Computing and Systems Technology Division Communications

Volume 13, Number 2, Summer 1990

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About This Issue

Peter R. Rony and Joseph D. Wright

CAST Communications regularly solicits articles–such as the one on SimuSolv (Dow) in the March 1989 issue or the one on APT (Texas Instruments) in this issue–that describe the characteristics of commercial software oriented towards the specific needs of the CPI. We hope to publish these types of contributions in the Summer issue of the newsletter. The Winter issue will usually contain feature articles from one or more of the CAST award winners. Authors retain copyright ownership to their contributions, and can distribute or publish them elsewhere without permission from the AIChE or the CAST Division.

Exciting things are happening at Cray Research, and we thank Steve, Dick, and Bob for taking the time to report on their program on supercomputing for chemical engineering. All three have provided their email and FAX addresses, and are very responsive to electronic inquiries.

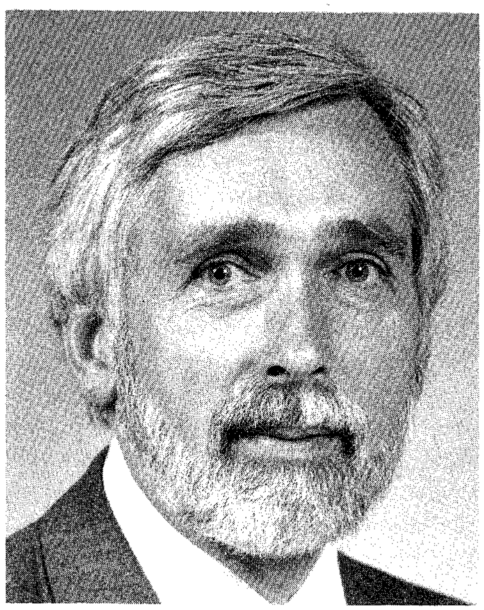
For the first time since your editor assumed responsibility for the newsletter, he is coauthor of a feature article. Karl, who clearly is related to the editor (one non-related Rony runs a commercial bakery north of Milan, Italy) received his B.S.ChE from Virginia Tech in 1987 and works three hours from Blacksburg. He is interested in promoting undergraduate ChE laboratory education, and reports in this newsletter on the adaptation of a simple, widely-used, simulation package, TUTSIM, for the creation of process simulation models that operate in real time while communicating with a programmable logic controller. APT, for Application Productivity Tool, is a 13 Mb CASE tool based upon object-oriented programming (OOP), graphical user's interface (GUI), and an extensive database. Readers may be interested in studying this software just to see how it is designed and structured.

At the March 1990 Orlando AIChE meeting, we were planning to publish in the Summer issue excerpts from the lead article, "Visualization: Expanding Scientific and Engineering Research Opportunities," by Thomas A. DeFanti, Maxine D. Brown, and Bruce H. McCormick (see pages 12–25 in the August 1989 issue of Computer magazine, an IEEE Computer Society publication). We finally decided not to reprint the article, but rather to direct readers to it.

CAST Communications received the "best division newsletter" award at the spring 1990 AIChE Officer's Conference. Your newsletter editorial team–Joe Wright, Colette Totino, and Peter Rony–thank the nominators and the AIChE for this kind recognition.

Chairman's Report

by Joseph D. Wright, Chairman



In each issue of CAST Communications, the Chairman is invited to present a status report of the Division or to present questions of interest to members for their consideration. Much of the news in the Division has been presented in other features of this issue. Therefore, it would seem more relevant to raise matters of long term importance to our members. Your Division Officers would very much like to hear your views on key questions facing our long term directions.

