* arm of the CAST Division. Gary Blau, Scott Keeler, and Angela Parker -- from Dow Elanco in Indianapolis -- will step into the shoes of Joe Wright and Colette Totino of the Xerox Research Centre of Canada. Biosketches and photos of our new members of the CAST Communications editorial team will be published in the Summer 1995 issue. Angela Parker, in collaboration with her colleagues, has been given the exciting responsibility to improve the layout of this newsletter.

Your editor was truly surprised in 1994, first in March 1994 when he discovered (with the assistance of Harry Kriz, a contributor to the Summer 1994 issue of CAST Communications) the existence of freeware and shareware Internet clients for the Windows platform. "Where have these packages been all my life," was his first reaction. The second surprise occurred in October 1994, when a junior ChE student, Robert Bour, at Virginia Tech succeeded -- in only several days -- in creating a World Wide Web server in the undergraduate ChE controls lab using HTTPd Internet client software (for Windows) and the guidance of Harry Kriz. Harry has given permission to your editor to include his recent February 2, 1995 email message, which is entitled "Teaching Online." His final statement--*"I continue to be amazed at the reach I can achieve with this technology without any help from publishers or learned societies. Information about my article has spread around the world by word of mouth."*

Consider a near-future scenario. Most students at a typical university have their own home pages on a university server, or perhaps their own WWW servers. The increasing use of FTP, Gopher, versions of Mosaic, and their Internet successors substantially facilitates communications between students and faculty. Interactive video is both common and affordable. The need for a student to be bound to the faculty at his/her university is eliminated. Faculty bypass the traditional textbook publishers and their expensive marketing mechanisms in favor of textbooks and ShareBooks™ on the Internet, which permit direct, electronic distribution of books to students at royalty rates ranging from $ 0 to $10. Instead of bulky, heavy, printed textbooks, students carry around low-cost, light weight, robust, CD-ROM-based notebook computers that cost in the range of $400 to $500. This "brave new world" of higher education and continuing education may be as little as 5-10 years away. In a panel session at the October 1994 Council for Chemical Research annual meeting, your editor has characterized this general phenomenon as "The Decline of the Information Gatekeepers." A point on this curve is contained in the Communications piece, "Peer Review in Cyberspace," paragraphs in which appeared originally in the November 11, 1994 issue of Science.

1995 CHAIR'S MESSAGE

by Rudolphe L. Motard

As incoming Chair of the CAST Division it is comforting to note how well managed the activities of the Division appear to be, thanks to the diligence of my predecessors. Still, one must be ever vigilant and not become complacent in maintaining the quality and effectiveness of our principal tasks and processes: Programming, Communications, Awards, Finances and Membership.

Programming

The San Francisco Annual Meeting (November 13-18, 1994) represented the Division's first attempt to peer review all CAST papers together to insure uniform session quality. This was a monumental task for 20.5 sessions and two poster sessions. My humble observation is that the papers were superb in the few sessions that I was able to attend. The organizers of the review process, led by Mike Malone (Area 10a Programming Chair), should be warmly congratulated for setting a new standard of excellence. The sessions were mostly overcrowded, a good sign in a way, but troubling with regard to organizational details if it persists. CAST expects to repeat collective peer review for all Annual Meetings. In the meantime, Gary Blau is organizing an attempt to collect more direct feedback on the quality of paper sessions.

Communications

The Newsletter continues to be a centerpiece of the Division under the outstanding productivity of Peter Rony, Joe Wright, his secretary, Colette Totino, and Gordie Ellis at AIChE. Joe Wright's recent move to a new assignment created a hard-to-fill vacuum, but Gary Blau, Scott Keeler, and their secretary, Angela Parker (Dow Elanco) rose to the occasion and assumed the Associate Editorship and newsletter production responsibilities starting with the Summer 1995 issue.

In addition to the newsletter, we are deeply appreciative of the job that Editor Peter Rony did in preparing the CACHE 25th-Anniversary CD-ROM, which contains a vast array of academic software tools and demonstrations. Is this a firm signpost for the future of CAST Communications?

Jeff Kantor's CAST10 mailing list on Internet has already generated substantial benefits in terms of quick turnarounds, communications and announcements. It has been a great help for programming activities, meeting notes and calls for papers. We have also seen free chemical engineering software prototypes offered for downloading via anonymous FTP (file transfer process). We hope that this medium will continue to grow as more and more members get tuned in to the efficiency and dividends of electronic mail, FTP, World Wide Web, Mosaic, etc. Even AIChE is experimenting with electronic communications, as we were pleased to see at the San Francisco meeting.

Awards

The Awards Banquet at the Annual Meetings is one highlight of the Division's year. The 1994 winners are introduced elsewhere in this issue. Ignacio Grossmann, the Computing in Chemical Engineering Award winner, delivered a very interesting lecture at the banquet in San Francisco. The on-going funding for the Awards appears to be in good shape thanks to the effort of Gary Blau in replenishing sponsor contributions.

Finances

Division finances are in good shape, again testifying to good governance. Many thanks to recent secretaries/treasurers Larry Biegler and Maria Burka.

Membership

Membership continues to rise slowly, and stands at about 2,000. The Executive Committee decided *not* to offer nonmember subscriptions to the CAST newsletter through AIChE. Too many imponderables and too costly.

Executive Committee

From the masthead you will note the makeup of the 1995 CAST Officers and Executive Committee. CAST welcomes new area programming Chairs and Vice-Chairs, an almost complete turnover this year. You will note, however, that the Chairs served in Vice-Chair roles for a couple of years before assuming leadership. Here is a place where volunteers can make a mark. Contact an area chair corresponding to your closest interest and arrange to meet with the committees at the national meetings. The area committees offer a lively forum for discussion of technological trends in computer applications development. Programming is our largest consumer of volunteer talent: writing papers, reviewing papers, and organizing sessions.

You may also wish to volunteer to run for election to the Executive Committee in some capacity. Contact the immediate past-Chair of the Division who organizes the elections, usually held in the Fall, before the Annual Meeting.

Regards to all.

CAST Programming Guidelines. Part I. Speakers

by J. J. Siirola

(Received January 12, 1995) A special welcome to the newly-elected Area Vice Chairs! Attached is the latest version of the CAST Programming Guidelines, which outline our expectations for speakers, session chairs, area chairs (and vice chairs), and the division program chair (currently me). Please reread these carefully, and feel free to comment. We are always looking for improvements. You will note that I generally have something to do with meeting organization up through the time that CAST's session requests are approved at the AIChE Programming Retreat (held in February of each year for the following year's meetings), but that after that approval, session responsibility and primary communication with the MPC passes on to you, the Area Chairs. Feel free to forward appropriate parts of these responsibilities to your session chairs and their speakers.

Duties of a CAST Division Speaker

7-12 months before meeting date

Submit title, authors, and abstract (camera ready) on a completed original, new-version AIChE Proposal-to-Present (PTP) form to Session Chair with a copy to the Session Co-Chair. Authors are reminded of the AIChE limitation that no person may author or co-author more than four contributions at any one meeting.

SPECIAL NOTE: Speakers submitting proposals for sessions at Fall Annual Meetings should accompany the completed proposal-to-present (PTP) form with an additional extended 550-word abstract and submit both to the Area Chair (*NOT* the Session Chair) for area-wide review and selection. Deadline for such submissions is one month earlier than for other meetings.

6 months before meeting

On acceptance of proposal, commit to meeting all deadlines established by the Session Chair and the Meeting Program Chair.

2 months before meeting

Submit, if desired, any revision (camera-ready) of the abstract to AIChE for inclusion in the Meeting Abstract Book.

1 month before meeting

Submit final manuscript to AIChE to facilitate archiving and post-meeting availability from AIChE.

30 Minutes before session

Attend Speakers Meeting to resolve last minute problems and details.

At session

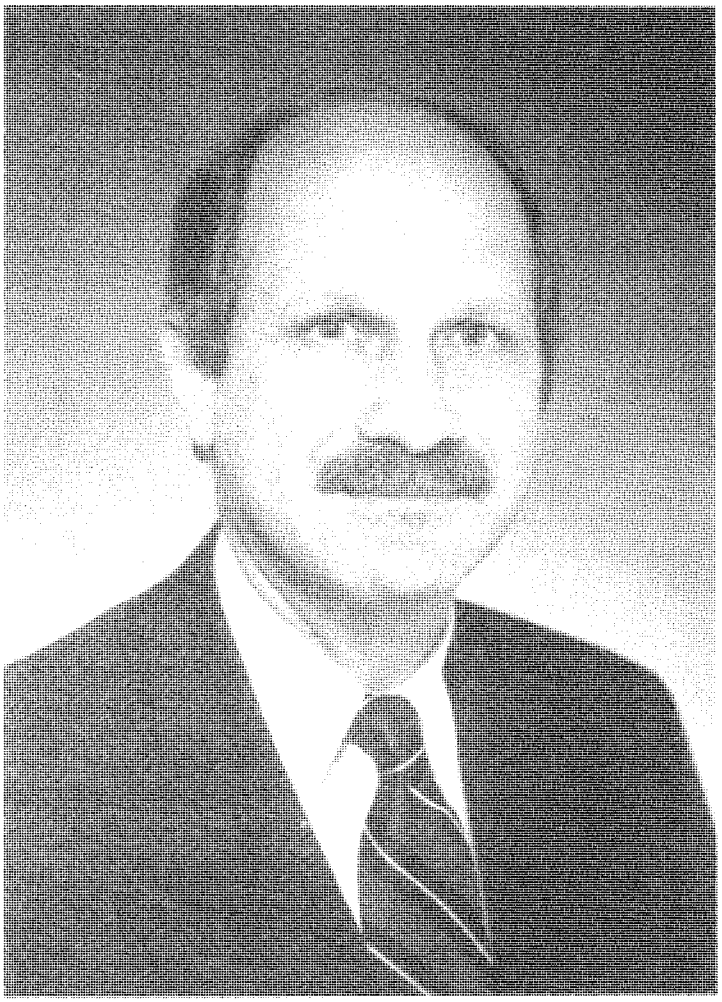
Bring 60-100 copies of visual aids to be given to audience during your presentation.

AIChE is developing electronic versions of the Proposal-to-Present (PTP) form. As these systems become available, authors will be encouraged to submit proposal information, the abstract for the Meeting Abstract Book, and the extended abstract (for CAST sessions at Fall Annual Meetings) electronically.

It is AIChE policy that no person may author or co-author more than four contributions at any one meeting nor more than one contribution at any one session.

It is also AIChE policy that all authors submit a manuscript to AIChE headquarters in advance of the meeting. Although permission is granted to AIChE to make copies of the manuscript, copyright ownership, if any, remains with the author. AIChE would prefer complete, full-length manuscripts. However, an extended abstract with figures, tables, and references will also satisfy the manuscript requirement.

It is CAST Division policy that all speakers provide hard copies of their visual aids to the audience in advance of each presentation. Visual aids that follow AIChE guidelines should be readily legible even if reduced to eighth-size and reproduced double sided.



Ignacio E. Grossmann Receives the 1994 CAST Division Computing in Chemical Engineering Award

"Leader in the development and use of mixed integer programming methods for continuous and batch process design and operation," Ignacio Grossmann received the 1994 CAST Division Computing in Chemical engineering Award. His featured after-dinner talk, "On the Scope and Future of Mathematical Programming in Chemical Process Systems," presented at the CACHE Annual Division Dinner on November 15, 1994 in San Francisco, is being published in this issue of CAST Communications.

Professor Grossmann received his B.Sc. degree in chemical engineering from the Universidad Iberoamericana (1974), and his M.Sc. and Ph.D. degrees from Imperial College, London (1975, 1977). He has been a Lecturer in Math and in Chemical Engineering at the Universidad Iberoamericana (1974), a process design engineer at the Instituto Mexicano del Petreoleo (1974), the leader of the process optimization group at the Instituto Mexicano del Petreoleo (1978-79), and assistant, associate, and full professor at Carnegie Mellon University (1979 to present).

The citation for Professor Grossmann was:

"Author of over one-hundred papers in process engineering and operations, Ignacio Grossmann is the master of problem formulation and solution techniques for applying mixed-integer (nonlinear) programming (MINLP) for heat exchanger network synthesis, flexible process design, batch process design and operation, long-term planning for new facilities, and total flowsheet synthesis. A recognized authority in the operations research community, his outer approximation algorithm and, lately, his inclusion of logic constraints yield algorithms that reduce solution times (sometimes by orders of magnitude). His DICOPT++ code that implements his algorithms is commercially available.

"Ignacio (and students) developed mathematical formulations for flexible design problems that others now use. One novel aspect is control parameters that better characterize process problems. With problems that are infinite in three dimensions, he showed how to reduce them to manageable size. He developed MINLP algorithms for the automatic synthesis of heat exchanger networks, including a formulation to allow embedding minimum utility use in the synthesis of total flowsheets. His models for batch process design and operation combine design and scheduling aspects. Through reformulations, he solved industrial scheduling problems involving over 1500 products.

"Four of his students are in academic positions: Swaney (Wisconsin), Floudas (Princeton), Pistiokopolis (Imperial College), and Sahinidis (Illinois).

"Ignacio is an outstanding 'good citizen' in our community. He has presented numerous papers at AIChE; chaired/cochaired many AIChE sessions; chaired CACHE, the CAST Division and the Programming Committee for Area 10c; and cochaired the last FOCAPD conference. Within Carnegie Mellon University, he has directed a major 'lab' within the Engineering Design Research Center. In September 1994, he became the head of the Chemical Engineering Department at Carnegie Mellon."

Statements in several supporting letters on behalf of Ignacio's candidacy include the following:

"Though Ignacio is most widely known for making mixed integer nonlinear programming a practical tool in engineering design, his contributions to research and education in process systems engineering are very broad indeed. I know him for tackling formulations all others in the field consider to be too challenging. The new formulations he introduced for several important problems in process design and operations have been adopted by many researchers and practitioners. He made fundamental advances in basic mathematical techniques that have impacted operations research and other areas outside chemical engineering.

"More specifically, he has developed rigorous analysis tools for quantifying flexibility, and for the explicit incorporation of this operational objective into the problem of design under uncertainty. He developed sophisticated algorithms for solving the complex mathematical problems that arise in flexibility."

"It has long been known that many chemical engineering process design problems can in, principle, be posed as an optimization over structure. The idea is that trial-and-error or other search methods over the generally large combinatorial space of discrete design alternatives might be replaced by mathematical programming techniques from operations research. The catch, however, has been that the resulting optimization problem is, more often than not, a non-convex, mixed-integer, non-linear program (MINLP), and MINLP codes do not exist. Ignacio Grossmann, with his students, challenged and changed that.

"At first, Ignacio concentrated on clever problem formulations that, in effect, either avoided non-linear problems or approximated non-linear effects through a mixture of linear and integer considerations, for which codes did not exist. With this technique, a number of heat recovery, refrigeration system design, and process operability and flexibility problems were formulated and first solved by mathematical programming techniques.

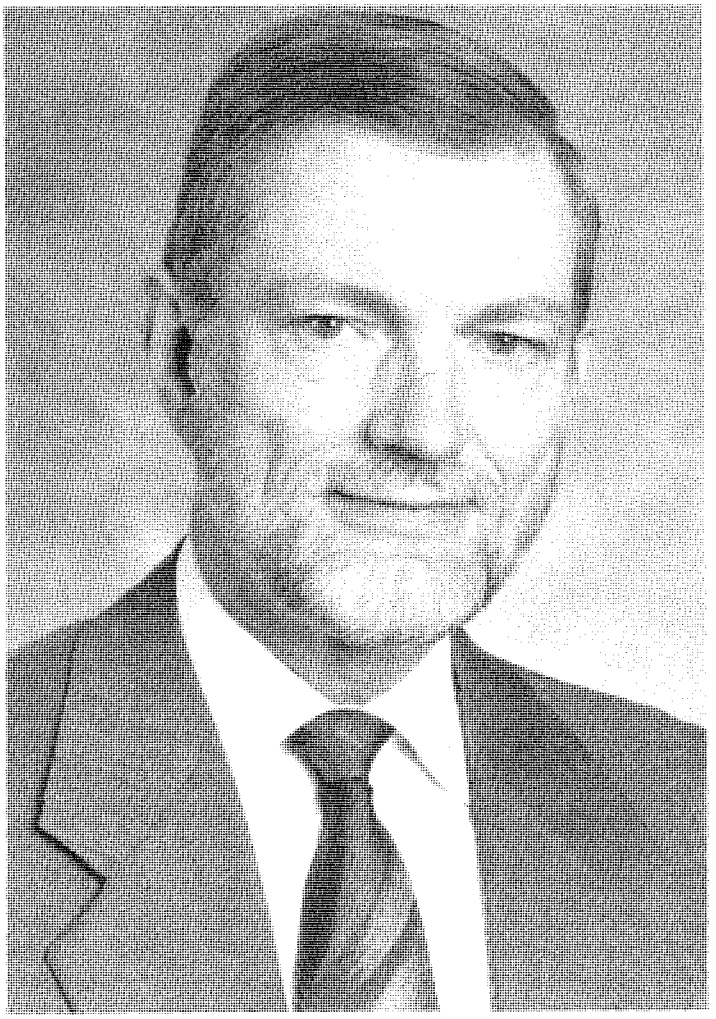
"Next, still lacking in MINLP code, Ignacio and his students nevertheless developed a procedure that solves non-convex MINLP problems through a series of interacting, mixed-integer linear programs (MILP) and non-linear programs (NLP) for which codes separately exist. The resulting system has evolved through three distinct generations and is currently known as DICOPT++. DICOPT++ is implemented in the GAMS modeling language, which itself contains hooks to available MILP and NLP solvers. DICOPT++ is currently being commercialized as a generalized MINLP solver by the GAMS Development Company.

"DICOPT++ is a significant achievement, and has allowed progress to be made in global optimization of non-convex problems in process design, in the incorporation of planning and scheduling in the design of batch processes, in long-range capital and other facilities planning, in improving the flexibility of process designs, and in simultaneous optimization of energy recovery and exchanger capital in heat integration networks for new and retrofit designs, among many other areas. It further has enabled the first practical application of the "superstructure optimization" approaches to overall process structure and continuous design parameters, and which I believe will ultimately prove far superior to existing algorithmic and heuristic systematic generation and evolutionary modification approaches.

"More recently, Ignacio has worked on integrating knowledge-based and optimization-based approaches to design. From this work has resulted clever, formalized procedures for the integration of logical inferences within mathematical optimization, as well as for enforcing logical relationships among structural variables. This has resulted in the improvement, sometimes by several orders of magnitude, of the efficiency of branch-and-bound searches, which are a part of the solution of integer programs. This, too, is a significant development that has greatly improved the efficiency of codes, including DICOPT++, in combinatorially complex problems typical of process synthesis superstructure optimizations.

"Ignacio has been steadfast in his belief that mathematical optimization techniques could be applied to process flowsheet invention and other process engineering problems. Along the way, he has had to invent clever formulations and practical MINLP solution strategies and additional techniques to efficiently execute these strategies with reasonable resources. These are indeed major advances in the applications of computing in chemical engineering.

"Ignacio and his students developed mathematical formulations for flexible design problems that others now use. One novel aspect is control parameters that better characterize process problems. Ignacio showed how to reduce these problems--infinite in three dimensions--to manageable size. He developed MINLP algorithms for the automatic synthesis of heat exchanger networks, including a formulation to allow embedding of minimum utility use in the synthesis of total flowsheets. His models for batch process design and operation combine design and scheduling aspects. Through reformulations, he solved industrial scheduling problems that involved over 1500 products."