One of A.I.Ch.E.'s most important objectives is to increase its membership. We in the CAST Division also subscribe to this objective since it is through the Division fees and the generosity of our Awards sponsors that we are able to offer services to our members. But who are our members? Looking back to the founding era of the CAST Division, we observe that we have grown out of a group of chemical engineers who were interested in machine computation. Then we expanded to include those interested in applied mathematics, control systems, and computer simulation. Today CAST is comprised of four Areas: Systems and Process Design, Systems and Process Control, Computers in Operations and Information Processing, and Applied Mathematics and Numerical Analysis. To many of our colleagues in chemical engineering, this group of eclectic engineers appears to be on the periphery of where chemical engineers ought to be. This might encompass the design of chemical plants, the study and applications of the fundamental concepts of energy, mass and momentum transfer, the application of principles of chemical reaction engineering, and so on. But to play with, or even use *Computing and Systems Technology*? These are within the sacred domain of electrical engineers, applied mathematicians, and others – not chemical engineers! However, my colleagues in the CAST Division will be quick to point out that chemical engineers use these technologies along with a host of enablers to function better, more efficiently, and, even to solve problems that otherwise could never be attempted.

In today's technological world, one is hard pressed to find someone who does not use computing and systems technology daily. What engineer does not use a calculator, a computer simulation, a filing or electronic mail system, a spread sheet, or at least a word processor? Even managers have a need to use critical path planners, personal information planners or company data base systems. This then leads me to my key questions. Who should belong to CAST and what should CAST provide? Given the wide acceptance of computing technology, should it not follow that all engineers (at least those who are members of A.I.Ch.E.) be members of CAST? Perhaps the view that CAST is really an organization too narrowly focussed towards expert users of the technologies and not on common applications is correct. If this is true, should we broaden the scope of CAST to provide services to a wider spectrum of users? As well, should we address the needs of those who only require personal information managers, electronic mail, or word processors? Do we provide sufficient help in simple evolutionary uses of our technologies? Probably we could offer more complete service, but would this attract more members? We would appreciate receiving your suggestions on these various points.

This issue of CAST Communications includes an application form for our Division. Pass it on to a colleague who is not a member of CAST. Help us grow. To help you respond to questions that may be posed, here are a few answers. The key benefits of CAST Division membership include: two issues per year of this newsletter; complete programming in A.I.Ch.E. meetings for sessions of interest to members; notification of "Calls for Papers"; liaison with other Societies; short courses; and from time to time, special services such as the Paper Retrieval Project described elsewhere in this issue. Not a bad deal for $5 per year!

Although we may, as a Division, be focussed on the needs of more advanced users of computing and systems technology, the impact of these new technologies continues to be astounding. Many of us now have desktop computing power that far surpasses that of university or company computing centers in very recent past. In the near future we will have common access to desktop systems and engineering workstations that will be rated at 50 to 100 MIPS or more. What are we going to do with all this power? The next generation of computer tools will allow us as designers and practitioners of chemical engineering to use visualization techniques to "see" the effects of variables in our designs, to investigate "what if" scenarios for extremely complex cases and to explore the sensitivity of the outputs by viewing the entire space of the design parameters. This power will influence the practice of chemical engineering in ways not yet determined. Already we have begun to emerge from the world of unfriendly computer systems into the realm of graphical user interfaces which provide us with easy access to the most powerful design tools we have ever seen. They will be available to novice engineers and will have captured the collective wisdom of research and development in the industrial and academic fields of chemical engineering. The CAST Division must respond to these forces and provide its members with the tools and the knowledge to update their skills.

One of the key functions of the CAST Division is to provide programming for our local and national A.I.Ch.E. meetings. As we look to the future with incredible new computer power at our fingertips, a major contribution of CAST can be to provide tutorial and awareness sessions for the many engineers who will not have received this training. This will benefit the many members of A.I.Ch.E. seeking new skills and may entice them to Division membership. We will look for leadership from our many pioneering members and for new engineers, trained to use the power of computers, to find applications not yet comprehended. This will be the new mandate of CAST and we will be seen in the long term as the Division that encompasses something of what every A.I.Ch.E. member should know. The outcome will be that virtually all members will find a home in the CAST Division.

CAST Executive Committee Meeting (March 20, 1990): Excerpts from Minutes

by Maria Burka, Secretary/Treasurer

Chairman's Report (Joe Wright)

1. Process Data Exchange Institute (PDXI). Discussion on this subject included:
   - AIChE has given its blessing.
   - Questions have arisen about the scope of the data to be collected and about potential conflict with DIPPER.
   - Originally planned to raise $100,000 to get started. If this does not materialize, will get going with whatever is in hand.
   - Overhead is a problem. How much will AIChE contribute? Probably 10% or less.
   - Plan to charge a flat rate of $5,000 per company.
   - Would take two years to come up with standards (should be called guidelines instead!).
   - Will be in the mail by June 1990.
   - Target: put together a set of bylaws to present to AIChE Council by August.
   - Plan to have contractor start on guidelines by mid-1991.

- Hope to have at least 20 companies involved.
- Are in the process of mailing flyers to prospective companies.

2. AIChE Council is presently going through a strategic planning process. It is looking at the objectives of the organization, detailed attributes, long-range goals, etc. Some of the ideas being considered include:
   - Hopes to increase membership of undergraduates by 30% between 1989 and 1992.
   - During this time period, AIChE plans to increase overall membership by a couple of thousand new members. AIChE wants to develop measurable criteria on what is a good chemical engineer.
   - Hopes to have break-even finances.
   - Increase the sales of CEP.
   - Headquarters will work with local sections more in the future.
   - Study the overlap between divisions and how to resolve conflicts.
   - Try to increase participation in continuing education courses.
   - Potential problems with the creation of the new Separations Division. Other divisions, such as the Environmental Division, are worried that it will cut into their membership.
3. CAST needs to make some slides showing the mission, objectives, etc. of the CAST Division, to be shown at meetings, presentations to potential members, etc.
4. AIChE wants multiple representatives at the June Officer's meeting from each division. The feasibility of this is unclear.

Secretary/Treasurer's Report (Maria Burka)

We still have not received the money for the advertisements that ran in the newsletter. This needs to be straightened out with AIChE headquarters.

1st Vice Chairman's Report

Concerning long-range planning, Joe Wright brought up one project that we might begin thinking about: computer imaging (visualization). Area 10A would like to have a session on this at some future meeting. All officers were asked to think about long-range planning for CAST and send any ideas they have to Rex Reklaitis.

The June Officer's meeting included discussions about AIChE's long-range plan (three-year, long-range plan, 1989–1992, as discussed by Joe Wright). CAST needs to comment on it.

2nd Vice Chairman's Report (Ignacio Grossman)

As of March 1990, there are five nominees for the CAST Award. The procedure for the selection of award winners was reviewed. The committee that makes the final decision consists of the six CAST directors plus five others chosen by the 2nd Vice Chairman with appropriate representatives from both universities and industry. AIChE is planning to put out the book for the fall Chicago meeting by the summer meeting. This places a much earlier deadline on when information on award winners have to be submitted to AIChE headquarters.

Past Chairman's Report (Bruce Finlayson)

Bruce sent a report on the paper retrieval project at the November 1989 AIChE meeting. The information retrieval cost $2,500 and was very time consuming. Bruce spent a large portion of his time at the meeting just working on software problems, and had little chance to attend any sessions. CAST should not continue to do this on its own; instead, the responsibility should now be handed over to AIChE. Whether we should continue this at the Chicago meeting on our own was debated.

Report of the Directors

Herb Britt wrote an advertisement (published in the last newsletter) to encourage membership in the CAST Division. Jeff Siirola mentioned that there were no brochures about CAST, or the CAST slide at any of the sessions at the Orlando meeting. A procedure needs to be formalized about whose responsibility it is to make copies of the slides, to bring them to all AIChE meetings, and to train session chairmen to use them. Peter Rony suggested that we display copies of the Newsletter at all sessions as a deliverable product that comes with membership. Decisions will have to be made on these issues before the Chicago meeting.

Programming Board Chairman (Jeff Siirola)

CAST participation in the Chicago meeting keeps growing. We are now scheduled to have 26 sessions, with three running in parallel at any one time. All of our requests were accepted.

PSE is finally getting going. It is behind schedule, but should be on track soon. FOCAPD 89 proceedings are in the mail.