Joe Boston Receives the 1994 CAST Computing Practice Award

The 1995 CAST Computing Practice Award, sponsored by Pergamon Press, was presented to Joe Boston "For pioneering development of methods for simulating distillation and other separation operations based upon the *inside-out* concept and for leadership as a founder of Aspen Technology, Inc."

One of the several letters that supported the nomination of Joe Boston gave the following detailed analysis of his critical contributions to chemical engineering:

"In 1970, Dr. Boston completed his Ph.D. in chemical engineering with a thesis entitled, "A New Class of Quasi-Newton Solution Methods for (Continuous) Multicomponent, Multistage Separation Processes," under the direction of Professor S. L. Sullivan, Jr. at Tulane University. At that time, iterative algorithms for solving such highly nonlinear problems were frequently plagued by inefficiency and lack of robustness when applied to practical separation problems. In his thesis, Dr. Boston recognized that most of the computation effort was spent by existing algorithms in computing thermodynamic properties and their derivatives. Accordingly, he attacked the inefficiency problem by developing a new approach, which was directed at two levels of calculations, one involving the rigorous property estimation equations and another involving approximate estimation equations that required much less computing time. The algorithm was designed to spend most of the time at the approximate level. To solve the problem of lack of robustness, he selected a new set of iteration variables, based on the stripping factor concept, that greatly reduced the possible ranges of the iteration variables and greatly increased the reliability of convergence. The result was an algorithm, now called the *inside-out method*, that has been so successful that it has become the standard method in most of the commercial simulation programs, including ASPEN-PLUS, ChemCAD, HYSIM, and PRO-II. The original inside-out formulation was restricted largely to hydrocarbon-type separations. But, in the 20-year period since the original 1974 article on the inside-out method in the Canadian Journal of Chemical Engineering, Dr. Boston has published a series of articles that present extensions of the method to general and highly non-ideal mixtures, three-phase systems, reactive systems, systems of interlinked separators, and batch distillation. In addition, the method permits the use of a wide variety of specifications, including Murphree tray efficiencies. In the 1992 McGraw-Hill book, *"Distillation Design,"* by H. Z. Kistler, on page 179 of the chapter, "Rigorous Distillation Calculations," written by J. R. Haas of UOP, the following statement appears:

"The inside-out methods are now the methods of choice for mainstream column simulation. While other methods still have their place, the inside-out methods have displaced the BP, SR, and 2N Newton methods, and their applications continue to grow.

"In addition to the just-described technical accomplishment, Dr. Boston has also demonstrated very significant leadership in the general application of computational technology to chemical engineering. He was one of eight engineers who founded Aspen Technology, Inc. in 1981. Three years later, he was elected President. Under his leadership, Aspen has grown to a company of more than 200 employees with offices in six worldwide locations. The Aspen simulator is being used on a worldwide basis in North and South America, Europe and North Africa, and Asia and Australia, by more than 70, 50, and 25 companies, respectively. The Aspen simulator is also being used for educational purposes by more than 200 departments of chemical engineering at universities in more than 30 countries around the world. Much of the success of Aspen Technology has been derived from the development of innovative and unique modeling algorithms and procedures for ASPEN-PLUS, in which Dr. Boston has played a key role. These major simulation developments include: thermodynamics of electrolyte systems; an efficient and robust three-phase flash algorithm; a simultaneous modular simulation strategy; a rate-based approach for modeling multicomponent, multistage separation problems; three-phase and reactive distillation; simultaneous calculation of interlinked separation systems; flowsheet optimization; and most recently, the enhancement of the equation-based, steady-state and dynamic simulation program known as Speedup. Many of these developments are described and discussed in the more than 30 technical publications authored or co-authored by Dr. Boston. In addition, he has made more than 30 presentations at meetings in the United States and in foreign countries to discuss progress in computer-aided design. The recent extension of ASPEN-PLUS versions to supercomputers, main-frame computers, mini-computers, workstations, and PCs with the Model Manager and MAX programs also represent significant developments achieved under Dr. Boston's leadership.

"The achievements of Dr. Joseph F. Boston in computing and systems technology have been very significant and have influenced greatly the practice and application of computer-aided chemical engineering around the world."

Peter C. Piela is the Recipient of the 1994 CAST Ted Petersen Student Paper Award

The 1995 CAST Ted Petersen Student Paper Award was presented at the AIChE National Meeting in San Francisco to Peter C. Piela "For the design and implementation of a new and significantly different environment for creating large, complex, equation-based models." Dr. Piela received his B.Sc. in chemical engineering at Imperial College (1979) and his Ph.D. in chemical engineering at Carnegie Mellon University (1989), where he worked under the supervision of Professor Arthur Westerberg. Currently, Dr. Piela is a Senior Scientist at AspenTech. The published paper for which the nomination was based is, "ASCEND: An Object-oriented Computer Environment for Modeling and Analysis: The Modeling Language," Computers in Chemical Engineering, Vol. 15, No. 1, pp. 53-72

(1991), co-authored by P. C. Piela, T. G. Epperly, K. M. Westerberg, and A. W. Westerberg. With his selection for the Ted Petersen Award, two of the three 1994 award winners in the CAST Division are currently associated with AspenTech.

The citation for Dr. Piela was as follows:

"Peter Piela has created a modeling environment, the ASCEND system, which demonstrates that the equation-based modeling approach can compete effectively with the more proven modular approaches for large, complex models.

"He adopted and extended advanced computer science concepts in this work, never compromising the need for an elegant, clean, and powerful declarative modeling language based on object-oriented principles. The complex data structures needed for finite-element modeling require about 100 lines of ASCEND code; distillation columns are an array of trays. He recognized the need of a modeler to add procedures to establish initial conditions and to select which variables to fix, a key to making these systems as easy to use as modular ones. He created a system that supports what he believes is a superior approach for modeling, the incremental addition of complexity: solve a simple version and/or part of a model, add complexity, resolve, etc.

"He believed that he had to prove the worth of his approach, a dangerous goal for an engineering student because it involves "measuring" human performance. Peter, more than most students, took over his project and went outside of chemical engineering to develop a solution to it. He went to computer science, to design (in the fine arts sense), to architecture, and to the English Department for approaches. He made this project what it is."

Paragraphs and statements in letters that supported the candidacy of Dr. Piela included the following:

"ASCEND has been described by one of the industrial testers as 'not a new software system, but a way of thinking about engineering design.' The dimensional checking and 'forced consistency' require a clarity of thought that quickly reveal the importance and interactions of various parameters of the model. The efficiency of the part/whole structuring and accessible power of the equation-oriented modeling approach should change the way we accomplish process design. I believe this to be a pivotal paper in modeling concepts for engineering design."

"Dr. Piela is unquestionably one of the leading researchers in the field of chemical process simulation. His research is pioneering, and has been focused in two areas: the development of a structured approach to equation-oriented simulation, and investigations into empirical methods for evaluating human-computer interactions."

"Equation-oriented simulation (EOS) is a method used to analyze design alternatives when the design can be described as an explicit set of mathematical relationships. EOS is considered valuable in engineering design because it enables flexibility in design analysis -- many design scenarios can be efficiently embedded in one declarative definition of a problem. However, the method has not fulfilled its promise due to the inherent complexity of the approach. The complexities are of two kinds, those of problem formulation and those of problem solution; Dr. Piela's work has focused on the former. Problem formulation is difficult for the following reasons. First, industrial problems are large, consisting of many thousands of variables and relationships. Second, it is easy to specify either too few or too many relationships. Third, it is easy to specify variables incorrectly. Lastly, solving algorithms fail unless provided with good initial variable values. Dr. Piela's original contribution is in applying the computer science concepts of structured types, strong typing, type inference, and type-manipulation operators to facilitate the efficient construction of equation-oriented simulations. Dr. Piela embodied these concepts in a new modeling language designed to address the difficulties described above. The hypothesized advantages of the structured approach to EOS were in the increased size and complexity of problems that users would be able to tackle, increased efficiency in working, and increased model reuse.

"To validate these claims, Dr. Piela developed a prototype interactive modeling environment in which users could work with the models created by the language, and distributed this environment to users in academia and industry. Through a program of systematic study of the users' modeling activity, Dr. Piela was able to demonstrate both the feasibility and efficacy of

the structured approach to EOS. While showing feasibility and efficacy in actual use were considered important in industry, this standard of validation was previously unknown in the chemical engineering research community.

"Studying users' modeling activity also required an extension of existing methods for evaluation of human-computer interaction. The cognitive psychological research that is dominant in that area has been focused on how different system features impact on users' short term learning and errors, and has generally been done by presenting novice users with isolated, laboratory tasks. This approach was inadequate because it does not extend to the typical EOS activity, where skilled users may work for days or even weeks in solving a problem. To understand human-computer interaction in EOS, Dr. Piela developed a methodology based on on-site observation, video documentation, and systematic analyses of users' actual problem-solving work. Through this methodology, Dr. Piela was able to verify hypotheses about the nature of structured modeling and to contribute new findings about how people accomplish it. First, he showed that an evolutionary approach to model-building is an effective and accepted way to lessen the difficulty of choosing initial variable values. Second, he showed that glass-box models -- where nothing is hidden from the user -- can be effectively used by the model-builder in arbitrarily accessing individual parts of the model. However, sharing of such models among users without extra support for learning can cause difficulties. Third, Dr. Piela showed that people could work effectively with the deeply nested models implied by the structured approach. And lastly, Dr. Piela demonstrated that the dominant mode of interaction in EOS is debugging, and that, given tools for debugging, people can successfully debug simulations consisting of tens of thousands of parts. Each of these findings are of great practical importance to the design and implantation of usable EOS systems."

George Stephanopoulos
2nd Vice Chair

The reader is referred to CAST Communications, Volume 17, Number 1, Winter 1994 for a write-up about George Stephanopoulos on the occasion of his selection as the recipient for the 1993 CAST Division Computing in Chemical Engineering Award. George's CAST Division banquet (November 1993) address, "Computers, Systems, Languages, and Other Fragments," was serialized as Part I and Part II in the Winter and Summer 1994 issues, respectively, of CAST Communications.

Christos Georgakis
Director (1995-1997)

Christos Georgakis, presently a Professor of Chemical Engineering at Lehigh University, received his Diploma in Chemical Engineering at the National Technical University of Athens in 1970. He received his M.S. and Ph.D. degrees from the Universities of Illinois and Minnesota in 1972 and 1975, respectively.

Christos started his academic career as a faculty member at the MIT Chemical Engineering Department where, between 1975 and 1983, he also held the DuPont Assistant Professorship and the Edgerton Associate Professorship. He was also recognized by the Dreyfus Foundation with its Teacher-Scholar Award in 1978. Between 1980 and 1983, he was Professor of Measurement and Control at the University of Thessaloniki, in Greece, where he initiated the development of the Chemical Process Engineering Research Institute. He has been with Lehigh University since 1983 where he played a central role in the development of the NSF-sponsored Industry/University Cooperative Research Center in Chemical Process Modeling and Control. He presently continues to serve as its Director. Since 1993 he has been Visiting OSPT Professor at both Delft University of Technology and the University of Amsterdam in the Netherlands. He is an Associate Editor of The Chemical Engineering Journal.

For the last 20 years Christos Georgakis has been a dedicated teacher and mentor of graduate and undergraduate students as well as an active researcher, lecturer, industry consultant and an active AIChE participant. His past research contributions and present activities have focused on the areas of process modeling and control with emphasis on reactor control, batch process control, nonlinear control and, recently, statistical process control. Along with his numerous graduate students, he has proposed, among other ideas, the use of extensive thermodynamic variables for the understanding of process dynamics, the use of "tendency models" for batch processes, and the use of the "reaction rate" and the "reference system synthesis" approaches for the design of nonlinear controllers. Besides their expression in almost ninety publications, several of these ideas have already found their application in important industrial processes.

Yaman Arkun
Director (1995-1997)

Yaman Arkun is Professor of Chemical Engineering at Georgia Institute of Technology. He received his B.S from University of Bosphorous, Istanbul, Turkey, and his M.S. and Ph.D. from the University of Minnesota. His research interests are in process dynamics, modeling and control. In particular he is interested in robust control, nonlinear and predictive control, and the synthesis of control systems for large-scale plants. He has held visiting positions at the Tennessee Eastman, DuPont and Weyerhauser companies. He is an Editor of Automatica, editorial board member of International Journal of Control, trustee of CACHE, and 1986 recipient of the Donald P. Eckman Award given by the American Automatic Control Council. He has chaired the Systems and Control Area 10b of CAST (1988-1990) and served as the AIChE Director to the American Automatic Control Council (1989-1991).

Communications

Obtaining PTP forms

by Jim Rawlings (jbraw@che.utexas.edu)

To obtain a PTP form electronically, Jim Rawlings and his colleagues in Area 10b have provided the following mechanism:

A LaTeX-style file that may be used to create AIChE Proposal to Present (PTP) forms is available via anonymous FTP from *ftp.che.utexas.edu* in the directory */pub/tex/aiche*. The LaTeX style allows you to create filled-in copies of the form directly with LaTeX. For those who prefer typing forms with typewriters, a blank form in PostScript is also available. You should retrieve the following files:

aiche-logo.300pk	AIChE logo in TeX PK font format
aiche-logo.tfm	TeX font metric file for AIChE logo
aiche-ptp.sty	LaTeX style for AIChE PTP forms
aiche-ptp.tex	Example of using aiche-ptp.sty

Be certain to use binary mode file transfer when transferring the PK and TFM files.

Teaching Online

by Harry M. Kriz (Harry_M_Kriz@vt.edu)
University Libraries, Virginia Tech

NOTE: I asked Harry Kriz, a major contributor to the 25th-Anniversary CACHE CD-ROM (see Internet menu), to comment on the statistics associated with his two WWW articles, one of which was published in the Summer 1994 issue of CAST Communications (Vol. 17, No. 2, pp. 6-14). Such statistics point to the enormous publication potential and power of the Internet.

... Peter R. Rony, Editor

(February 2, 1995) The Web server article [which was commissioned for the 25th-Anniversary CACHE CD-ROM] was accessed 2,300 times in the 6 weeks following my announcement of its availability in mid-October 1994. Word about it has spread, apparently, as interest in it continues. In January 1995 it was accessed nearly 600 times by individuals in about 20 countries.

In January 1995, my Web server distributed over 14,000 files totaling more than 80 MB. Virtually all the traffic is generated by individuals who desire to read one or both of my two articles. The first is my "Web server" article and the second is my article on "Windows and TCP/IP." The latter was accessed 3766 times in January. The total number of files distributed is greater than the sum of readers for each article because each article consists of several files. The counts I report for each article are the total accesses of the Abstract page in each article, i.e. the entry point for the article.

It is also interesting to observe that 257 people accessed my personal page with my little biographical sketch. Only 182 users out of those 257 actually had the View Images option turned on for their client so they could download the picture of me in my garden that appears on my personal page. I am guessing a lot of those who don't get the picture are using character-based Unix command line interfaces, which will not handle images.

In January 1995, the server was accessed by machines in 46 countries. Also, some 3500 machines at commercial organizations and 2885 machines at U. S. educational institutions accessed the server. There is no way to tell how many individuals used these separate machines, and I do not have figures at this time on the total number of individual academic institutions. My statistics generator just counts the total number of unique IP addresses or hostnames. At least some of the addresses are gateway or proxy machines that channel multiple users onto the Internet from behind organizational firewalls. All the server knows is the IP address (and hostname) of the machine that makes the contact. Addresses such as ccvax.fullerton.edu probably involve multiple users. Other addresses obviously represent a single individual.

I continue to be amazed at the reach I can achieve with this technology without any help from publishers or learned societies. Information about my article has spread around the world by word of mouth.

Peer Review in Cyberspace

by Gary Taubes and Peter R. Rony

An article, written by Gary Taubes, in the November 11, 1994 issue of Science magazine provides a point on the curve concerning one possible future for peer-reviewed scientific and engineering journals.

The article starts with the following paragraph:

"Where do you find the fastest growing physics journal in the world? The answer: http://xxx.lanl.gov/. Three years ago, theoretical physicist Paul Ginsparg created an electronic archive at Los Alamos, accessible at that internet address, to which physicists e-mail preprints and from which they receive the latest work of colleagues and competitors. Since then, the archives have grown almost exponentially. They now include a dozen physics

disciplines, plus mathematics, economics, computation, and linguistics, among others; they have more than 20,000 subscribers; and they receive roughly 1000 new preprints a month. Indeed, they have become so indispensable to physicists that they've left many asking whether traditional journals are necessary anymore?"

The article continues to discuss the reaction of the American Physical Society, and the prospect and details concerning peer reviewing submissions to the to the electronic archives. The two-thirds-page article (see page 967 of the issue of Science magazine) ends with the following:

"As for the question of why the physics community needs journals anyway, Michael Peskin, a physicist at the Stanford Linear Accelerator Center, put the issue this way: 'The traditional journals might survive, he says, "because senior people like me think that paper is permanent. However, our younger colleagues do not feel that there is a difference between a page and a disk. And now that peer review may be added to the electronic version of scientific publication, the difference is likely to grow just that smaller."

The above is a teaser for readers both to search for the full article and to pursue the WWW journal at *http://xxx.lanl.gov/.*

And now for a bit of prognostication. In the editor's opinion, the **printed** versions of archival journals -- e.g., the AIChE Journal or the Journal of the American Chemical Society -- will likely become obsolete by the year 2005, if not sooner. Such journals will be made available electronically to subscribers, either as a CD-ROM disc -- or its successor high-density storage medium -- or over the Internet. Such journals will be multimedia oriented, and may even provide raw experimental data (e.g., X-ray crystal structure data) that now is submitted to data storage archives. Scientific visualization of raw and analyzed experimental data will become important and common. The burden of providing properly formatted articles, most likely using SGML, HTML, PDF or a successor markup language, will be shifted from journal publishers to authors. Increasingly, the high prices charged, by some journal publishers, for subscriptions to libraries will become indefensible. Intellectual property rights to the articles will likely reside with the authors and/or their respective organizations, and not with the publishers. In terms of intellectual property issues, the scientific/engineering article will become similar to the musical composition or work of art, situations where users of a creation pay a royalty on a per use basis. The Federal Government will insist that articles resulting from government-sponsored research be made available to the public on a royalty-free basis rather than being held captive by the copyright policies of a technical journal.

The information gatekeeping role of journal publishers will ultimately decline but perhaps not disappear. There may be chaos during the transition period from the printed page to the electronic file.

Should the Meeting, Conferences, Congresses, Short Courses, and Workshops section of CAST Communications be *reduced in size in future issues* ? The proposal to the CAST Executive Committee would be to provide the name of the meeting, its location, and its date, with full details being available on the WWW pages maintained by Jeff Kantor for Area 10b. We would start with the Summer 1995 issue. Please send your opinions to either SIIROLA @ EMN.COM or RONY @ VTVM1.CC.VT.EDU

Articles

On The Scope and Future of Mathematical Programming in Chemical Process Systems

 Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA 15213

Introduction

In writing this article for the 1994 Computing in Chemical Engineering Award which I have been honored to receive from the CAST Division of AIChE, I would like to first acknowledge the work and contributions of my Ph.D. students with whom I have had the privilege of working over the last 15 years.

One of the exciting aspects of an academic career is the opportunity to do research work with young people who are willing to engage in the exploration of new ideas and solution methods. I am very proud to present the list of my former and present Ph.D. students in Table 1 because every one of them has made original contributions to the development of models and solution methods for the optimal synthesis and operation of chemical processes. In fact all these students fit very nicely the description that John F. Kennedy gave of young people that are idealistic and who are willing to take intellectual risks:

The problems of the world cannot be possibly solved by skeptics or cynics whose horizons are limited by obvious realities. We need people who can dream things that never were.