Jeff attended the AIChE workshop for programming board chairmen and brought back the following: (1) AIChE has hired Peter Knox as a permanent employee to be in charge of programming. (2) The workshop concentrated on themes: specialty programming, block programming, etc. (3) Underrepresented groups (young engineers, etc.) who do not attend AIChE meetings were identified and solutions sought on how to get them to the meetings (4) The number of attendees at meetings has been steady over the last few years. (5) Meeting Program Chairmen

(MPCs) are poorly trained; something needs to be done to remedy this. (6) Outcome of the workshop: plan to meet every February to set themes for two years out. Each meeting will also have a theme. The theme for the Houston meeting is operations; CAST fits in fine.

Report of the Area Chairmen

Area 10C wants to know how to get, and who pays for, visualization equipment–movie projector or VCR–for the Chicago meeting. Siirola will contact AIChE and request that they provide such equipment. Otherwise, CAST will have to pay for it.

New Business

Larry Biegler was chosen to represent the CAST Division on the Research Committee. Since the committee always meets during the day for a whole afternoon during the middle of AIChE meetings, CAST participation is only tentative; it is questionable that anyone wants to miss out on a whole afternoon of presentations to attend their meetings. We will decide after a few meetings.

Report of the CAST Division Programming Board (March 1990)

by Jeffrey J. Siirola

The members of the 1990 Programming Board are listed on the inside front cover of CAST Communications. CAST Programming activities can be summarized as follows:

1. 1990 Spring National AIChE Meeting, Orlando (March 18–22 1990): The CAST Division sponsored 13 sessions (10A, 4; 10B, 1; 10C, 7; and joint 10A/10C, 1). This was one less than originally planned.

2. 1990 Fall Annual AIChE Meeting, Chicago (November 11–16 1990): Two additional sessions were requested by Area B, bringing the total requested to 16.5 sessions (10A, 6; 10B, 9; 10C, 6; 10D, 5; and joint 10B/15C, 0.5). The Meeting Program Chairman has devised sessions of 2 hours, 3 hours, and 3.5 hours length and allocated some of each length to each CAST area. One of the 10B sessions will be poster format. The MPC had set a March 12 deadline for his review of accepted Proposal to Present Forms, a date that was in conflict with our published April 1 deadline for receipt of same. I assured him of the status of each session, but that we reserved the right to change papers accepted until April 1. Subsequently, he extended the deadline to April 18.

3. Chemical Process Control IV (South Padre Island, TX, February 1991): Area 10B is continuing plans for the next specialty conference in the control series. Harmon Ray is conference chairman. CACHE Corporation will facilitate the meeting arrangements. The technical program has been finalized.

4. Process Systems Engineering '91 (Montebello, Quebec, August 1991): The CAST division will cosponsor this continuation of the PSE series of meetings with the Canadian Society for Chemical Engineering, the Institution of Chemical Engineers, and the Society for Chemical Engineering, Japan. Gerry Sullivan is conference chairman.

5. 1991 Spring National AIChE Meeting, Houston (April 7–11 1991): The CAST Division is requesting 12.5 sessions (10A, 4; 10B, 3; 10C, 5; and joint 10C/5D, 0.5). Initial calls for papers appeared in the Winter issue of CAST Communications; final calls will appear in the upcoming Summer issue.

6. 1991 Fall Annual AIChE Meeting, Los Angeles (November 17-22 1991): The CAST Division is requesting 27 sessions (10A, 6; 10B, 7; 10C, 6; 10D, 6; joint 10A/10B, 1). Texts for the first call for papers will appear in the Summer issue of CAST Communications.

7. 1992 Spring National AIChE Meeting, New Orleans (March 29 to April 2, 1992): Although the program is not finalized, it looks as if CAST will request about 12 sessions for this meeting. The preliminary program will also be published in the Summer issue of CAST Communications.

8. Foundations of Computer-Aided Plant Operations (FOCAPO '92): Plans for the second FOCAPO conference, summer of 1992, are under way. Mark Stadtherr and John Hale are conference cochairmen. The advisory committee met in Orlando. CAST area 10C is the technical sponsor and CACHE Corporation will again be approached to facilitate the conference.

Programming Comment:

An AIChE programming retreat was held just prior to the Orlando meeting by the planning team of the EBPC. Topics included block programming, meeting formats, joint sponsorships, regional meetings, outreach, and content and presentation quality. Results will be presented at a CAST Executive Committee Meeting.

Also, the evaluation team of the EBPC is scheduled to meet in Orlando to devise a workable audit system to critique and improve our programming effort. The CAST Programming Chairman will represent the division at both of these meetings and report results to the Executive Committee.

Report on Paper Retrieval Project, CAST Division, AIChE Meeting (November 1989)

At the AIChE meeting in San Francisco (November 1989), the CAST Division had a paper retrieval project. Attendees at the meeting were invited to leave their address and a list of papers for which they desired to receive copies. This information was entered into a database program by session aides. After the meeting, the information was sorted by presented paper, and a list of mailing labels was printed and sent to each author. Each author was requested to send copies of his/her paper; there was no mechanism either to ensure that the authors did send their papers, or that all of the papers actually existed. This report summarizes information about the project.

Overall statistics are:

226 people used the service

170 papers were in 22 sessions

2,531 requests for papers were made

1,326 of these were for individual papers

1,205 of these were for papers, as part of all the papers in a session

154 requests were made for all papers in a session

For papers that were on the official AIChE list of reprinted papers:

70 of 170 papers were reprinted (41%)

543 of 1,326 individual requests were reprinted (41%)

546 of 1,205 papers from session requests were reprinted (45%)

To ensure the success of this type of project:

The data must first be collected. In this experiment, it was entered into a portable computer (on loan from Xerox) by session aides using dBASE II software that Bruce Finlayson had available. The session aides liked the process, were pleased to use a computer, and were knowledgeable about database programs. Bruce wrote and ran the computer programs after the meeting to print the mailing labels as a function of paper or session requested. A secretary typed the mailing labels for the speakers using the abstract booklet. Each author was then sent a letter requesting him/her to send copies of his/her paper to the names enclosed.

Problems did arise. Somebody must be in attendance at the computer terminal during the meeting full time, or at least at the start of each day, before and after lunch, and at the end of the day. Bruce Finlayson performed this service, and missed most of the technical sessions. The address format used in the data retrieval program was not well suited to foreign addresses. The number of papers and sessions that each attendee could request was too low in the computer program; some addresses had to be entered twice. The biggest problem was that the project was so successful that it required significant time to prepare mailing labels. The initial program to do this was inefficient because there was a large number of labels. The program was run on an IBM-class personal computer.

The total cost of the project was $438 plus cost items absorbed by the University of Washington and by Xerox:

Session aides, two per day, 4 days, budgeted at:	$ 240
Postage, envelopes (University of Washington):	94
Secretarial time:	104
Rental of computer, 4 days (from Xerox):	–
Running dBASE, 3 days (University of Washington):	–
Total, minimum cost:	$ 438

If it is assumed that the only papers that were actually sent were the ones that were preprinted (1,089) by AIChE, the cost per paper to the CAST Division can be computed to be $0.40, minimum. Not included were the costs of photocopying and mailing by authors. For an average of 20 pages per paper, the estimated cost for 1,089 copies was $2 per paper, or a total of $2,180 spent by authors.

CAST Division Receives Outstanding Newsletter Award at AIChE Officers Meeting

by Ignacio E. Grossmann, 2nd Vice Chairman

The 1990 AIChE Officers Conference took place in Buffalo on June 10–12, 1990. The three major themes at that meeting were: (a) Volunteers and Effective Chapter Operation; (b) Resources for Successful Programming; (c) Communicating Effectively in the 90's. A large percentage of the participants were from AIChE Local Sections around the country, while there were relatively few representatives from AIChE Divisions.

A number of the sessions were conducted by facilitators who outlined various strategies for recruiting members and for communicating effectively the activities of the AIChE. Information was also provided on the resources that are available from AIChE for programming meetings, and for helping local sections to identify speakers with current topics. Participants also had the opportunity to interact with members of AIChE Council. The meeting concluded with workshops that were offered in the areas of local section finances, public relations, government interaction committees and the institute's long range planning.