If we view our students in the light of the above quote we can indeed consider ourselves to be very fortunate.

Table 1. Former and Present Ph.D. Students of Ignacio E. Grossmann

Keshava P. Halemane (1982)
Soterios Papoulias (1982)
Ross E. Swaney (1983)
Marco A. Duran (1984)
Jane A. Vaselenak (1985)
Mark R. Shelton (1985)
Christodoulos A. Floudas (1986)
Gary R. Kocis (1988)
Efstratios N. Pistikopoulos (1988)

Deepak B. Birewar (1989)
Terrence F. Yee (1990)
Nikolaos Sahinidis (1990)
David Straub (1991)
Ramesh Raman (1992)
Ignacio Quesada (1993)
Vasilios Voudouris (1993)
Dimitrios Varvarezos (1994)
Robert Clay (1994)
Mark Daichendt
Jose Pinto
Metin Turkay
Ramaswamy Iyer
Craig Schmidt
Juan Zamora

Our research work over the last 15 years at Carnegie Mellon has been driven by the following vision that we have of process systems engineering:

Design and Operating Decisions in Chemical Process Systems can be Mathematically Modeled and Optimally Determined within a Mathematical Programming Framework

Of course we are not the only ones to have had this vision because it has, in fact, been advocated by a number of other prominent researchers. What, however, has distinguished our work is the idea that we can model explicitly both discrete and continuous decisions through mathematical programming problems known as mixed-integer linear and nonlinear programming (i.e. MILP or MINLP). These are problems that involve discrete (integer) and continuous variables, and in which the extremum of an objective function is to be determined subject to both equality and inequality constraints. This class of problems we have investigated include model problems in process synthesis, process flexibility, and planning and scheduling.

Given the nature of this article I do not want to go into the technical details of this work since these can be found in the relevant research literature. Instead, I would lie to, first, clarify some common misconceptions about mathematical programming. Second, I would like to briefly outline the scope and future directions of mathematical programming.

The Misconceptions

To address common misconceptions about mathematical programming I would like to make clear what the math programming is **NOT** about. The first common misconception is that math programming is about getting accurate answers to mathematical optimization models. While getting accurate answers can be important, it is certainly not the central objective in mathematical programming. There are, of course, different extremes of accuracy; a very good example of one extreme is the work by Shanks and Wrench. In 1962 these authors published a paper in which they reported *5000 significant digits of the number pi* is shown in Fig. 1. It is important to note that since *pi* is an irrational number it means that every one of this 5000 digits does not follow a regular pattern. However impressive this result is, what I want to reassure the reader is that this level of accuracy is rarely needed in mathematical programming ! In the fact the value of 3.1416 will do for most applications!

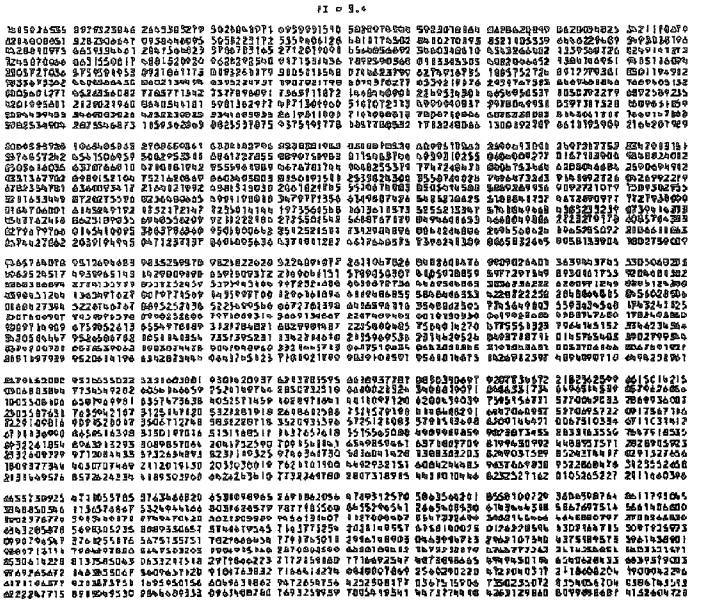
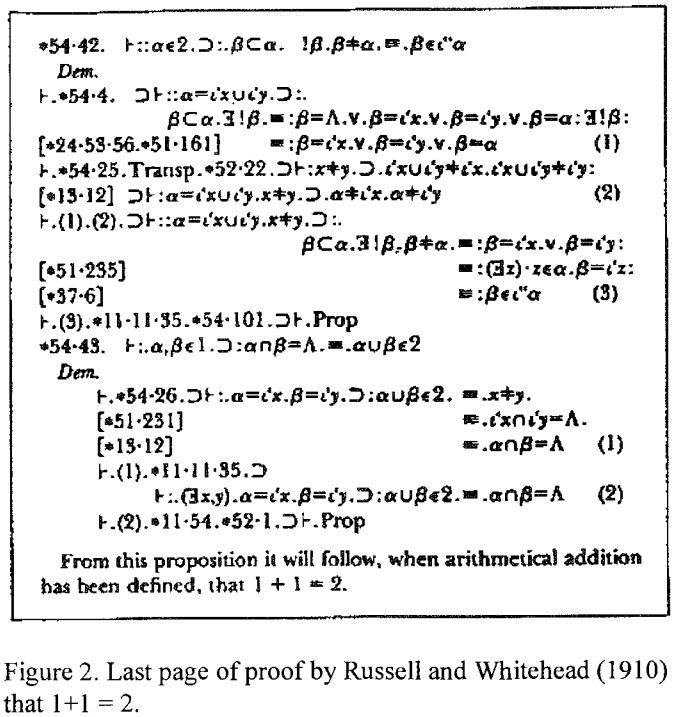


Figure 1. Number pi with 5000 significant digits (Shanks and Wrench, 1962). (Courtesy of *Mathematics of Computation*).

The second common misconception is that mathematical programming provides a nice and convenient excuse to academics for engaging themselves in the pleasures (sometimes tortures) of deriving rigorous proofs through a web of lemmas,



*54·42. ⊢::α∈2.⊃:.β⊂α. ≡.β,β≠α.≡.β∈ι"α

Dem.

⊢.*54·4. ⊃⊢::α=ι'x∪ι'y.⊃:.
β⊂α.∃!β.≡:β=Λ.∨.β=ι'x.∨.β=ι'y.∨.β=α:∃!β:
[*24·53·56.*51·161] ≡:β=ι'x.∨.β=ι'y.∨.β=α (1)
⊢.*54·25.Transp.*52·22.⊃⊢:x≠y.⊃.ι'x∪ι'y≠ι'x.ι'x∪ι'y≠ι'y:
[*13·12] ⊃⊢:α=ι'x∪ι'y.x≠y.⊃.α≠ι'x.α≠ι'y (2)
⊢.(1).(2).⊃⊢::α=ι'x∪ι'y.x≠y.⊃:.
βCα.∃!β,β≠α.≡:β=ι'x.∨.β=ι'y:
[*51·235] ≡:(∃z):z∈α.β=ι'z:
[*37·6] ≡:β∈ι"α (3)
⊢.(3).*11·11·35.*54·101.⊃⊢.Prop

*54·43. ⊢:.α,β∈1.⊃:α∩β=Λ.≡.α∪β∈2

Dem.

⊢.*54·26.⊃⊢:.α=ι'x.β=ι'y.⊃:α∪β∈2. ≡.x≠y.
[*51·231] ≡.ι'x∩ι'y=Λ.
[*13·12] ≡.α∩β=Λ (1)
⊢.(1).*11·11·35.⊃
⊢:.(∃x,y).α=ι'x.β=ι'y.⊃:α∪β∈2.≡.α∩β=Λ (2)
⊢.(2).*11·54.*52·1.⊃⊢.Prop

From this proposition it will follow, when arithmetical addition has been defined, that 1 + 1 = 2.

Figure 2. Last page of proof by Russell and Whitehead (1910) that 1+1 = 2.

theorems and corollaries. While proofs are certainly important in mathematical programming, it is in fact only relatively few of them that are truly relevant. In discussing proofs all kinds of extremes are of course possible, and a very good example is the

proof that *1+1=2*. At the beginning of this century, Bertrand Russell and Whitehead in their monumental work, Principia Mathematica, proved that 1+1=2 after 250 pages of rigorous logical proof! Fig. 2 shows the last page of that proof where the last line reads:

From this proposition it will follow that when arithmetical addition has been defined, that 1+1=2.

This is of course a very important result. But what I can assure the reader is that in mathematical programming one can take a number of things for granted without having to prove them. Accepting that 1+1=2 is certainly one of them!

Having clarified misconceptions on the more scholarly or theoretical aspects of mathematical programming, another common misconception has to do with the fact that many academics who are engaged in mathematical programming are affiliated with business schools. The specific suspicion is that theoreticians or practitioners of mathematical programming are mercenaries that provide to management "scientific" justification or rationalization of practices or beliefs. Here again, although there might be some truth to this, this is not the central objective of mathematical programming. A very good example of how one can provide scientific justifications for practices and beliefs through mathematics is the following historical event that took place in the 18th century.

Figure 3a. Euler

Catherine the Great, wife of the czar in Russia, had invited the well-known French philosopher and encyclopedist Diderot to spend some time in her court in St. Petersburg. Catherine, however, became very quickly disenchanted with Diderot. Since he was an atheist, he questioned the religious beliefs of the members of the court. Furthermore, he tried to convince them that God did not exist. To solve this problem Catherine the Great had the vision to resort to a scientific solution. She invited Euler, the great Swiss mathematician, to help her to solve this problem. When Euler arrived in St Petersburg a debate was arranged between Euler and Diderot (Fig. 3). Extrapolated to modern times this would have been like a debate between a scientist and a lawyer. The opening statement was by Euler who said:

"Sir, $(a + b^N) / N = X$. Therefore God exists. What do you have to say to this?"

Although Diderot was well versed in history, philosophy and literature, he was very weak in mathematics. For this reason he had no idea what Euler was talking about! Because of this Diderot remained silent; he truly thought that Euler had the proof. Having lost the debate Diderot had to leave the court and return to his native France. What this example shows in a very powerful way is the effectiveness that mathematics can have for supporting arguments that are not entirely obvious. But, again, the point I want to emphasize here is that this is not the main point of mathematical programming.

At this point of the article the reader might think that maybe I am trying to push things a bit too far by idealizing mathematics, and by perhaps by trying to equate chemical engineers to mathematicians. This, again, is a misconception. I would argue that in fact we do not want to equate chemical engineers to

Figure 3b. Diderot

mathematicians. This is not only because chemical engineering is based on both the physical and mathematical sciences, but also because the perception by the public of mathematicians is in fact not very good. To illustrate this point, Fig. 4 shows a painting by the Mexican painter Diego Rivera. The title of this painting is El Matematico (The Mathematician). As you can see in this painting the mathematician is being portrayed as a shy, introverted, inward looking individual. As my children would say, he really looks like a nerd! The mathematician in this painting is in great contrast to the active, dynamic, goal-driven individuals that clearly chemical engineers are! So, hopefully, this example will

put to rest the conjecture that there is a conspiracy for converting chemical engineers into mathematicians.

Figure 4. *El Matematico*, by Diego Rivera (1936).

The Scope of Mathematical Programming

Having addressed some of the more common misconceptions, the main question that is still unanswered is, How does mathematical programming fit in the great scheme of things, and how is it relevant to chemical engineering?

Interestingly, the answer to this question can be found in the history of mathematics. As proposed by Guillen (1983), a mathematician from Cornell, the history of mathematics, in fact, can be divided into 3 periods as seen in Table 2. The first period is the one of *fantasizing*. Here the fundamentals of Euclidean geometry, logic, calculus, set theory were developed. The main feature of this period was that mathematics was conceived as a pure science in which all knowledge was either true or false. There was no room for uncertainty or ambiguity because mathematics was assumed to be infallible. In short this was an intellectual paradise, at least for rationalists.

But then the second period took place which Guillen has called as the period of *compromising*. It is here where some of the basic foundations of mathematics were shaken. First there was the discovery that Euclid's 5th postulate was in fact only a postulate; in other words not a universal truth. Both Lobatchevsky and Riemann developed new geometries in which, for instance, it was possible to have that for a given line and point not one but rather an infinite number of parallel lines. This meant that Euclidean geometry was only man-made and not a universal truth. The second development was Gödel's Theorem. Here Gödel, an Austrian mathematician, motivated by paradoxes discovered by Bertrand Russell, proved that there will always be mathematical properties that cannot be proved with logic. Or, in other words, Gödel proved that any system of logic is unable to prove its own logic consistency. Ironically, he used logic to prove this.

Table 2. History of Mathematics (Guillen, 1983)

Period	*Topic*
Fantasizing	**Euclidian Geometry** **Logic** **Calculus** **Set Theory** **Group Theory**
Compromising	**Non-euclidean Geometry** ***(Lobachevsky, Riemann)*** **Gödel's Theorem**
Optimizing	**Probability, Statistics** **Game Theory** ***Combinatorics***

While these developments created uncertainty in mathematics, a third period emerged that was prompted by 20th century developments in technology and computers. This, in fact, led to what Guillen calls the *optimizing* period. (Please be aware that in fact we are living in the age of optimization!!) In this period the main areas that have emerged are probability and statistics, game theory and combinatorics, which traditionally had been downplayed in mathematics. These areas specifically address the modeling and solution of *decision making* problems,.that is, problems dealing with complex systems and organizations in which logistics and strategies play a central role. In fact, it is the developments in these areas that finally gave credibility to algorithmic mathematics as an intellectually valid body of knowledge. It became clear that algorithmic mathematics can co-exist and complement pure mathematics, or as the numerical analyst, Peter Henrici, put it (1972):

Dialectic mathematics is a rigorously logical science; statements are either true or false; objects with specified properties either do or do not exist. *Algorithmic mathematics* is a tool for solving problems.

Dialectic mathematics invites contemplation. *Algorithmic mathematics* invites action.

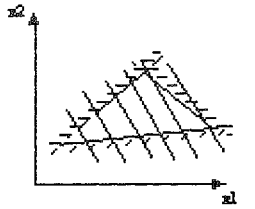
Dialectic mathematics generates insight. *Algorithmic mathematics* generates results.

The significance of the above is that algorithmic mathematics deals with problem solving, which lies at the heart of engineering. It is in fact in the context of algorithmic mathematics that the area of Mathematical Programming was born.

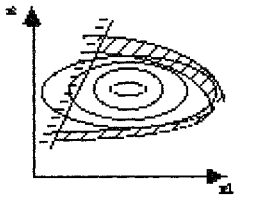
Mathematical programming is an abstraction that views the problems of the real world as constrained optimization problems. The conceptualization is as follows:

Given a space of alternatives defined by constraints that are specified through a mathematical model, select decision variables to maximize/minimize an objective function

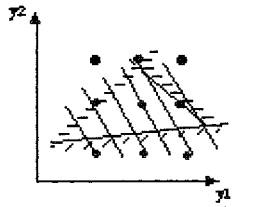
While the statement of this abstraction is very simple, it has proved to be a remarkably powerful model for conceptualizing decision problems. The founders of mathematical programming were George Dantzig, who invented linear programming in 1949; Kuhn and Tucker, who invented the basic theory for nonlinear programming in 1951; and Gomory, who was the first one to develop a solution method for integer programming in 1958.



(a) Linear Programming



b) Nonlinear Programming



(c) Integer Programming

Figure 5. Geometrical representation of major types of mathematical programs.

Figure 5 shows a geometrical interpretation of these three basic optimization problems. It is important to note that the key difference between "classic" optimization, developed mostly by Lagrange, and mathematical programming, is the presence of inequality constraints which greatly expand the modeling capabilities of real problems. It is also interesting to note that the term, Mathematical Programming, was used for the first time in 1959 at a conference organized by the Rand Corporation in Santa Monica. It was here that linear, nonlinear and integer programming were all put together in a conference for the first time.

Table 3. Evolution of Mathematical Programming (Balas in Minoux, 1987)

1950's	**Linear Programming**
	Nonlinear Programming
1960's	Network Theory
	Dynamic Programming
1970's	Nondifferentiable Optimization
	Combinatorial Optimization: Graph Theory
1980's	Theory Computational Complexity
1990's	Large-Scale Computation

Mathematical Programming has been a very active area of research over the last four decades. As seen in Table 3, the 50's and 60's were characterized by a period in which the basic theory and methods for the main optimization problems were developed. The 70's were dominated by highly structured problems that could be represented through graph theory. The 80's were characterized by the formalization, through computational complexity theory, of the degree of difficulty for solving different types of combinatorial optimization problems. The 90's are being characterized by large-scale computation, which is being made largely possible by the great increase in computational power. It should also be noted that the field of mathematical programming continues to be a very active area of research, as evidenced by the significant number of journals and conferences on this topic.

Role and Contributions in Chemical Engineering

Developments shown in Table 3 have had an important impact in Chemical Engineering. Both concepts and methods have been used to successfully tackle problems in the following areas:

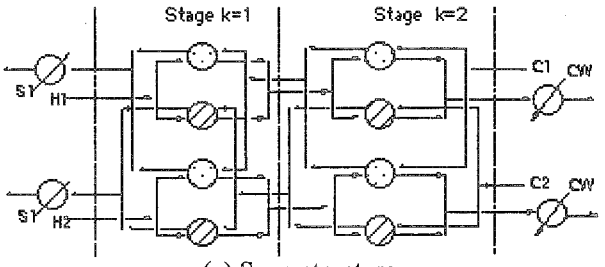
Production Planning
Process Design
Process Synthesis
Retrofit Design
Batch Scheduling
Process Control

Chemical engineers have made the following important contributions in the development of optimization models and solution methods for the above problems.

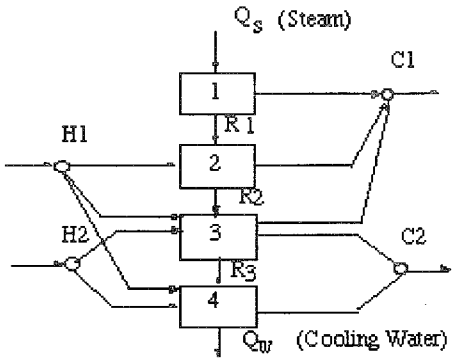
I. Solution Strategies. Engineering problems are fuzzy and ill-defined. A major contribution by chemical engineers has been in the formulation of problem solving strategies and approaches through optimization. Examples are *Simultaneous Optimization Strategie,* in which the objective is to simultaneously capture all the relevant trade-offs and interactions in a chemical process system. Another example are *Decomposition Techniques* for effectively solving realistic sized problems.

II. Representations. A major challenge in the formulation of mathematical programs is how to effectively represent the space of alternatives that in turn gets to be translated through a mathematical model. Contributions by engineers include detailed superstructures that systematically embed families of alternatives (e.g. exchanger networks in Fig. 6), as well as targets that

represent higher level abstractions that capture main features in a lower dimensional space (e.g. transshipment model in Fig.6).



(a) Superstructure



(b) Target

Figure 6. Superstructure and Target Representations for Heat Exchanger Network.