Finally, in order to recognize the importance of disseminating useful and timely information to AIChE members through newsletters, awards were given for the first time to the best newsletters of the AIChE divisions, local sections and student chapters. We are happy to announce that the Computing and Systems Technology Division was the 1990 recipient of the "Outstanding Newsletter Award" which was delivered by AIChE President Sheldon Isakoff. Congratulations are in order to our editors, Peter Rony and Joe Wright, for this well deserved award.

AIChE Recognition System

Purpose:

The AIChE Recognition System is implemented beginning in 1989 to recognize and publicize the activities of a group or individual in the organization whose performance showed significant accomplishment toward the Institute's mission and objectives. Presentation of the "AIChE Recognition Award" is intended primarily for single-event performance, but can be used to recognize long-term performance in special cases.

Mechanics:

(1) No more than 10 awards will be presented in one calendar year.

(2) Nominations for the award can be made by individual member(s) or groups in AIChE, but must be sponsored by a current council member. Nomination is accomplished by completing form "1989 RS," acceptance by a Council member for sponsorship, with forwarding to the current AIChE secretary for processing and review by the executive committee.

(3) Decision on awards presented will be the responsibility of the executive committee, with the secretary acting as coordinator of the system.

(4) Each award will be presented at an AIChE meeting, and will be subsequently publicized in AIChEXTRA. The award will consist of a plaque and an explanation letter from the current president of the Institute.

(5) An official history of the system, including record of each recipient and sponsored nominee, will be kept in the member services department at the New York office.

(6) Nomination forms can be obtained from the member services department at the New York office.

If you have questions about this new "recognition" system, please contact Gordie Ellis, the local section and division coordinator at AIChE headquarters; call (212) 705-7328.

Procedure:

(1) Nominator completes items 1, 2, and 3 of form 1989 RS.

(2) Nominator contacts potential Council sponsor, forwards form to him/her.

(3) If Council sponsor approves, he/she completes item 4 and forwards form to current secretary. If Council member chooses not to sponsor, he/she contacts nominee with explanation.

(4) Secretary submits all sponsored nominations to Executive Committee for review and decision. When the Executive Committee chooses a particular nomination for award, the plaque and letter are prepared, and a Council member is designated to present the award. The award will be kept confidential until presentation to the recipient(s). The form is further completed by the secretary and forwarded to the member services department for recording. If the Executive Committee declines a nomination, the Council sponsor is notified.

(5) The plaque and letter are presented by a Council member at an AIChE meeting. AIChEXTRA publicity follows the presentation.

(6) The completed form is forwarded to the member services department for record keeping.

AIChE Recognition System Nomination Form:

(1) Group/individual Nominee:

(2) Summary of Accomplishment (Relating to AIChE Mission and Objectives):

(3) Nominator(s), Date, and Telephone No(s):

(4) Executive Committee Approval and Date:

(5) Date/Location of Plaque Presentation:

AIChEXTRA Publicity (Issue):

1989RS

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Awards

Roger W. H. Sargent is Honored With the 1990 Computing in Chemical Engineering Award

Roger W. H. Sargent–Courtaulds Professor of Chemical Engineering at Imperial College of Science, Technology, and Medicine–whose career has spanned over thirty years during which time his name has become synonymous with Process Systems Engineering, is the recipient of the 1990 Computing in Chemical Engineering Award. Sponsored by Simulation Sciences, Inc. and Dow Chemical, The Computing in Chemical Engineering Award is given in recognition of an outstanding contribution in the application of computing and systems technology to chemical engineering. The winner receives a plaque, a check for $1500, and an invitation to be the after-dinner speaker at the CAST Awards Banquet at the Chicago National AIChE Meeting in November.

The supporting statement for his award includes the following:

Professor Sargent's interest in computing applications is evident from his very first publication (1958) entitled, "Applications of an Electronic Digital Computer in the Design of Low Temperature Plant." He went on to pioneer the concepts of equation-oriented methods for the design and control of process plants. In 1964, the first publication appeared on SPEEDUP, a revolutionary approach to the design of chemical plants. Even though the computer limitations of that era prevented large-scale problems to be solved, it was the "vision" presented that was the paramount contribution. Today, SPEEDUP is one of the foremost steady-state and dynamic simulation and optimization design packages available, and is in commercial use in many process companies throughout the world. Through SPEEDUP and other commercially available packages, the principles of equation- oriented methods presented over thirty years ago are now deeply entrenched into chemical engineering practice.