III. Solution methods. In this area chemical engineers have had to face a number of taboos in mathematical programming that in fact were prevalent not only among skeptics of mathematical optimization but even among operations researchers. Some of the major taboos have been:

(a) Only a small number of variables can be handled in nonlinear problems

(b) NP-combinatorial optimization problems are not amenable to rigorous solutions

(c) Mixed-integer nonlinear programming is not solvable

(d) Global optimization can only be solved with expensive random search methods

I believe that we, as members of CAST and of the systems community at large in Chemical Engineering, can take pride in the fact that we have provided answers to each of the above taboos. In (a) we currently are starting to solve nonlinear programs involving 50,000-100,000 variables with SQP algorithms. In (b) effective branch and bound methods have been developed to greatly reduce the combinatorics, especially in scheduling problems (e.g. traveling salesman, MILP state-task-network). In (c) algorithms such as the outer-approximation have been developed and even commercialized in a code (DICOPT) that is used in other disciplines. In (d) very significant progress has been made in problems with special structure (e.g. bilinear) to rigorously find the global optimum (e.g., GOP algorithm).

From a theoretical point of view the significance of the above contributions is that the Mathematical Programming Framework for Chemical Process Design provides:

- *Unified representation of alternatives and decisions in process applications*
- *Systematic approach to process modeling*

From a practical point of view the framework provides:

- *Methodology for addressing relevant industrial problems*
- *Tools that can help to identify more profitable answers*

In short, it is a technology that works !

Future Directions

As we examine the future needs of the chemical industry which is being subjected to greater economic pressures, and to globalization trends, there is a clear need for:

- *Increased efficiency in operations*
- *Integration of planning, production, marketing*
- *Improved design capabilities*

All these needs clearly point to a greater role and need of mathematical programming tools. In addition, there are a number of future research challenges that still need to be addressed:

1. Expanding scope of models. For instance, a major challenge is how to integrate equations and symbolic logic in optimization models.

2. Integrating diverse models. A major challenge here is the integration of models for design, planning, scheduling, control, each of which exhibits different levels of detail and time scales.

3. Anticipating effects of uncertainty. Here the effective solution of stochastic optimization models still remains a major computational challenge.

4. Solution of large-scale models. Orders of magnitude increase are still expected for solving realistic problems.

5. Global optimization of general models. Finding global optima in general models such as mixed-integer differential-algebraic models will certainly remain a major challenge.

All the above problems are quite challenging and will require significant research work. We should accept the fact that the challenges will not be solved overnight, and that resources and manpower will be needed. So the question that arises is, who will do the job? There will always the temptation that a new "magic" technology will appear to solve not only the above problems but perhaps many more. That is clearly wishful thinking.

The main danger is that if we do not place enough attention to the education and formation of the new generation of engineers, and we do not insist on keeping high standards and let the learning of

mathematics decrease in importance, the solutions to the above challenges will most likely remain elusive. In fact, we may have to face a number of undesirable situations such as not having a strong technical workforce of engineers that can produce the products and technologies of the future. To avoid this situation it is clear that industry and government must invest in education and in people, that is, in the engineers of the future.

With this note I would like to finish this article by borrowing Kennedy's quote and modifying it to our own situation. The quote is as follows:

The optimization problems of the chemical industry in design and operations cannot be possibly solved by skeptics and cynics whose horizons are limited by obvious short term results . We need chemical engineers who can dream of methods and solutions that never were.

. . . . .*Ignacio E. Grossmann*

References

Davis, P.J. and R. Hersh, "The Mathematical Experience", Houghton Mifflin, Boston (1981).

Guillen, M., "Bridges to Infinity", Houghton Mifflin, Boston (1983).

Grossmann, I.E., "Mixed Integer Nonlinear Programming Techniques for the Synthesis of Engineering Systems," *Research in Engineering Design* **1**, 205 (1990).

Henrici, P., "Reflections of a Teacher of Applied Mathematics", *Quarterly of Applied Mathematics*, 30, 31-39 (1972).

"México: Esplendor de Treinta Años", The Metropolitan Museum of Art, New York (1990).

Minoux, M., "Mathematical Programming: Theory and Algorithms", John Wiley (1986).

Russell, B. and A.N. Whitehead, "Principia Mathematica", Cambridge University Press, Cambridge (1910).

Shanks, D. and J.W. Wrench, *Mathematics of Computation*, 16, (1962)

Acknowledgments

I am grateful to all of those who have made this award possible. I would like to thank my Ph.D. advisor Roger Sargent who introduced me to mathematical programming. Many thanks to my colleagues at Carnegie Mellon University, particularly to Art Westerberg, who was responsible for my hiring at CMU. I am grateful to my graduate students, who have provided me with a most stimulating research environment. I would also like to thank many of my colleagues at a number of universities and in industry with whom I have had the opportunity of establishing friendships and having a meaningful exchange of research ideas. I am also most grateful to government agencies, particularly to NSF, as well as the corporate members of our Computer Aided Design Consortium, who have supported our work. Finally, last but not least I am most grateful to my family, wife, children as well as to my parents.

Low Cost Virtual Reality and its Application to Chemical Engineering

John T. Bell and H. Scott Fogler, University of Michigan

Virtual reality (VR) is an important emerging technology in computer visualization. While the concept of virtual reality has been around since the early 1960s, until recently the capabilities of VR have been limited, and only available to those institutions with large computing budgets. Recent developments have greatly increased the capabilities of this technology and have brought the price to within the range of the average researcher and even home hobbyist. This paper will provide a brief overview of this rapidly growing field, with emphasis on entry-level implementations, and will finish with a discussion of how it can be, and is being, applied to chemical engineering.

Background

The underlying concept behind virtual reality is to produce a computer-generated environment that is as lifelike as possible; to make the user believe that he[1] is actually present in the computer-generated world. In a perfect implementation, the user would be completely unable to distinguish the virtual world from the real one. As Ivan Sutherland put it, in one of the founding quotes of the field, "The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal."[2] StarTrek fans will instantly see this as a description of the holodeck. Much of the current research in virtual reality involves striving to attain this pinnacle of realism.

In addition to the real world, other environments can also be modeled using virtual reality. For example, VR can be used to explore the inside of a catalyst pellet or an operating nuclear reactor. With VR an engineer can pick up a distillation tower and move it to a better location. Abstract concepts such as entropy, safety, or flexibility can be visualized and manipulated. In fact, the virtual world does not have to bear any resemblance to the real world, and is not constrained by gravity, the laws of physics, or even any sense of reasonableness. In addition, multiple users can enter into the same virtual world and interact with each other even though they may be physically located thousands of miles apart.

Virtual reality is commonly considered to be an expensive endeavor involving fast, expensive computers and lots of specialized hardware. This hardware includes head-mounted displays and head-tracking devices, that, in combination, allow the user to look in all directions and have his view change in accordance with his head position. While VR *can* be quite expensive, this does not have to be the case. If one is willing to accept a slightly lower performance level, virtual reality can be implemented on an ordinary personal computer with less than

---

[1]. Please read he/she, him/her, etc. wherever pronouns are used.
[2]. Sutherland, Ivan E., "The Ultimate Display", Proceedings of the IFIP Congress, 1965.

$500 worth of additional equipment. The progression of this paper will be to start with the minimum cost alternatives, and then to move on to more complex and expensive solutions. This is a normal path of progression for new entrants into this field.

Increasing Immersion = Increasing Cost

The question of exactly what is and is not virtual reality is still a topic of much heated debate. The key concepts that separate virtual reality from other forms of computer interfaces are *immersion* and *believability*. A VR participant should be completely immersed in the virtual environment, and should believe, as much as possible, that the environment around him is "real". There are many different degrees to this immersion, with higher levels of immersion requiring more sophisticated hardware and software and having appropriately higher costs.

If one could produce a scale with which to measure the degree of immersion, at the low end of the scale would be a simple table of numbers. Next would come charts, graphs, and then three-dimensional graphic images. None of these are, of course, virtual reality, because in all these cases the user is an external observer looking in on the data, and is not immersed within the scene. The closest interfaces to be almost, but not quite, virtual reality are video games, some of which take a first-person perspective and contain quite realistic graphics. What separates these games from true virtual reality is that the video game graphics are all pre-computed and stored, (which may take man-years to complete), and are then presented to the user as appropriate. True virtual reality maintains a database of objects, and calculates for each frame update which objects are visible and what they look like from the user's current viewpoint. The functional difference is that in VR you can look at the world from any viewpoint and perspective you wish, whereas the video games can only show you views for which the graphics have been stored. Conversely, video game graphics are generally of much higher quality, as the time required to generate them is not a concern, whereas virtual reality must re-compute all the graphics images several times per second, thereby limiting feasible graphics quality.

As the immersion level increases, the simulation becomes more and more realistic, and the user believes to a greater and greater extent that they are actually within the computer generated environment. Obviously higher screen resolution and faster, more detailed images increase the immersion level. This is accomplished using faster, often specialized, computers and high speed graphics boards. In some cases, multiple computers work together to handle different portions of the overall task. Other common features of VR which add to the immersion level and hence the experience are 3-D (stereoscopic) vision, 3-D audio (the user can sense the direction of the sound), wired gloves, and most notably the head mounted display.

Minimum Cost Virtual Reality

The lowest cost level of virtual reality is commonly referred to as "homebrew VR", or "garage VR". This level of hardware and software has been developed by hobbyists literally working in their basements and garages, using parts and techniques scavenged from whatever source is available. Prices for homebrew VR start at essentially free, assuming one already has a personal computer.

The lowest cost software implementation of virtual reality would have to be Rend386, a public domain program that runs on ordinary personal computers and is tuned to run efficiently without requiring a lot of computing power. (Using only integer math, Rend386 does not require a floating point math co-processor, and will ignore one if present.) Rend386 is available via anonymous FTP, but a better source is the floppy included with the book "Virtual Reality Creations", by Roehl, Stampe, and Eagan. Bernie Roehl and Dave Stampe are the original creators of Rend386, and their book provides the best documentation for the program, as well as some good tutorials concerning the basics of virtual reality, a number of support utilities that are useful for building virtual worlds, and numerous sample worlds.

Rend386 allows the user to construct their own virtual worlds, merely by describing the geometry of their objects in simple data files. Numerous sample worlds and extensive documentation make this a relatively simple task, depending of course on the level of complexity of the geometry involved. Numerous utility programs are available for constructing simple geometrical shapes, such as cylinders, spheres, and objects of revolution, and for manipulating the resulting objects (combining, stretching, inverting, etc.) No programming skills are required, though a firm grasp of three dimensional geometry is helpful. (An appendix in the aforementioned book provides a good refresher for those who are rusty in this respect.)

In addition to simply defining objects, (including their color, material, and other properties), Rend386 also supports animation, i.e. moving objects. An early prototype for a virtual chemical plant developed with Rend386 included a CSTR with a moving stirrer. If the user got too close, the stirrer would grab on and spin the user around the tank! Although Rend386 does not require any special hardware, a number of peripheral devices are supported, including the Sega LCD shutter glasses and Nintendo PowerGlove described below.

Additional Software Choices

There are a number of other software packages available for implementing virtual reality, and an increasing number of them run on ordinary personal computers. Most of these do not require any particular special hardware, but do support various items of low-cost hardware if you have them. In general, the more costly the software, the more costly the hardware supported by that software. Some of the more popular low-cost virtual reality programs are VREAM, Virtual Reality Studio, Vistapro, Virtus Walk Through, and Superscape VRT. For full descriptions of these and other programs, including purchasing information and a number of free demo versions, see the books listed in the bibliography. One program not covered in the books, but available via anonymous ftp to qualified individuals is MR Toolkit. Contact lloyd@cs.ualberta.ca for more information concerning this package, or better yet, visit the web site http://web.cs.ualberta.ca/graphics/MRToolkit.html.

The software development package that we have chosen for most of our VR development work is WorldToolKit, (WTK), from Sense8 corporation. The main factor influencing our decision was the wide range of platforms supported. There are versions of WTK available for MS Windows, DOS, Silicon Graphics, and numerous platforms in between. The Windows version only requires a math co-processor, i.e., a 486 or above. The DOS version also requires a special graphics board, the SPEA Fire RISC board, available for $1800 from Sense8. This graphics card and its associated monitor are in addition to the regular VGA card and monitor that a PC would normally have.
WorldToolKit is actually a library of C language routines, along with a few support files and demo programs. In order to use WTK, one must have C programming skills and an appropriate compiler / linker. Other supporting programs, such as AutoCAD and photo management utilities, can be very useful for developing the objects and images necessary to populate a virtual world.

Additional Hardware Options

Other than an adequate personal computer, and the special graphics card required for the DOS version of WTK, most low-cost VR development packages do not require any special hardware. On the other hand, most of them do support various hardware items if you happen to have them or are willing to buy them. Some of these additional peripherals include LCD shutter glasses, other 3-D viewing devices, 3-D audio cards, and head-mounted display units.

Alternate Input Devices

Recall that the driving force behind virtual realty is to produce a world as realistic as possible, into which the user can become so immersed as to forget that it is just a simulation. Using a keyboard to navigate such a world is completely counterproductive to this underlying goal, even if the keyboard commands are simple and straightforward. To produce a truly immersive environment requires a navigation device that is as intuitive as possible, one that a user can implement without thinking about or even realizing what he is doing. This is especially true when head-mounted displays or other devices are being used which restrict access to the outside world. To this end, mice make better navigation tools than keyboards, but joysticks are better yet. At $13 for the joystick and $10 for the game card, there is no reason not to have this peripheral for VR applications. (Don't let their resemblance to a child's toy inhibit you on this point; Joysticks add immensely to the navigability and thereby the effectiveness of a virtual world.)
There are a wide variety of other input devices which have been used with virtual reality, either extensively or experimentally. Two of the more common ones are 6 degree-of-freedom (DOF) mice and forceballs. 6 DOF mice have six degrees of freedom, three translational and three rotational, which allow the user to pick the mouse up off the table and manipulate objects in three dimensional space. (A variation, the wand, resembles the light pen used by many public speakers.) Forceballs are similar to joysticks, but like 6 DOF mice, they also respond to three translational and three rotational degrees of force, and are generally ball shaped. Special purpose devices are widely varied, such as bicycles, golf clubs, and wheelchairs. A more common and well known virtual reality input device is the wired glove.

Wired Gloves

A wired glove is a device, worn by a user, that contains sensors for measuring hand location and position, and finger and thumb movement. This allows the computer to track a user's hand and finger movements, thereby allowing a user to point to objects, pick up and move objects, and in general interact "manually" with the virtual environment. Rend386 supports the Nintendo PowerGlove, which was once manufactured by Mattel, but is unfortunately no longer manufactured. PowerGloves have been available in scattered Toys-R-Us stores, (often in a back room, not on display), for around $30 or so. Alternatively they are occasionally sold on the Internet for negotiable prices, typically between $30 and $100. In true homebrew fashion, you must rig up your own wiring for the PowerGlove, (Eglowstein, 1990), or there are connection boxes available from various sources. (Jacobson, 1994) Higher quality wired gloves are also available, at a cost of thousands to tens of thousands of dollars. These high-quality gloves track finger movement via fiber-optic technology, or for even greater accuracy, mechanical linkages (Eglowstein, 1990). Extremely expensive virtual reality setups may incorporate entire suits of wired clothing.

3-D Viewing Devices

There are many different cues that indicate to the human mind how far away something is, including size, parallax, level of detail, relative motion, and others. By far the most important depth cue is stereoscopic vision, produced by the left eye having a slightly different viewpoint from the right. Good software can handle all of the first items mentioned, but true stereoscopic vision also requires the use of special hardware.

An inexpensive stereoscopic option is the Cyberscope at $80. This device, which attaches to the front of the monitor, splits the screen image in two, and presents the left half to the left eye, and the right half to the right eye. Because the human eye has a wider range of vision horizontally than vertically, the Cyberscope also rotates the images 90° using mirrors, and the software must, of course, produce the proper screen images for the device. More elaborate and generally more effective stereoscopic vision is produced by LCD shutter glasses and stereoscopic head-mounted display units, as described below.

It should be noted that stereoscopic vision is not always required for effective VR. There are many other ways to make the user believe what they are seeing is real, and in virtual reality, as in magic, it is what the viewer believes that counts, not what they actually see. With head-mounted displays in particular, most users report seeing stereoscopic 3D images, even when using a monoscopic device.

LCD Shutter Glasses

Rend386 supports stereoscopic vision through the use of low-cost LCD shutter glasses. The basic principle behind shutter glasses is that the computer alternates displaying the left-eye image and then the right-eye image on the same screen, while at the same

time the glasses use LCD shutters to alternately block the vision of the right eye and then the left eye in sync with the changing screen images. The net result is that the left eye sees only the left-eye image and the right eye sees only the right-eye image. In the case of Rend386, the LCD glasses that are supported are known as Sega glasses, since they were originally manufactured by Sega, or Toshiba glasses, who also manufactured them for awhile. The problem is that neither manufacturer is still making them, which means that the thing to do is to find a supplier who still has some. Over the last few years the going price for these goggles has risen from $70 to $250, as their popularity has increased and supplies have dwindled. At last report 3DTV corporation, (P.O. Box Q, San Rafael, CA 94913-4316, (415) 479-3516), still had some of these glasses available.

There are some pros and cons of the Sega glasses as opposed to alternative LCD shutter glasses that are currently being produced (Crystal Eyes glasses described below). The advantages of the Sega glasses are that they are inexpensive, use an ordinary computer/monitor combination, and happen to be the only ones supported by Rend386. The disadvantages are the dwindling availability, the fact that they cut the effective frequency in half, thereby producing a noticeable "flicker," hence the other name for these glasses -- flicker glasses, and the fact that you must wire your own circuit to connect them to a serial port. The circuit is fairly simple and entails about $30 worth of Radio Shack parts and some simple soldering skills. Instructions for building this circuit are available from many sources, including (Stampe, 1993).

A higher quality though more costly implementation of LCD shutter glasses are Crystal Eyes from StereoGraphics corporation in Sausalito, CA. While the principal is the same, there are a few critical differences between the Crystal Eyes and Sega glasses. First of all, the synchronization of the Crystal Eyes glasses is handled via an infra-red signal rather than a serial wire. This means that (1) there is no circuit to be wired up by the user, (2) the user is unencumbered by a tether wire, and (3) multiple participants can view the 3-D effect simultaneously, limited only by the number of pairs of eyewear purchased and the number of people who can simultaneously crowd around the same monitor. (StereoGraphics also sells products for displaying 3-D images to large audiences, via special projectors and polarized eyewear.) Crystal Eyes glasses work by *doubling* the vertical refresh rate of the video signal, which has the advantage of reducing the distracting flicker sometimes associated with LCD glasses, and the disadvantage of requiring a more expensive monitor, capable of handling the higher vertical sync frequency. Crystal Eyes glasses normally run from $1000 to $1300 for the PC platform, though a recent show special had them priced below $500.

Head-Mounted Displays

As the name suggests, the head-mounted display (HMD) is a display unit that the user wears on his head. The immediate benefits of this display are that the user is no longer confined to the computer monitor, and the sensory deprivation factor: when the user can no longer see the real world, he becomes much more immersed in the virtual one. In addition, HMDs are generally used in conjunction with a head tracking device, which informs the computer of the current position and orientation of the user's head. Whenever the user turns his head to look in a new direction, the computer adjusts the displayed image to show whatever is in that direction in the virtual world. The net result is a highly believable cause-and-effect relationship between the user's movements and the displayed image.

Head-mounted displays can be either monoscopic or stereoscopic, and generally range in price from $3000 to $8000, though at the low end there are a few HMDs available for under $500, and at the high end the military has some that cost over a million dollars. HMDs generally take a television (NTSC) type signal instead of a computer video (VGA) signal, which necessitates the use of a RGB to NTSC converter of some kind. This usually results in some loss of image quality, as the TV standard does not support either the color depth or the resolution of today's modern computer video signals. (The HMDs use a TV signal because they are based upon the screens developed for camcorder viewfinders.) HMDs are limited by the weight that can be worn comfortably by the average user. Boom-mounted displays do not have this problem, and offer much better image quality at a correspondingly higher price. Monoscopic HMDs can be used with any software, (including non-VR applications), since the converter box converts the ordinary VGA signal, or they can be used to watch television signals. Stereoscopic HMDs require two separate video signals, such as produced by a computer with two video cards, or two computers working in parallel. HMDs are most effective when used in conjunction with a head tracking device.

Head Trackers

Head trackers are devices that keep track of the position and orientation of the user's head, so that the computer can update the video image when the user looks around. The three methods most commonly used for head tracking are mechanical, acoustical, and electromagnetic. Mechanical trackers are generally incorporated into expensive boom-mounted display devices. The low-cost option is the acoustic approach for about $700 from Logitech. This method places three small speakers, emitting ultrasonic pulses, in a triangle above the user, and three small microphones attached to another triangle on the users head. By measuring the relative intensity of the three sound sources from the three microphones, the system is able to determine the position and orientation values. Drawbacks are the intrusive nature of the speaker unit, and the low accuracy and range of the system.

Electromagnetic trackers are preferable, but carry a higher price tag. These devices work by using three mutually orthogonal wire coils in a baseball sized transmitter, and three similarly arranged coils in a receiver about the size of a cherry. Current is pulsed alternately through the three transmitter coils, and the current induced in the three receiver coils by the resulting magnetic pulses is measured, yielding nine measurements that are used to determine the position and orientation values. This system was originally developed by Polhemus, who makes an alternating current version, though the direct current version manufactured

by Ascension Technology is purported to be more accurate and have fewer interference problems.

Other head tracking methods that have been used include gyroscopic devices and the monitoring of blinking LEDs via multiple cameras, where either the LEDs or the cameras are mounted to the user's head and the other to the ceiling. The advantage of the latter system is that it provides the user with complete mobility within a room sized area, at a rather high cost. Head trackers can, of course, be used to track other moving objects, such as the user's hand when using a wired glove.

Coming in Part Two

Part two of this paper will look at applications of virtual reality, starting with general applications, and then addressing applications of virtual reality to chemical engineering. In particular, Vicher™, the virtual-reality-based educational simulation being developed in the Chemical Engineering department at the University of Michigan will be covered. The article will conclude with a discussion of the additional sources of virtual reality information that are available besides the bookstore.

Additional Information

Obviously there is much more to virtual reality than can be included in a report of this size. The products, applications, and research efforts that have been mentioned are only a few of the hundreds available. There are many good sources of additional information available, starting with those listed in the bibliography.

For those who have access to the Internet, or Usenet, there is much information on-line. First of all, there is a news group, *sci.virtual-worlds*. This newsgroup includes active discussions of current topics by active members in the field, as well as helpful questions and answers. Secondly, there are several active ftp sites, where interested parties can anonymously download hundreds of Megabytes of useful information.

One such ftp site is *ftp.u.washington.edu*. One of the host computers for the *sci.virtual-worlds* newsgroup, this ftp site contains an archive of several years worth of news messages, as well as several faq (frequently asked questions) files, and other information. For beginning searchers, faq files are generally the best first step. Highly recommended as a starting point is "Meta-FAQ", in the *public/virtual-worlds* directory on *ftp.u.washington.edu*. The University of Washington is also home to the Human Interface Technology (HIT) Laboratory, one of the leading sites for virtual reality development.

Another excellent ftp site is *sunee.uwaterloo.ca*. Rend386 was developed by Bernie Roehl and Dave Stampe of that institution, and so it is the logical archive site for the Rend386 programs as well as many utilities and worlds developed by others and submitted into the public domain. Get the readme files first to avoid downloading unnecessary files. Other VR information can be obtained from *sunsite.unc.edu* (UNC Chapel Hill info), and *wuarchive.wustl.edu* (Washington University in St. Louis, a generally good VR site.) Reading the faq files and other information available at these sites will lead to other sources of information as well.

For Web surfers, there are WWW sites on virtual reality too numerous to mention. An excellent starting point is *http://www.hitl.washington.edu/project/knowledge_base*, and in particular, follow the thread from there to "On The Net: Internet Resources in Virtual Reality." That alone will provide an overwhelming amount of information.

Bibliography

Aukstakalnis, Steve and Blatner, David, "Silicon Mirage: The Art and Science of Virtual Reality", Peachpit Press, 1992.

Eglowstein, Howard, "Reach Out and Touch Your Data", BYTE, July 1990.

Jacobson, Linda, "Garage Virtual Reality", Sams Publishing, 1994.

Larijani, L. Casey, "The Virtual Reality Primer", McGraw Hill, 1994.

Pimentel, Ken and Teixeira, Kevin, "Virtual Reality: Through the New Looking Glass", Windcrest Books, 1993.

Stampe, Dave, Bernie Roehl, and John Eagan, "Virtual Reality Creations", The Waite Group, 1993.

Wodaski, Ron, "Virtual Reality Madness", Sams Publishing, 1993.

MEETINGS AND CONFERENCES

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, 615-229-3069, 615-229-4558 (FAX), siirola@emn.com.

Workshop on Noninvertible Dynamical Systems: Theory, Computation, Applications
Minneapolis, Minnesota
March 13-17, 1995

A workshop on Noninvertible Dynamical Systems is being organized by Yannis Kevrekidis, Richard McGehee, Christian Mira, Leonid Shil'nikov, and Raymond Adomaitis to be held at the Geometry Center of the University of Minnesota March 13-17, 1995. Noninvertible systems arise in a number of applications, from numerical analysis, engineering, biology and economics to the modeling of systems involving discrete-time decisions. Specific examples include the breakdown of numerical integrators; discrete-time modeling of nonlinear time series using artificial neural networks; instabilities in asynchronous parallel computation; electronics circuits with switching elements; dynamics of adaptive and model-based control systems; some

modulators in signal processing; and discrete-event manufacturing processes. The mathematical theory of these systems is currently under development, and numerical experiments are crucial in both exploration of the rich new phenomenology and guidance of theoretical studies. One of the workshop's ambitions is to establish a link and a common terminology between the rapidly expanding numerical observations, the theory and the applications. Papers discussing basic theoretical tools of noninvertible maps (study of the phase and bifurcation spaces), numerical algorithms, instabilities particular to noninvertible systems, chaotic dynamics generated by noninvertible maps), as well as particular applications will be presented. For additional information, please contact Workshop Coordinator, The Geometry Center, Suite 500, 1300 S. Second St., Minneapolis, MN 55454, 612- 612-626-0888, 612-626-7131 (FAX), admin@geom.umn.edu.

Hyprotech Inc.
1995 Seminars and Workshops

A series of identical new product seminars that introduce HYSIS: The Future of Process Modeling. Seminars will be held in Los Angeles (March 7, 1995), San Francisco (March 9), Chicago (March 13), Cleveland (March 14), Parsippany NJ (March 27), Princeton NJ (March 28), Philadelphia (March 28), New Orleans (April 4), Baton Rouge (April 7), and Tulsa OK (April 11). For additional details, contact Jeanine Voss, Hyprotech, 11490 Westheimer, Suite 750, Houston, TX 77077-6841. Phone, 713-870-1900. FAX, 713-870-1039.

Hyprotech also offers the following workshops: "Overview of Hysim" (Jan 31 - Feb 1, March 28-29, May 9-10, and June 13-14); "Intermediate HYSIM" (Feb 21-22); "Simulation of Oil Refining Processes" (Apr 18-20); and "Computer-Aided Process Design: Oil and Gas Processing" (March 1-4).

Noninvertible Dynamical Systems: Theory, Computation, Applications (workshop)
The Geometry Center, University of Minnesota, Minneapolis
March 14-18, 1995

Noninvertible systems arise in a number of applications, from numerical analysis, engineering, biology and economics to the modeling of systems involving discrete-time decisions. Specific examples include the breakdown of numerical integrators; discrete-time modeling of nonlinear time series using artificial neural networks; instabilities in asynchronous parallel computation; electronics circuits with switching elements; dynamics of adaptive and model-based control systems; some modulators in signal processing; and discrete-event manufacturing processes. The mathematical theory of these systems is currently under development, and numerical experiments are crucial in both exploration of the rich new phenomenology and guidance of theoretical studies. One of the workshop's ambitions is to establish a link and a common terminology between the rapidly expanding numerical observations, the theory and the applications. Papers discussing basic theoretical tools of noninvertible maps (study of the phase and bifurcation spaces), numerical algorithms, instabilities particular to noninvertible systems, chaotic dynamics generated by noninvertible maps, as well as particular applications will be presented. For further details, please contact: Workshop Coordinator, The Geometry Center, 1300 South Second Street, Suite 500, Minneapolis, MN 55454. FAX: 612-626-7131. Email: *admin@geom.umn.edu* .

1995 AIChE Spring National Meeting
Houston, Texas
March 19-23, 1995

CAST is sponsoring the following sessions at the Houston National Meeting:

Area 10a: Systems and Process Design

1. Design and Analysis.
2. Process Synthesis.
3. Batch Process Design and Scheduling.
4. Electronic Process Data Exchange -- Tutorial Review of the PDXI Project.

Joint Area 10a and Area 10c Session

1. Emerging Technologies in Process Design and Synthesis.

Joint Area 10a and Area 16e Session

1. Design for Waste Minimization.

Area 10b: Systems and Process Control

1. Economic Benefits of Process Control.
2. Novel Applications in Process Control.
3. Applications of Statistics in Process Control.
4. Control Strategies and Integration of Design and Control.

Joint Area 10b and Area 1b Session

1. Contributions Honoring Frank R. Groves, Jr.

Area 10c: Computers in Operations and Information Processing

1. Developments in Supply Chain Design and Optimization.
2. Process Operator Training.
3. Automated Supervision of Processes.

Joint Area 10c and Area 9d Session

1. Process Systems Engineering for Environmental Applications.

First International Plant Operations and Design Symposium

Also at the 1995 AIChE Spring National Meeting, CAST is cosponsoring a block of sessions being organized by the South Texas Section and cosponsored by the ISA Houston Section focusing on practical solutions to process plant needs. Sessions in Computing and Advanced Process Control are expected to include:

1. Case Histories of Dynamic Simulation for Plant Operations and Start-up Improvement.
2. Applications of Computer Integrated Manufacturing.
3. Applications of Advanced Process Control and Analysis.
4. Computing and Advanced Process Control Program Demonstration.
5. Using Computers to Improve Project Productivity.
6. Design and Analysis of Process Plants.
7. Waste Minimization and Design.
8. Process Simulation Tutorial
9. Process Simulation in Refining.
10. Integrating Pollution Prevention into Process Design.
11. Advancements in Instrumentation and System Design.

1995 SCS Simulation Multiconference
Phoenix, Arizona
April 9-13, 1995

Cosponsored by CAST Division

The 1995 Simulation Multiconference brings several conferences together providing a variety of formats for presenting and learning about aspects of simulation and simulators. Of special interest should be conferences on Simulation in Petrochemical, Chemical, and Manufacturing Industries, Computer Simulation in Industrial and Process Simulators, Computer Simulation in Waste Management and Environmental Sciences, High Performance Computing, and Visualization, Validation, and Verification of Computer Simulations. In addition there will be conferences on Mission Earth, Military, Government, and Aerospace Simulation, and Simulators for Emergency Management.

Topics of interest in industrial and process simulators include many CAST- related areas including process design, process control, plant simulation, operations and information processing, applied mathematics, and artificial intelligence in process engineering. For further information contact the Industrial and Process Simulation chair Maurice J. Ades, Westinghouse Savannah River Company, Aiken, SC 29803 or the overall conference chair Ariel Sharon, c/o The Society for Computer Simulation, PO Box 17900, San Diego, CA 92177- 7900, 619-277-3888, 619-277-3930 (FAX).

Analysis and Design of Event-Driven Operations in Process Systems
London, United Kingdom
April 10-11, 1995

Over the last decade, a number of researchers in the process systems community have approached the problem of modeling, analysis, verification and synthesis of event-driven or hybrid operations. Typical problems of this nature arise in plant start-up/shut-down, emergency operating procedures, and batch operations. These are key aspects in the development of plant automation systems. However, there is no well established theoretical framework comparable to that existing for the design and analysis of continuous feedback control systems. The main difficulty with these systems is their event-driven characteristics, which complicate their modeling and analysis. Researchers have therefore explored the use of a number of different methods and tools, such as logic-based planning, Petri nets, mixed integer optimization and automata theory. Some of these approaches are mainly theoretical, while others are oriented to specific applications. The similarities and differences between the approaches adopted and their applicability to practical problems are often difficult to establish.

A workshop on the analysis and design of event-driven operations will be held in the Centre for Process Systems Engineering at Imperial College on April 10-11, 1995. The aim of the workshop is to bring together researchers and practitioners interested in the control and operation of event-driven chemical industry processes so as to establish the current state of the field, future trends, and to identify applications in the process industry as well as benchmark case studies. Sessions are planned on modeling and simulation, analysis and verification, design and synthesis, industrial applications, and available tools and software. For more information, contact the workshop secretariat Diana Goreham, Centre for Process Systems Engineering, Imperial College, London SW7 2BY, UNITED KINGDOM, 44-71-694-6609, 44-71-594-6606 (FAX), d.goreham@ic.ac.uk.

Third SIAM Conference on Control and Its Applications
St. Louis, Missouri
April 27-29, 1995

The Third SIAM Conference on Control and Its Applications will be held at the Adam's Mark Hotel, St. Louis, April 27-29, 1995. The conference will be organized around several major themes chosen to highlight both significant recent developments and challenging open questions in control theory, systems theory, and their scientific, engineering, and industrial applications. The major themes of the conference will include control of large heterogeneous computer networks, control in dynamics and mechanics, convex optimization in control and systems theory, control and identification of distributed parameter systems, stochastic control filtering and estimation, adaptive control, hybrid event systems, discrete event systems, robust control, industrial and aerospace applications, nonlinear systems, dynamic programming, computational and algorithmic methods in control, and control of fluids. For further information, contact SIAM, 3600 University City Science Center, Philadelphia, PA 19104-2688, 215-382-9800, 215-386-7999 (FAX), meetings@siam.org.

Control of Particulate Processes IV
Kananaskis, Alberta
May 14-19, 1995

This meeting will address three important areas of particulate processing: process technology, measurement techniques, and

process control. In particular, papers have been solicited on the analysis and synthesis of mechanisms and the understanding of systems for particle formation, growth, breakage, settling, etc. in a number of operations including crystallization, precipitation, nucleation, atomization, etc. Papers have also been solicited in the areas of measurement of powder characteristics using off-line and on-line instrumentation to determine bulk and individual particle properties, sampling techniques, and simulation techniques, parameter estimation, system identification, physical modeling, and AI, neural net, and expert systems approaches to particulate process control. For further information, contact Hani Henein, Advanced Materials and Processing Laboratory, University of Alberta, Edmonton, Alberta T6G 2G6, CANADA, 403-492-7304, 403-492-0704 (FAX), henein@alloy.mineral.ualberta.ca.

Symposium on Process Control, Diagnostics, and Modeling in Semiconductor Manufacturing
Spring Electrochemical Society Meeting
Reno, Nevada
May 21-26, 1995

This symposium is part of the Spring Electrochemical Society Meeting and is aimed at bringing together the technical community involved in various aspects of process control, process diagnostics, and modeling in semiconductor manufacturing. Topics related to automation, for example computer controlled feedback and feedforward of information for controlling a single process, or a series of processes, will also be highlighted. Processes of interest include, but are not limited to, CVD, PVD, PECVD, etching, RTP, cleaning, and lithography. Topics include control methodologies, modeling approaches, and in situ measurement techniques. For additional information, contact the symposium organizers M. Mayyappan, Scientific Research Associates Inc., PO Box 1058, Clastonbury, CT 06033, 203-659-0333, 203-633-0676 (FAX), meyya@srai.com, D. J. Economou, Department of Chemical Engineering, University of Houston, Houston, TX 77204-4792, 713-743-4320, economou@uh.edu, or S. W. Butler, Texas Instruments, PO Box 655012 MS 944, Dallas, TX 75265, 214-995-4241, butler@spdc.ti.com

Process Modeling and Optimization in Process Design and Operation (short course)
Carnegie Mellon University, Pittsburgh
June 4-9, 1995

Please seen the advertisement in this section of the newsletter.

Fourth IFAC Symposium on Dynamics and Control of Chemical Reactors, Distillation Columns, and Batch Processes (DYCORD+ '95)
Helsingor, Denmark
June 7-9, 1995

DYCORD+'95 (Dynamics and Control of Reactors, Distillation Columns and Batch Processes), organized by the Danish Automation Society, will be held June 7-9, 1995 in Helsingor, Denmark. Main topics include dynamic modeling, model verification and calibration, simulation, new control methods, applicability of control methods, experiments with distributed control systems, multivariable quality control, optimization methods, minimization of feed and utility costs, and computer-aided process and plant design. For further information, contact the international program committee chair James B. Rawlings, Department of Chemical Engineering, University of Texas, Austin, TX 78712-1062, 512-471-4417, 512-471-7060 (FAX), dycord@che.utexas.edu or the Danish Automation Society, Copenhagen Science Park Symbion, Fruebjergvej 3, DK-2100 Copenhagen O, DENMARK, 45-3917-9980, 45-3120-5521 (FAX), symbjeba@inet.uni-c.dk.

Second International Conference on Industrial Automation
Nancy, France
June 7-9, 1995

The second international conference on industrial automation will be sponsored by ISA and the International Association for Industrial Automation. The purpose of the conference is to allow scientific researchers, teachers, and engineers to meet, present their works, inquire into recent developments in industrial automation, and to define future directions of research. Communications presenting original work in all aspects of theory and practice will be welcomed. Main topics include diagnosis, process control, manufacturing, artificial vision, and biomedical engineering. Contributions are especially solicited which deal with automation engineering, information and communication technology, man-machine management technology, systems design and engineering, and education. For more information, contact Secretariat 2eme Conference Internationale sur l'Automatisation Industrielle, CRAN-ESSTIN, Rue Jean Lamour, 54500 Vandoeuvre-les-Nancy, FRANCE, 33-83-50-33-64, 33-83-57-80-25 (FAX), congres95@esstin.u-nancy.fr.

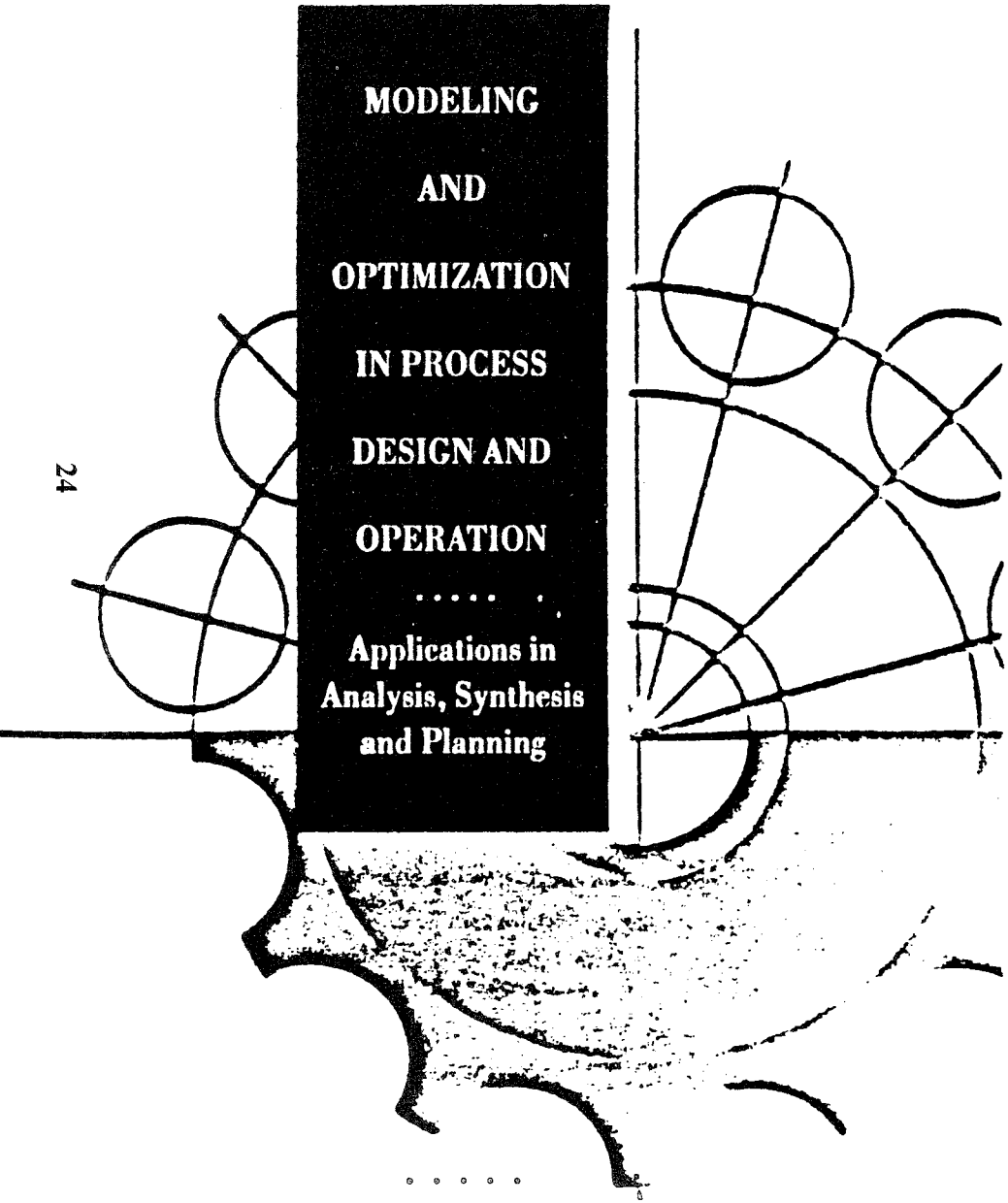
ESCAPE-5
Bled, Slovenia
June 11-14, 1995

The ESCAPE symposia series is organized annually by the Computer Aided Process Engineering Working Party of the European Federation of Chemical Engineers. ESCAPE-5, in collaboration with the engineering branch of the Slovenian Chemical Society, will be held in Bled, Slovenia on June 11-14, 1995. ESCAPE-5 will give special emphasis to process synthesis, integration, design, and retrofit; process flowsheeting, simulation, optimization, and process data estimation, reconciliation, and management; process dynamics, safety, and control; process operation, economics, and computer integrated manufacturing; computing, graphics, and numerical methods; and expert systems, artificial intelligence, logic, and neural networks in process systems engineering. For more information, contact the conference secretariat Dr. Kravanja, Department of Chemical Engineering, University of Maribor, Smetanova 17, PO Box 224, SLO-62001 Maribor, SLOVENIA, 38-62-25-461 x-648, 38-62-227-774 (FAX), escape5@uni-mb.si.

CARNEGIE MELLON UNIVERSITY

ENGINEERING DESIGN RESEARCH CENTER

Computer-Aided Process Design Laboratory



Process, Modeling and Optimization in Process Design and Operation

Pittsburgh, PA
June 4-9, 1995

The Engineering Design Research Center of Carnegie Mellon University is conducting research into new concepts, methodologies and computer tools that can be used to improve productivity in process design and optimization. The EDRC offers this six-day course in conjunction with the Computer-Aided Process Design Laboratory. This course stresses the application of recently developed design concepts and optimization-based strategies to practical process problems. Topics covered in this course include nonlinear programming and mixed integer nonlinear programming, modeling environments for simulation and optimization, concepts and algorithmic methods for process synthesis, and batch process design and scheduling. Instructors for the course are Art Westerberg, Ignacio Grossmann and Larry Biegler.

The advance registration fee through March 31, 1995, is $1600. All instructional materials, background materials, manual of notes, a copy of " Chemical Engineering Optimization Problems with GAMS" which includes software for IBM-PC, computer use, continental breakfasts and a closing lunch are included in the fee.

To register or to request more information, you may contact Toni McIltrot at the Chemical Engineering Department of Carnegie Mellon University at (412) 268-3573 or by fax at (412) 268-7139 or by E-mail at TM2L@andrew.cmu.edu.

IFAC Workshop on Fault Detection and Diagnosis in the Chemical Industries
Newcastle upon Tyne, United Kingdom
June 12-13, 1995

For information on this fault detection workshop, contact Professor A. J. Morris, Department of Chemical and Process Engineering, University of Newcastle upon Tyne, Newcastle NE1 7RU, UNITED KINGDOM, 44-91-222-6000, 44-91-261-1182 (FAX), julian.morris@newcastle.ac.uk

1995 American Control Conference (ACC)
Seattle, Washington
June 21-23, 1995

Cosponsored by the CAST Division

The American Automatic Control Council will hold the fourteenth American Control Conference June 21-23, 1995 at the Westin Hotel in Seattle, Washington. Held in cooperation with the International Federation of Automatic Control (IFAC), this conference will bring together people working in the fields of control, automation, and related areas from the American Institute of Aeronautics and Astronautics, American Institute of Chemical Engineers, American Society of Mechanical Engineers, Association of Iron and Steel Engineers, Institute of Electrical and Electronics Engineers, Instrument Society of America, and the Society for Computer Simulation.

Both contributed and invited papers will be included in the program. The ACC will cover a range of topics relevant to theory and practical implementation of control and automation. Topics of interest include, but are not limited to robotics, manufacturing, guidance and flight control, power systems, process control, measurement and sensing, identification and estimation, signal processing, modeling and advanced simulation, fault detection, model validation, multivariable control, adaptive and optimal control, robustness issues, intelligent control, expert systems, neural nets, industrial applications, and control education.

CAST-sponsored sessions include:

1. Nonlinear Process Modeling and Control (Henson/Arkun)
2. On Line Process Monitoring (Qin/Braatz)
3. Process Control Applications to Batch Reactors (Palanki/Bagdwell)
4. Biomedical Control Applications (Doyle/Pottman)
5. Industrial Applications of Nonlinear Process Control (Daoutidis/Souroush)
6. Integration of Modeling, Identification, State Estimation, and Control (Lee/Crisalle)
7. Process Control Education (Ogunnaike)
8. Plant Wide Control (Allgower/Downs)

For further information, contact the general chair Masayoshi Tomizuka, Department of Mechanical Engineering, University of California, Berkeley, CA 94720, 510-642-0870, 510-643-5599 (FAX), tomizuka@euler.berkeley.edu. The AIChE review chair is James B. Rawlings, Department of Chemical Engineering, University of Texas, Austin, TX 78712-1062, 512-471-4417,512-471-7060 (FAX), jbraw@che.utexas.edu.

Third IFAC Symposium on Nonlinear Control Systems Design (NOLCOS 95)
Tahoe City, California
June 26-28, 1995

Sponsored by the International Federation of Automatic Control Technical Committee on the Mathematics of Control and organized by the American Automatic Control Council and the Institute of Theoretical Dynamics, University of California, Davis.

This symposium will present the state of the art in the design of nonlinear control systems. It will explore current theoretical developments as well as their latest applications to engineering problems. The symposium will provide a forum for the presentation and discussion of papers which describe new design methodologies for the control of nonlinear plants and will feature novel applications of these methods. The program will include invited survey papers by leading international authorities and encourage wide ranging discussions by all participants on basic problems and future directions. The range of topics to be discussed includes applications of nonlinear control, algebraic theory of nonlinear systems, geometric theory of nonlinear systems, discrete-time nonlinear control systems, stability and feedback stabilization, nonlinear observers and filters, optimal control of nonlinear systems, variable structure systems, robust and H-Infinity control, adaptive control of nonlinear systems, singular perturbations in nonlinear control, expert control for nonlinear systems, and computational methods for design and control. For further information, contact David Q. Mayne, Institute for Theoretical Dynamics, University of California, Davis, CA 95616-8618, 916-752-8832, nolcos@itd. ucdavis.edu.

Intelligent Systems in Process Engineering (ISPE '95)
Snowmass Village, Colorado
July 9-14, 1995

Cosponsored by CAST Division and CACHE Corporation

The first International Conference on Intelligent Systems in Process Engineering is scheduled for July 9-14, 1995 at Snowmass Village, Colorado. The objectives of this conference are to bring together a diverse group of people with interests in modeling and simulation, design, operations and control, process management, computer science and technology, operations research, statistics, and systems and control theory, all of which are components in the solution of process engineering problems; to present the state-of-the-art developments (theoretical and

practical) in intelligent systems for various areas of process engineering; to discuss the experiences gained from numerous applications of intelligent systems in the process industries; and to provide a forum for in-depth discussions between researchers and practitioners on the theoretical and practical challenges in developing and deploying intelligent systems in industry.

Conference themes include Monitoring, Analysis, and Support of Process Operations (monitoring, analysis, and interpretation of process data; process fault diagnosis and computer-aided diagnostic advisors; supervision and decision support of process operations); Intelligent Control (expert and fuzzy control; neural control; autonomous control); Intelligence in Integrated Manufacturing (logic and heuristics in optimal planning and scheduling; integrating control, planning, and scheduling in batch operations management; intelligent data management systems); Intelligence in Modeling and Computing (computer-aided modeling assistants; logic and combinatorial optimization; supervision of and learning from numerical computations); Knowledge-Based Product and Process Design (molecular knowledge-based product engineering; knowledge-driven approaches in process design; knowledge-based safety and HAZOP analysis in process engineering); Knowledge and CAD Environments in Engineering Design (cooperative engineering design; future CAD environments for process design; new approaches in CAD automation); Paradigms of Industrial Applications of Intelligent Systems in Process Engineering; and Future Prospects.

The conference is being organized by George Stephanopoulos, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, 617-253-3904, 617-253-9695 (FAX), geosteph@athena.mit.edu, Venkat Venkatasubramanian, School of Chemical Engineering, Purdue University, West Lafayette, IN 47907-1283, 317-494-0734, 317-494-0805 (FAX), venkat@ecn.purdue. edu, and James F. Davis, Department of Chemical Engineering, Ohio State University, Columbus, OH 43210-1180, 614-292-0090, 614-292-3769 (FAX), davis64@ osu.edu. For an attendance application, contact immediately the ISPE '95 Secretariat, CACHE Corporation, PO Box 7939, Austin, TX 78713-7939, 512-295-4498 (FAX), cache@utxvm.cc.utexas.edu.

3rd IEEE Mediterranean Symposium on New Directions in Control and Automation
Sheraton Hotel, Limassol, Cyprus
July 11-13, 1995

The 3rd Mediterranean Symposium is a continuation of the 1st and 2nd successful symposia that took place in Crete, Greece. The site for the 3rd symposium is chosen to be on the island of Cyprus, located in the east part of the Mediterranean Sea at the crossroads of three continents, Europe, Asia and Africa.

The central theme of the 3rd IEEE Mediterranean Symposium is control, automation with emphasis on the current theoretical developments as well as the latest applications to engineering problems. The purpose of having such a broad theme is to bring together researchers and engineers from different areas with overlapping interests to identify new problems and future directions in the area of control and automation. New and fast emerging technologies in the areas of transportation, environmental engineering, multimedia, robotics, manufacturing and others, open the way for new and unique applications of control and automation that will be addressed in the conference. The program will include invited survey papers by leading international authorities on several topics that cover the broad theme of the symposium. Early registration is before May 10, 1995. For further information, please contact the General Chairman: Petros Ioannou, Center for Advanced Transportation Technologies, University of Southern California, 3740 McClintock Avenue, Suite 200B, Los Angeles, CA 90089-2562. email: *ioannou@bode.usc.edu*

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.

Fifth IFAC Symposium on Automated Systems Based on Human Skill
Berlin, Germany
September 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
September 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. Manuscripts were due by February 1, 1995. 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.

Operations Research and Engineering Design
St. Louis, Missouri
October 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 to 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. 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
November 12-17, 1995

Meeting Program Chair: Tim Anderson, Department of Chemical Engineering, University of Florida, Gainesville, FL 32611, 904-392-0882, 904-392-9513 (FAX), tim@nervm.nerdc.ufl.edu.

The CAST Division is planning the following sessions at the Miami Beach Annual Meeting which have 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 is March 1, 1995.

Area 10a: Systems and Process Design

1. New Topics in Process Synthesis. Ka Ng, University of Massachusetts, (Chair) and Richard Colberg, Eastman Chemical Company (Co-Chair).

2. Advances in Process Synthesis. Oliver M. Wahnschafft, Aspen Technology, Inc. (Chair) and Urmila M. Diwekar, Carnegie Mellon University (Co-Chair).

3. Design and Analysis. Vivek Julka, Union Carbide Corporation (Chair) and Stratos Pistikopoulos, Imperial College (Co-Chair).

4. Advances in Process Design. Mahmoud El-Halwagi, Auburn University (Chair) and Amy R. Ciric, University of Cincinnati (Co-Chair).

Joint Area 10a and Area 10d Session

1. Computational Approaches in Systems Engineering. Antonis C. Kokossis, University of Manchester Institute of Science and Technology (Chair) and B. Eric Ydstie, Carnegie Mellon University (Co-Chair).

Joint Area 10a and Area 12a Session

1. Modeling and Simulation in Pilot Plants. Shiah Cherney, Chevron Research and Technology (Chair) and Reed L. Christiansen, Eastman Chemical Company (Co-Chair).

Area 10b: Systems and Process Control

1. Advances in Process Control. Ahmet N. Palazoglu, University of California - Davis (Chair) and David T. Dalle, Amoco Chemical Company (Co-Chair).

2. Nonlinear Process Control. Derinola K. Adebekun, Praxair, Inc. (Chair) and Masoud Soroush, Drexel University (Co-Chair).

3. Model Predictive Control. Jose Romagnoli, University of Sydney (Chair) and Thomas A. Badgwell, Rice University (Co-Chair).

4. Control System Performance Monitoring and Diagnosis. George N. Charos, Amoco Research Center (Chair) and Carlos E. Garcia, Shell Development Company (Co-Chair).

5. Control Relevant Identification and Estimation. Gerardo Mijares, M. W. Kellogg Company (Chair) and Richard D. Braatz, University of Illinois (Co-Chair).

6. Batch Process Modeling, Monitoring, and Control. Srinivas Palanki, FAMU/FSU College of Engineering (Chair) and Michael J. Henson, Louisiana State University (Co-Chair).

Joint Area 10b and Area 10c Session

1. Issues in On-Line Optimization for Control. Babatunde A. Ogunnaike, E. I. du Pont de Nemours & Company (Chair) and Alan B. Coon, Aspen Technology, Inc. (Co-Chair).

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) Venkat Venkatasubramanian, Purdue University (Chair) and Shinji Hasebe, Kyoto University (Co-Chair).

2. Planning and Scheduling. Patrick McCroskey, Dow Chemical Company (Chair) and Thanos Tsirukis, Air Products and Chemicals, Inc. (Co-Chair).

3. Computing for Plant Operations. Jorge A. Mandler, Air Products and Chemicals Inc. (Chair) and Lyle H. Ungar, University of Pennsylvania (Co-Chair).

4. High Performance Computing for Process Engineering. Mark A. Stadtherr, University of Illinois (Chair) and Stephen E. Zitney, Cray Research Inc. (Co-Chair).

Area 10d: Applied Mathematics and Numerical Analysis

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

2. Parallel Computing Applications in Chemical Engineering. Antony N. Beris, University of Delaware (Chair) and Sangtae Kim, University of Wisconsin (Co-Chair).

3. Chemical Engineering Applications of Stochastic Processes. Doraiswamy Ramkrishna, Purdue University (Chair) and Kyriakos Zygourakis, Rice University (Co-Chair).

4. Numerical Issues in Fluid Mechanics, Transport, and Materials Processing. Pedro Arce, FAMU/FSU College of Engineering (Chair), Andrew N. Hrymak, McMaster University (Co-Chair), and Jorge Vinals, FAMU/FSU College of Engineering (Co-Chair).

Joint Area 10d and Area 15d/e Session

1. Mathematical Models Applied to Cell Biology. Kyriakos Zygourakis, Rice University (Chair) and Douglas A. Lauffenburger, University of Illinois (Co-Chair).

Division-wide POSTER SESSION

1. Advances in Computing and Systems Technology. Michael L. Mavrovouniotis, Northwestern University (Co-Chair), James B. Rawlings, University of Texas (Co-Chair), Joseph F. Pekny, Purdue University (Co-Chair), and Hsueh-Chia Chang, University of Notre Dame (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).

Supercomputing '95
San Diego Supercomputer Center (SDSC)
December 4-8, 1995

Papers representing results and experiences related to high performance computing and communications will be presented at Supercomputing '95. Material will be original and not previously published. Topics include applications, algorithms, architecture, software, compilers, tools, archival storage, programming environments, programming techniques, trends, limitation, performance evaluation, system integration, networking, and visualization.

The World Wide Web (WWW) is the preferred tool that SC'95 will use for all activities. To encourage proposals for technical papers, education papers, panels, workshops, and tutorials in a WWW format, a two-week extension to the March 15, 1995 deadline has been given. That is, proposals submitted in PostScript, ASCII, and hard copy are due two weeks earlier than those submitted in WWW/HTML format. Upon request, the conference will assist presents in preparing their papers for the WWW. For information on acceptable formats or assistance, write *sc95 @ sdsc.edu* or call 1-619-534-5100 pr 1-800-nii-sc95. All final submissions and presentations are expected to be in a WWW format. Again, assistance, including converters, guidance for compatibility, and the conversion itself, is available for those who need help.

During SC'95, video projection, along with laptop-based computer equipment, will be the standard A/V technology for all rooms. Large-screen projection and laptop and workstation computers will be available in the major meeting

rooms. Major meeting rooms will also have networked access to local computers on the exhibition floor and to remote computers all over the world. Presenters will be able to access and display their research in a large, single-screen projection environment in real time. (A specially configured room, designed as part of the NII Testbed, is also available for special presentations.) If you have a strong interest in doing an on-line, networked-based presentation, please contact both the chair of your session and Tom DeFanti at *tom @ eecs.uic.edu* .

For further details about paper submission, please contact Jim Bottom, SC'95 Program Vice Chair, NCSA/University of Illinois at Urban Champaign, 605 E. Springfield Ave., Champaign, IL 61820. Phone, 217-244-0633. FAX, 217-244-8195. Email, *papers @ ncsa.uiuc.edu* .

NOTE BY EDITOR: Welcome to the new world of the "high-tech conference," of which Supercomputing '95 is a superb example. This is one *possible* future for AIChE meetings. It would be exciting to attend SC'95 simply to observe the new conferencing technology in action.

34th IEEE Conference on Decision and Control
New Orleans, Louisiana
December 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@nd.edu.

Computer Process Control V (CPC-V)
Tahoe City, California
January 21-26, 1996

Cosponsored by CAST Division and CACHE Corporation

The fifth Chemical Process Control Conference is tentatively scheduled for the third week of January, 1996 at Granlibakken Conference Center near Tahoe City, California. In the tradition of previous conferences in this series, CPC-V will focus on advances that have taken place recently in the process control field. These will be put in perspective, used to define practical needs and intellectual challenges in the area, and to help narrow the gap between process control theory and application. The organizers of this conference will be 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 and Carlos E. Garcia, Shell Development Company, POO Box 1380, Houston, TX 77251-1380, 713-493-8876, 713-493-8936 (FAX).

1996 AIChE Spring National Meeting
New Orleans, Louisiana
February 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. AIChE and the Meeting Programming Chair will finalize the sessions at the 1995 Programming Retreat in February, and any corrections will appear in the next issue of CAST Communications. A first call for papers for this meeting appears later in this issue. Deadline for submission of presentation proposals is August 11, 1995.

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).

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. Miguel J. Bagajewicz, Simulation Sciences Inc. (Chair) and Joseph F. Pekny, Purdue University (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, Flordia 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, Batch Process Technologies (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).

13th IFAC World Congress
San Francisco Marriott Hotel
June 30 - July 5, 1996
Pre-Congress Tutorial Workshops June 29-30, 1996

Hosted by the American Automatic Control Council; Co-sponsored by the AIChE

Technical Program

The technical program of the congress will feature: Plenary lectures, Regular Paper Sessions (contributed and invited sessions, sessions in lecture and poster format), Special Sessions and Lectures (survey papers/case studies, benchmark sessions/panel discussions.).

Congress Symposia and Technical Areas

All technical activities of the Congress, with the exception of the Plenary Lectures, will be organized in the form of Congress Symposia. The program of each symposium will be further subdivided into Technical Areas. The Congress Symposia titles are as follows:

1. Manufacturing and Instrumentation
2. Design Methods
3. Systems and Signals
4. Infrastructure and Resources
5. Systems Engineering and Management
6. Human Aspects of Automation
7. Industrial Applications
8. Transportation and Vehicles
9. Computer Control

A full list of the Technical Areas can be found in the formal Call for Papers. To obtain a printed copy of the Call for Papers, write to IFAC96, P.O.Box 111, Mabelton, GA 30059, USA. For an electronic copy, send e-mail to *ifac96@eecs.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 sessions on the implications of information technology, artificial intelligence, simulation, and process control on the future of the process industries. For further information, contact AIChE at 212-705-7373, 212-752-3297 (FAX).

1996 AIChE Annual Meeting
Chicago, Illinois
November 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 considering the following programming topics for the Chicago Annual Meeting. AIChE and the Meeting Programming Chair will finalize the sessions at the 1995 Programming Retreat in February, and the approved program will appear in the next issue of CAST Communications. Deadline for submission of presentation proposals is expected to be March 1, 1996.

Design and Analysis.
Synthesis and Analysis of Separation Systems.
Process Synthesis.
Special Topics in Design and Analysis.
Synthesis and Analysis for Safety and Environmental Concerns.
Thermodynamic Modeling and Property Computation for Chemical Process Design.
Process Design and Synthesis for Pharmaceutical Production.
Nonlinear Control.
Advances in Process Control.
Applications of Process Control.
Integrated Estimation and Control.
Plantwide and Decentralized Control.
Process Performance Monitoring.
On-Line Optimization and Control.
Modeling, Monitoring, and Control of Materials/Composites Manufacturing.
Optimization I - Methodology and Fundamentals.
Optimization II - Computer Integrated Manufacturing Applications.

Process Monitoring and Data Interpretation.
Large Scale Dynamic Modeling.
Intelligent Systems for Process Operations.
Nonlinear Dynamics and Pattern Formation.
General Papers in Applied Mathematics.
Novel Numerical Methods.
Inverse Problems.
Polymer Flow and Process Modeling.
Mathematical Modeling and Simulation in Bioengineering.
Advances in Computing and Systems Technology.

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

CALL FOR PAPERS

Final Call for CAST Sessions
1995 AIChE Annual Meeting
Miami Beach, Florida
November 12-17, 1995

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, Tim Anderson.

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 on the Proposal-to-Present Form for the Meeting Abstract Book.

Because of this centralized review and selection process, the deadline for receipt of proposals is ONE MONTH EARLIER than formerly:

March 1, 1995: Submit an abstract (camera-ready) on a completed original AIChE Proposal-to-Present Form, or electronically, and also six copies of an extended abstract of approximately 550 words for use by the selection panel to the corresponding CAST AREA CHAIR. It is appropriate to indicate for which session the contribution might best fit.

May 5, 1995: Session content is finalized authors are informed of selection.

September 11, 1995: Authors submit, if desired, any revision of their abstract (camera-ready) to AIChE for the Meeting Abstract Book.

October 13, 1995: Authors submit final manuscript to AIChE.

November 12, 1995: Speakers bring hardcopies of visual aids to be distributed to the audience at the presentation.

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.

Proposal-to-Present forms may be obtained from each session chair or directly from AIChExpress, 800-242-4363.

Area 10a: Systems and Process Design

NOTE: PLEASE SUBMIT PROPOSAL-TO-PRESENT FORM AND SIX COPIES OF AN ADDITIONAL EXTENDED ABSTRACT FOR ALL AREA 10A SESSIONS TO THE 1995 AREA CHAIR:

Michael F. Malone
Department of Chemical Engineering
University of Massachusetts
Amherst, MA 01003-0011
413-545-0838
413-545-1647 (FAX)
mmalone@ecs.umass.edu

1. New Topics in Process Synthesis.

We solicit papers that deal with all methods and philosophies for conceiving chemical process systems. Areas that are not well-developed or that have not received adequate attention in the traditional process synthesis literature are particularly encouraged. Topics of interest include reaction path and reactor network synthesis, synthesis of novel separation schemes, overall flowsheet synthesis, integration of synthesis, operability and control, synthesis of plants for the manufacture of advanced materials (polymers, inorganics, semiconductors, pharmaceuticals, biomaterials, etc.), synthesis of plants involving solids processing steps, and other nontraditional areas (environmental applications, synthesis issues in capital planning, etc.).

Submit extended abstract to Michael F. Malone, Area 10A Chair at address above.

Session Chair (For Information Only)

Ka M. Ng
Department of Chemical Engineering
University of Massachusetts
Amherst, MA 01003-0011
413-545-0096
413-545-1647 (FAX)
ng@ecs.umass.edu

Co-Chair

Richard Colberg
Eastman Chemical Company
PO Box 1972
Kingsport, TN 37662-5150
615-229-3184
615-229-4558 (FAX)
rcolberg@emn.com

2. Advances in Process Synthesis.

Process synthesis, a key step in chemical process design, is concerned with identifying the basic flowsheet structure to be used from a typically large number of alternatives. The process economics and a number of other quality measures such as controllability, safety, compliance with environmental and other regulations, largely depend on the results of this conceptual design phase. This session will focus on new developments and applications of process synthesis methodologies such as mathematical programming approaches, heuristic strategies, thermodynamic methods, etc. Areas of application are not limited, but contributions considering environmental issues are especially welcome. Also, papers addressing problems and future trends and challenges in process synthesis research are sought.

Submit extended abstract to Michael F. Malone, Area 10A Chair at address above.

Session Chair (For Information Only)

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

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

3. Design and Analysis.

Papers are solicited on recent developments in process design and analysis. Areas of interest include, but are not limited to new process modeling methodologies, design and analysis of integrated continuous and/or multipurpose plants and tightly coupled process subsystems, techniques for the design of specific units, design under uncertainty, use of molecular structure and properties in design, techniques to analyze the operability (flexibility, controllability, reliability) of process plants, design and analysis of novel separation systems, and design for waste minimization.

Submit extended abstract to Michael F. Malone, 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

Stratos Pistikopoulos
Centre for Process Systems Engineering
Imperial College
London SW7 2BY
UNITED KINGDOM
44-71-225-8131
44-71-581-9488 (FAX)
e.pistikopoulos@ic.ac.uk

4. Advances in Process Design.

Papers are sought in the area of designing chemical engineering systems. Design may be at the level of individual unit operations or integrated processes. Priority will be given to papers that provide systematic and generally applicable frameworks and can be extended to a wide spectrum of applications.

Submit extended abstract to Michael F. Malone, Area 10A Chair at address above.

Session Chair (For Information Only)

Mahmoud El-Halwagi
Chemical Engineering Department
Auburn University
Auburn, AL 36849-5127
205-844-2064
205-844-2063 (FAX)
mahmoud@eng.auburn.edu

Co-Chair

Amy R. Ciric
Department of Chemical Engineering
University of Cincinnati
Cincinnati, OH 45221-0171
513-556-2763
513-556-3473 (FAX)
amy.ciric@uc.edu

Joint Area 10a and Area 10d Session

1. Computational Approaches in Systems Engineering.

Papers are sought which discuss recent and projected advances in computational and algorithmic procedures. The contributions are intended to address issues related to the implementation of new and existing technologies for the successful design and operation of chemical processes. The session welcomes developments of new algorithmic methods in engineering analysis, advanced reasoning techniques for chemical design applications, applications of process integration methods, and efficient optimization approaches.

Submit extended abstract to Michael F. Malone, Area 10A Chair or to Ioannis G. Kevrekidis, Area 10D Chair.

Session Chair (For Information Only)

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

B. Erik Ydstie
Department of Chemical Engineering
Carnegie Mellon University
Pittsburgh, PA 15213-3890
412-268-2230
412-268-7139 (FAX)
ydstie@andrew.cmu.edu

Joint Area 10a and Area 12a Session

1. Modeling and Simulation in Pilot Plants

Papers are solicited for a session on modeling and simulation in pilot plants. Topics of interest include, but are not limited to use of process or kinetic models to plan experiments, pilot plant data as input to models, pilot plant data as input to decision and risk analyses, use of decision and risk analyses to guide experimentation, and statistical design of experiments in the modeling process.

Chair

Shiah Cherney
Chevron Research and Technology Company
PO Box 1627
Richmond, CA 94802-0627
510-242-4461
510-242-1599 (FAX)

Co-Chair

Reed L. Christiansen
Eastman Chemical Company
PO Box 1972
Kingsport, TN 37662-5150
615-229-6034
615-229-4558 (FAX)
reed@emn.com

Area 10b: Systems and Process Control

NOTE: PLEASE SUBMIT PROPOSAL-TO-PRESENT FORM AND SIX COPIES OF AN ADDITIONAL EXTENDED ABSTRACT FOR ALL AREA 10B SESSIONS TO THE 1995 AREA CHAIR:

James B. Rawlings
Department of Chemical Engineering
University of Texas
Austin, TX 78712-1062
512-471-4417
512-471-7060 (FAX)
jbraw@che.utexas.edu (use for questions about sessions)
area10b-1995@che.utexas.edu (use for abstract email submission)

Please submit abstracts by email and postal mail. FAX is the least preferred method of submission since it does not lend itself well to sending out for review.

1. Email Submission

Prospective authors must submit a PTP form and an extended abstract (500 words) to the chairmen, and one copy of the extended abstract to *area10b-1995@che.utexas.edu* by March 1, 1995. Paper selections will be announced by May 1, 1995.

Electronic PTP forms are available from *che.utexas.edu*. A detailed announcement on how to obtain electronic PTP forms follows.

2. Postal Submission

Prospective authors must submit a PTP form and an extended abstract (500 words) to the chairmen, and six copies of the extended abstract to Professor James B. Rawlings by March 1, 1995. Paper selections will be announced by May 1, 1995.

A LaTeX style file that may be used to create AIChE Proposal to Present (PTP) forms is available via anonymous FTP from *ftp.che.utexas.edu* in the directory */pub/tex/aiche*.

I would like to thank John W. Eaton of the University of Texas and James C. Hill of Iowa State University for preparing these forms. The forms were prepared for AIChE in order to free us of the tyranny of the scarce printed PTP forms. If there are problems using the forms, please send email to jwe@che.utexas.edu. Hopefully these forms will be available directly from AIChE on their new bulletin board in the near future. The LaTeX style allows you to create filled-in copies of the form directly with LaTeX.

We are considering the following programming ideas from our discussion at the programming meeting at the 1994 meeting in San Francisco. These changes are an experiment intended to provide more value to the attendees at the sessions. In particular, we would like the industrial attendees to feel that the control sessions are of value to them.

1. Increase the alloted time from 15 minutes to 20 minutes. The speakers will only be allowed 15 minutes to present. Five minutes will be reserved for discussion and questions -- even if it is five minutes of silence.

2. Encourage session chairmen to lead or close their sessions with papers that provide an overview or tutorial on the theme of the session. Such papers may also provide an overview or summary of the individual papers presented in the session. The chairmen may decide to allow these papers extra time for presentation. The session chairmen are encouraged to solicit these papers or present these types of papers themselves in their own or other sessions.

3. To continue to handle the high load of submitted abstracts while increasing the time from 15 to 20 minutes, we will use poster sessions for selected topics. It was agreed that the Model Predictive Control papers will be presented in the poster session during the 1995 meeting.

We will continue to use the centralized review process to handle the large number of submitted abstracts and meet the constraints on the total allowed number of presentations. The review committee is composed of the area 10b session chairs and area chair.

Area 10b: Systems and Process Control

1. Advances in Process Control.

Papers are sought that address recent developments in the control of chemical process systems. Priority will be given to papers that discuss novel theories and innovative strategies. Papers which demonstrate the application of existing theory to new problem areas are also welcome. Area of research is open, but papers dealing with nonlinear control, model predictive control, control system monitoring and diagnosis, process identification and estimation, and batch process control will be considered first for other available sessions.

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

Session Chair (For Information Only)

Ahmet N. Palazoglu
Department of Chemical Engineering and Material Science
University of California
Davis, CA 95616-5294
916-752-8774
916-752-1031 (FAX)
anpalazoglu@ucdavis.edu

Co-Chair

David T. Dalle Molle
Amoco Chemical Company
PO Box 3011
Naperville, IL 60566
708-961-6230
708-420-4678 (FAX)
dtdallemolle@.amoco.com

2. Nonlinear Process Control.

Contributions are sought in the general area of nonlinear control. Papers dealing with both theoretical developments and applications of techniques are solicited in model predictive control, differential geometrical control, robust control, adaptive control, and nonlinear dynamic analysis of control systems.

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

Session Chair (For Information Only)

Derinola K. Adebekun
Praxair, Inc.
PO Box 44
Tonawanda, NY 14151-0044
716-879-7318
716-879-7091 (FAX)
adebekun@chera6.che.wisc.edu

Co-Chair

Masoud Soroush
Department of Chemical Engineering
Drexel University
Philadelphia, PA 19104
215-895-1710
215-895-5837 (FAX)
soroushm@duvm.ocs.drexel.edu

3. Model Predictive Control.

This session will focus on recent advances made in the area of model predictive control. Both theoretical and application-oriented papers are welcome. Topics may include, but are not limited to theoretical analysis of MPC controllers, alternative formulations of the MPC control problem, MPC-oriented modeling and identification, MPC implementation issues, and real time applications.

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

Session Chair (For Information Only)

Jose Romagnoli
Chemical Engineering Department
University of Sydney
Sydney, NSW, 2006
AUSTRALIA
61-2-692-4794
61-2-692-2854 (FAX)
jose@chemeng.ce.su.oz.au

Co-Chair

Thomas A. Badgwell
Department of Chemical Engineering
Rice University
Houston, TX 77251-1892
713-527-4902
713-524-5237 (FAX)
tab@rice.edu

4. Control System Performance Monitoring and Diagnosis.

Performance monitoring and diagnosis control systems to detect and avoid potentially costly problems is of significant benefit to the process industry. Multivariate statistical methods have proven to provide a framework for both monitoring and diagnosis. Neural networks also have been successful in fault detection. Artificial intelligence and fuzzy logic are alternative approaches. We solicit papers which address the theoretical and application problems associated with control system performance monitoring and diagnosis. Topics include, but are not limited to process chemometrics or other multivariate statistical methods, fuzzy logic, neural networks, and artificial intelligence for monitoring and diagnosis of control systems.

Submit extended abstract to James B. Rawlings, 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

Michael J. Piovoso
E. I. duPont de Nemours & Company
PO Box 80101
Wilmington, DE 19880-0101
302-695-3678
302-695-2645 (FAX)
piovoso@esvax.dnet.dupont.com

5. Control Relevant Identification and Estimation.

This session intends to present theoretical or application papers addressing identification and estimation issues as they pertain, or are related, to process control problems. Areas of interest include, but are not limited to parametric/non-parametric modeling to achieve specific control objectives, identification and estimation to enhance controller robustness, design of experiments and refiltering for better process identification, and evaluation of existing identification or estimation methods from the perspective of closed loop control.

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

Session Chair (For Information Only)

Gerardo Mijares
M. W. Kellogg Company
PO Box 4557
Houston, TX 77210-4557
713-753-3014
713-753-5353 (FAX)

Co-Chair

Richard D. Braatz
Department of Chemical Engineering
University of Illinois
Urbana, IL 61601-3792
217-333-5073
217-244-8068 (FAX)
braatz@aries.scs.uiuc.edu

6. Batch Process Modeling, Monitoring, and Control.

Papers are sought in all areas of batch process modeling, monitoring, and control. Papers which describe experimental applications will be given high priority. Papers dealing with the following issues are especially encouraged: System Identification in Batch Reactors, Novel Monitoring schemes in Batch Reactors, Model Based Control Algorithms for Batch Reactors, On-line Optimization Issues in Batch Reactors, and Practical Implementation Issues and Experimental Case Studies

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

Session Chair (For Information Only)

Srinivas Palanki
Department of Chemical Engineering
FAMU/FSU College of Engineering
Tallahassee, FL 32316-2175
904-487-6163
904-487-6150 (FAX)

Co-Chair

Michael J. 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

Joint Area 10b and Area 10c Session

1. Issues in On-Line Optimization for Control.

Papers are solicited which describe new developments, methodologies, and/or applications in the general area of on-line optimization for process control. The main issues addressed by the paper should be clearly described in the abstract. Priority will be given to papers with aspects not covered in the other process control sessions. Papers dealing with actual experimental and industrial applications are encouraged.

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

Session Chair (For Information Only)

Babatunde A. Ogunnaike
E. I. du Pont de Nemours & Company
PO Box 80101
Wilmington, DE 19880-0101
302-695-2535
302-695-2645 (FAX)
ogunnaike@essptc.dnet.dupont.com

Co-Chair

Alan B. Coon
Aspen Technology, Inc.
Ten Canal Park
Cambridge, MA 02141-2201
617-577-0100
617-577-0303 (FAX)
coon@aspentec.com

The abstracts will be sent out for review by Joe Pekny and the paper selection will be based on evaluation rankings. The extended abstract must state the title of the session to which the paper is being submitted. Do not submit a full paper at this time, as contributions will be judged on the basis of the extended abstract only. You are encouraged to include in the abstract figures and tables that might help to convey the contents of the work better. If the research work has been presented previously in this or other conferences, the authors must include a paragraph stating how the proposed paper differs from previous presentations.

Area 10c: Computers in Operations and Information Processing

NOTE: PLEASE SUBMIT PROPOSAL-TO-PRESENT FORM AND SIX COPIES OF AN ADDITIONAL EXTENDED ABSTRACT FOR ALL AREA 10C SESSIONS TO THE 1995 AREA 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. Progress in 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. Abstract should summarize the scope of the work, the methodology employed, and significant conclusions and accomplishments.

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

Session Chair (For Information Only)

Venkat Venkatasubramanian
School of Chemical Engineering
Purdue University
West Lafayette, IN 47907-1283
317-494-0734
317-494-0805 (FAX)
venkat@ecn.purdue.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

2. Planning and Scheduling.

Many companies are currently faced with the challenge of reducing working capital while providing improved customer support, particularly reduced product lead times. This has resulted in renewed interest in all aspects of supply chain management, but particularly in the areas of production planning and scheduling. This session will address all aspects of production planning and scheduling including, but not limited to reactive scheduling, industrial case studies, resource constrained scheduling, planning and scheduling under uncertainty, novel scheduling methodologies or problem representations, mathematical or heuristic optimization/simulation methods, integrated approaches to planning and scheduling, and support tools. Priority will be given to papers addressing issues of importance to industrial planning and scheduling problems.

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

Session Chair (For Information Only)

Patrick McCroskey
Dow Chemical Company
1776 Building
Midland, MI 48674
517-636-9826
517-638-9707 (FAX)
pmccroskey@dow.com

Co-Chair

Thanos Tsirukis
Air Products and Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195-1501
610-481-4452
610-481-2446 (FAX)
tsiruka@ttown.apci.com

3. Computing for Plant Operations.

Papers are sought on advances in the application of computers to improve plant operations. Both industrial and academic contributions are welcome. Topics of interest include, but are not limited to process data management and reconciliation, fault detection and diagnosis, on-line modeling and dynamic simulation, advanced control and its implementation in host computers and/or DCSs, on-line optimization, operator training and operator advisory tools, knowledge-based systems, and information systems for plant operations and plant data management. Case studies (successes or failures) may include details of the implementation, new techniques and/or software tools applied, and the economic impact of the application.

Submit extended abstract to Joseph F. Pekny, Area 10C 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

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

4. High Performance Computing for Process Engineering.

Impressive gains in computer technology, in particular vector and parallel processing architectures, as well as advances in the numerical techniques used to take advantage of this technology, make possible today the solution of larger-scale and more realistically modeled chemical process engineering problems. Papers describing applications of such technology and techniques in process operation, optimization, simulation, and other areas of process engineering are sought. Also sought are papers describing numerical algorithms and codes for better exploiting vector and parallel processing in such applications.

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

Session Chair (For Information Only)

Mark A. Stadtherr
Department of Chemical Engineering
University of Illinois
Urbana, IL 61801-3792
217-333-0275
217-244-0868 (FAX)
markst@turing.scs.uiuc.edu

Co-Chair

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

Area 10d: Applied Mathematics and Numerical Analysis

NOTE: PLEASE SUBMIT PROPOSAL-TO-PRESENT FORM AND SIX COPIES OF AN ADDITIONAL

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

1. Pattern Formation and Dynamics

Papers in the area of nonlinear dynamics and pattern formation are solicited. Potential topics include spatial, temporal, and spatio-temporal patterns in various chemical engineering applications such as reactors, catalysts, fluid flow, control, heat and mass transfer, separations, etc. Papers can treat either theoretical, computational, or experimental aspects.

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

Session Chair (For Information Only)

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

Co-Chair

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

2. Parallel Computing Applications in Chemical Engineering.

Presentations on parallel computing and its applications in chemical engineering are solicited. We plan to include a wide range of topics from massively parallel algorithms on commercial machines to coarse grained approaches on networked workstations.

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

Session Chair (For Information Only)

Antony N. Beris
Department of Chemical Engineering
University of Delaware
Newark, DE 19716
302-451-8018
302-451-1048 (FAX)
beris@.che.udel.edu

Co-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

3. Chemical Engineering Applications of Stochastic Processes.

Innovative contributions are invited on the application of stochastic processes and probabilistic concepts to chemical engineering problems. Papers stressing formulation issues and on computational aspects are both welcome.

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

Session Chair (For Information Only)

Doraiswamy 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

Kyriakos Zygourakis
Department of Chemical Engineering
Rice University
Houston, TX 77251-1892
713-527-3509
713-285-5478 (FAX)
kyzy@rice.edu

4. Discretization Methods in Computational Strategies for Chemical Engineering Applications.

The goal of this session is to provide a forum for the discussion of recent developments in the field of PDE solution methods for steady and unsteady state problems in chemical engineering applications. Problems in the areas of fluid dynamics, transport phenomena (with and without reaction), and materials processing are of particular interest. Boundary integral, finite element, and boundary element methods have been used to address problems which feature complicated designs, moving and free interfaces, and transport in multiphase systems. The session welcomes contributions dealing with the implementation of the techniques to any of the fields listed above, as well as fundamental

contributions that address issues such as uniqueness of solutions, non-homogeneous boundary conditions, adaptive gridding strategies, and the use of integral equation methods. Furthermore, papers that focus on the use of computational algorithms on vector or massively parallel computers will be considered.

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

Session Chair (For Information Only)

Pedro Arce
Department of Chemical Engineering
FAMU/FSU College of Engineering
Tallahassee, FL 32316-2175
904-487-6166
904-487-6150 (FAX)
arce@evax12.eng.fsu.edu

Co-Chair

Andrew N. Hrymak
Department of Chemical Engineering
McMaster University
Hamilton, Ontario L8S 4L7
CANADA
905-525-9140 x-23136
905-521-1350 (FAX)
hrymak@mcmail.cis.mcmaster.ca

Co-Chair

Jorge Vinals
Department of Chemical Engineering
FAMU/FSU College of Engineering
Tallahassee, FL 32316-2175
904-487-6166
904-487-6150 (FAX).

Joint Area 10d and Area 15d/e Session

1. Mathematical Models Applied to Cell Biology.

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

Session Chair (For Information Only)

Kyriakos Zygourakis
Department of Chemical Engineering
Rice University
Houston, TX 77251-1892
713-527-3509
713-285-5478 (FAX)
kyzy@rice.edu

Co-Chair

Douglas A. Lauffenburger
Department of Chemical Engineering
University of Illinois
perhaps Doug can be reached at:
Deptartment of Chemical Engineering
MIT 66-446
Cambridge, MA 02139
617-253-4561
617-258-8224 (FAX)
lauffen@mit.edu

Joint Area 10 and Area 4

Educational Computer Software Demonstrations

Coordinator

Douglas J. Cooper
Department of Chemical Engineering
University of Connecticut
Storrs, CT 06269-3222,
203-486-4092
203-486-2959 (FAX)

Coordinator

David B. Greenberg
Department of Chemical Engineering
University of Cincinnati
Cincinnati, OH 45221-0171
513-556-2741
513-556-3473 (FAX

Group-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 accommodate late-breaking news, submissions will be accepted up until September 1, 1995, 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
708-491-7398
708-491-3728 (FAX)
mlmavro@nwu.edu

James B. Rawlings
Department of Chemical Engineering

University of Texas
Austin, TX 78712-1062
512-471-4417
512-471-7060 (FAX)
jbraw@che.utexas.edu

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

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

First Call for CAST Sessions
1996 AIChE Spring National Meeting
New Orleans, Louisiana
February 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 not yet been established and may be changed by the Meeting Program Chair, David A. Rosenthal:

August 11, 1995: Submit an abstract (camera-ready) on a completed original new-version AIChE Proposal-to-Present Form, or electronically, 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 to the abstract (camera-ready) to AIChE.

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

February 25, 1996: Speakers bring hardcopies of visual aids to be distributed to the audience at the presentation.

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.

Proposal-to-Present forms may be obtained from each session chair or directly from AIChExpress, 800-242-4363.

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.

Chair

Paul I. Barton (Chair)
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

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@aries.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

Miguel J. Bagajewicz
Simulation Sciences Inc.
601 S. Valencia Avenue
Brea, CA 92621
714-579-0412 x249
714-579-0113 (FAX)
71726.2353@compuserve.com

Co-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

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
Batch Process Technologies, Inc.
1291 Cumberland Ave.
West Lafayette, IN 47906
317-463-6473
317-463-7004 (FAX)
kavuri@ecn.purdue.edu

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 economics. 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

Call for Papers
13th World Congress, International Federation of Automatic Control
San Francisco
June 30 - July 5, 1996

It gives us great pleasure to invite you to participate in the Thirteenth World Congress of IFAC to be held in San Francisco, California, USA, from June 30 to July 5, 1996. As this Call for Papers suggests, there will be a spectrum of categories for technical presentations, including plenary lectures, survey papers, regular papers of both lecture and poster session types, panel discussions, and case studies. Immediately preceding the formal opening of the Congress, tutorials are being planned to provide participants an opportunity to learn new principles, methodologies, technologies, and applications that have been developed in recent years.

This IFAC World Congress is the major control conference in the world for 1996. It will be the second of the triennial series of IFAC Congresses to be held in the United States. The first one was in Boston, Massachusetts, in 1975.

Technical Program

The technical program of the Congress will feature:

(1) Plenary lectures
(2) Regular paper sessions
  Contributed and invited sessions
  Sessions in lecture and poster format
(3) Special sessions and lectures
  Survey papers
  Case studies
  Benchmark sessions
  Panel discussion sessions.

Lecture and Poster Sessions. In addition to the usual lecture sessions, the Congress will feature poster sessions. Accepted papers will be assigned to lecture or poster sessions according to the kind of presentation that fits the nature of work better; no value ranking is implied. Authors will also be asked to indicate their preference. Poster and lecture papers will be allowed the same number of pages in the Congress Preprints/ Proceedings.

An *invited session* is a set of papers on a well-defined subject of current interest; in case of lecture presentation, it normally contains 5 papers. A *survey paper* summarizes the state of the art in a technical area of special interest; it is to be presented in a lecture session of contributed or invited papers where it usually takes the slots of two regular papers (about 40 minutes). A *case study* describes a particularly important application in some depth; its length may be an hour. A *benchmark session* compares several methods using a previously defined example; its length may be an hour. A *panel discussion* is a discussion session on a subject of current interest, usually with a strong industrial emphasis, with the participation of the audience and several recognized experts in the "panel". Its length is usually an hour.

Congress Symposia and Technical Areas

All technical activities of the Congress, with the exception of the Plenary Lectures, will be organized in the form of Congress Symposia, each one covering a coherent sub-field within automatic control. The program of each Symposium will be further subdivided into Technical Areas, following the Technical Committee structure of IFAC. All material submitted or proposed for presentation at the congress will be reviewed by sub-committees of the International Program Committee (IPC), set up according to the Congress Symposium - Technical Area structure. Listed below are the Congress Symposia, with their Technical Areas and International Program Subcommittees.

1. Symposium on Manufacturing and Instrumentation
   a. Manufacturing, Modeling, Management and Control
   b. Robotics
   c. Architectures for Enterprise Integration
   d. Components and Instruments
   e. Low Cost Automation
   f. Advanced Manufacturing Technology

2. Symposium on Design Methods
   a. Control Design
   b. Nonlinear Systems
   c. Optimization Methods
   d. Robust Control

3. Symposium on Systems and Signals
   a. Modeling, Identification and Signal Processing
   b. Adaptive Control and Tuning
   c. Discrete Event Dynamic Systems
   d. Stochastic Systems

4. Symposium on Infrastructure and Resources
   a. Control in Agriculture
   b. Modeling and Control of Biomedical Systems
   c. Control Education
   d. Control Terminology
   e. Natural Resource Systems
   f. Automation in Developing Countries

5. Symposium on Systems Engineering and Management
   a. Large Scale Systems
   b. Modeling and Control of Biomedical Systems
   c. Computer Aided Control System Design
   d. Business and Management Techniques
   e. Modeling and Control of National Economies
   f. Supplemental Ways of Improving International Stability

6. Symposium on Human Aspects of Automation
   a. Social Impact of Automation
   b. Cultural Aspects of Automation

7. Symposium on Industrial Applications
   a. Chemical Process Control
   b. Mining, Mineral and Metal Processing
   c. Control of Pulp and Paper Processes
   d. Power Plants and Power Systems

e. Control of Biotechnological Processes
f. Fault Detection, Supervision and Safety of Technical Processes

8. Symposium on Transportation and Vehicles
   a. Aerospace
   b. Automotive Control
   c. Marine Systems
   d. Air Traffic Control Automation
   e. Transportation Systems
   f. Intelligent Autonomous Vehicles

9. Symposium on Computer Control
   a. Distributed Computer Control Systems
   b. Real-Time Software Engineering
   c. Artificial Intelligence in Real-Time Control
   d. Algorithms and Architectures for Real-Time Control
   e. Safety of Computer Control Systems
   f. Distributed Intelligence Systems

Congress Publications

The Congress publications will consist of: (1) A CD-ROM disc containing the full technical material of the Congress. (2) Printed Subject Volumes containing the material of the Congress Symposia. About 15 Subject Volumes are planned, each one covering a full Symposium or several Technical Areas within a Symposium. (3) A Printed Plenary and Index Volume, containing the Plenary Papers and the Table of Contents, Authors' Index and Subject Index for the full material. Each full-paying participant is to receive, included in the registration fee, the CD-ROM disc, two Subject Volumes of their choice and the Plenary and Index Volume. Student participants will receive two Subject Volumes and the Plenary and Index Volume. All participants may purchase additional Subject Volumes and student participants may purchase the Compact Disk. The Compact Disk will also be marketed after the Congress, as the official Congress Proceedings, by the IFAC publisher Elsevier Science Ltd.

Preparation of Camera-Ready Manuscripts

Authors whose papers have been accepted by the International Program Committee for presentation at the Congress, and thus for inclusion in the Congress publications, will be required to submit their final manuscripts in camera-ready form. The printed publications will be prepared from a photo image of the authors' manuscript and the compact disk will be made by photographically scanning the same. Detailed typing instructions and sample sheets will be provided together with the acceptance notification.

Authors are urged to prepare their camera-ready manuscript in target-size (A4 or 8.5"x11"), with small-size characters, using advanced word processing software and a laser printer. Exceptionally, the camera-ready manuscript may be prepared by a good quality typewriter, on oversized special sheets (which will then be photo-reduced before scanning and printing). Authors wishing to follow this second path should indicate this when submitting their draft paper. They will then receive special sheets together with their typing instructions.

IFAC Publication and Copyright Policy

The material submitted for presentation at an IFAC Congress must be original, not published or being considered elsewhere. All papers accepted for presentation will appear in the Preprints of the meeting and will be distributed to the participants. They will also be included in the Proceedings (compact disk) and offered for sale by Elsevier Science Ltd, Oxford, UK. The papers which have been presented will be further screened for possible publication in the IFAC journals Automatica and Control Engineering Practice, or in other, IFAC affiliated journals. A record of all papers presented will also appear in Control Engineering Practice.

Copyright of material presented at an IFAC meeting and/or included in the Proceedings is held by IFAC. Authors will be sent a copyright transfer form. Automatica, Control Engineering Practice and, after these, IFAC affiliated journals have priority access to all contributions accepted for the Congress. However, if the author is not contacted by an editor of these journals, within three months after the Congress, the author is free to re-submit the material for publication elsewhere. In this case, the paper must carry a reference to the IFAC Congress where it was originally published.

Authors are free to submit their IFAC Congress papers directly to Automatica or Control Engineering Practice. They may also directly submit to an IFAC affiliated journal, before the three-month deadline. The notification of acceptance will contain a list of journals affiliated with IFAC at the time. Authors directly submitting to any of these journals must indicate that the paper has been accepted for the Congress.

No-Show Papers

It is assumed that authors submit their papers in good faith, that is, they do intend to attend the Congress and there is a reasonable chance they will be able to. Acting otherwise would be professionally unethical; an unpresented paper takes away a slot from another author and holes in the lecture sessions cause serious inconvenience to the audience and the organizers.

Financial Aid

Limited funds are expected to be available to assist a small number of authors who would not otherwise be able to attend the Congress. The exact conditions and procedures have yet to be worked out. Prospective authors wishing to obtain more information should contact

Professor Peter Luh, Financial Aid Coordinator
Department of Electrical and Systems Engineering
University of Connecticut
Storrs, CT 06269-3157, USA
Phone: (203) 486-4821. FAX: (203) 486-2447
e-mail: *Luh@farside.ese.uconn.edu*

IFAC Congress Prizes

The International Program Committee is announcing the following prizes awarded to authors for Congress contributions: (1) IFAC Congress Applications Paper Prize, for the best applications paper. (2) IFAC Congress Young Author Prize, for the best paper by an author (or authors) younger than 35 years at the time of the Congress. (3) Best Educational Video Prize for the best videotape on control laboratory experiments. The tapes should be no longer than seven minutes, should sufficiently explain the relevant theory and must be self standing. For further information on the educational video competition, contact

Professor K.H. Fasol
Fakultat fur Maschinenbau
Ruhr-Universitat Bochum
D-44780 Bochum, Germany
Fax: (49-234) 709-4155

The first two Congress awards carry a certificate and a prize of Sfr 1,500; the winners are selected by a committee appointed by the IFAC Council. The Educational Video Award consists of a certificate; the winner is selected by the Technical Committee on Control Education. All prizes will be awarded at the closing ceremony of the Congress.

Call for Contributed Papers

Authors are invited to submit individual contributed papers in any of the technical areas listed above.

What to Submit: (a) Submit six copies of the draft paper. The length of the paper should be no more than 15 double-spaced pages (300 words per page), including references, tables and figures. (b) Submit four additional copies of the front page of the paper, containing the title; list of authors (including address, phone and e-mail); abstract (about 120 words); 3 to 5 keywords characterizing the subject of the paper. Also submit four completed copies of the Paper Submission Form (see last page). Do not forget to include the mailing address of the author with whom the Program Committee is to correspond; suggested Congress Symposium and Technical Area; your preference concerning lecture or poster presentation; if you need oversized typing sheets for the camera-ready paper.

Where to Submit:

Please send the above to the central IPC address:

Michael Peshkin, IFAC'96
Mechanical Engineering Dept.
Northwestern University
2145 Sheridan Road
Evanston, IL 60208-3111 USA

For inquiries only:

e-mail: IFAC96@nwu.edu (preferred)
Phone: (708) 467-2666
Fax: (708) 491-3915 (no manuscripts)

When to Submit: The submitted papers must reach the above address by June 30, 1995. Papers arriving late can not be considered.

Call for Invited and Special Session/Paper Proposals

Proposals are also welcome for invited lecture or poster sessions, survey papers, case-studies, benchmark sessions, and panel discussions.

What to Submit:

For Invited and Benchmark Sessions, 4 copies each of: a description of the theme and significance of the session - the Congress Symposium (and Technical Area) where it belongs; the name, affiliation and mailing address of the organizer; the list of papers and authors; an extended abstract (3-4 pages) for each paper; a completed Paper Submission Form for each paper.

For Survey Papers and Case Studies, 4 copies each of: the description of the theme and significance of the paper; the suggested Congress Symposium (and Technical Area); an extended abstract (3-4 pages); a completed Paper Submission Form.

For Panel Discussions, 4 copies each of: the description of the theme and significance of the session; the Congress Symposium (and Technical Area) where it belongs; the name, affiliation and mailing address of the organizer; the list of panelists, with affiliation and the status of their agreement to participate.

Where to Submit:

Proposals for invited and special sessions/papers should be sent to the central IPC address given above.

When to Submit:

Proposals must reach the above address by June 30, 1995. Only proposals received at the central IPC address by the above deadline can be considered.

Time Table

Individual draft paper submissions must reach the central IPC address by: June 30, 1995. Invited session, survey paper, case-study, benchmark session, and panel discussion proposals must reach the central IPC address by: June 30, 1995. Notification of acceptance of submitted papers and invited/special paper/session proposals is expected in: First week of December, 1995. Preliminary program and registration material are expected in: Late Fall, 1995. Deadline for receiving camera-ready manuscripts of accepted papers: February 1, 1996.