Professor Sargent extended the "systems" concept from design, to control, synthesis, and optimization (steady-state and dynamic), of both continuous and batch processes. He is well known for his work on extended horizon controllers, optimal control techniques, decomposition techniques, process synthesis, as well as design of multipurpose plants. His achievements in the development of efficient numerical methods for the solution and optimization of differential-algebraic systems have been long recognized by both the numerical analysis and chemical engineering communities. This entire breadth of work comes with both deep technical insight and an uncompromising standard of excellence.

If the process systems adventure was initiated by Roger's vision, then clearly it has been his ability to inspire that has launched an international legion of enthusiastic voyageurs. His academic family, now six generations strong, comprises almost two hundred outstanding scholars and industrialists who themselves are now making profound contributions in the process systems field. This inspiration is also projected to those far beyond the bounds of his academic family. The long list of invited keynote lectures at many international conferences will attest to the fact that his views and foresight are valued by anyone working in the field. His method style, seasoned with a dash of his British wit, makes him the most sought after speaker in the process systems community.

It would be remiss not to mention Professor Sargent's deep concern for chemical engineering education as he has helped to shape the computer application curriculum throughout Great Britain and Europe. He has always been willing to give of his time to serve his profession as evident through the almost endless list of membership and chairmanship positions on strategic committees, and working parties. This included a hectic year as President of the Institution of Chemical Engineers.

As a scholar, as a visionary, as an inspirer, as a mentor, as a colleague, Roger Sargent personifies the phrase, "world class."

Supporting statements on behalf of his candidacy included:

"Without question, Roger is and remains the most distinguished chemical engineer active today in the process systems engineering field. Over the 30-plus years of his professional career, he has contributed significantly and led in the number of important research areas, including process dynamics and simulation, process control, nonlinear programming, flowsheeting methodology, and solution methods for algebraic and differential systems. He has had a major impact on the field not only through his work but also through that of his students, who have grown to form a very prolific academic tree. He has led the development of the SPEEDUP system, which is becoming an important commercial process simulation/optimization software product. More recently, he was instrumental in the creation and is now serving as the Director of the nationally-funded Process Systems Center at Imperial College."

"Roger Sargent is undoubtedly the father of modern computer-aided process engineering and has been, through his many and diverse contributions, a dominant force in the field of analysis, synthesis, controls and optimization over the last 30 years. From his early experimentation with digital computers, through his multi-faceted investigations on computer-aided simulation and optimization (static and dynamic), to the integrated synthesis of engineering systems (process flowsheets, control systems, batch plants), Roger has maintained very high standards of excellence, leading to contributions of long and profoundly lasting impact. By matching academic scholarship with industrial relevance, he has been able to offer contributions of both archival value (e.g., his work on optimization, non-linear systems' analysis) and practical (e.g., SPEEDUP) significance."

"Roger's contributions to chemical process engineering are legendary. These include not only fundamental advances in numeric methods, simulation, optimization, control, synthesis, and computer-aided design, but also, and especially, in education. He has inspired many of his students with a contagious excitement for process design research. This has led to a dynasty of similarly-inspired researchers, which is represented in virtually every process design research organization in the world."

George D. Byrne Wins the CAST Division Computing Practice Award

George D. Byrne, a Research Associate at Exxon Research and Engineering Company, New Jersey, will be presented the 1990 Award at the CAST Division Award Dinner at the AIChE National Meeting in Chicago. He was cited "for his contributions in numerical methods, especially differential equations, related software, and their applications in chemical engineering." The Computing Practice Award, sponsored by Pergamon Press, honors an outstanding effort that has resulted in a specific embodiment, or possibly an industrial or commercial application, of computing and systems technology. The award consists of $1000 and a plaque.

George received his B.S. degree in Mathematics at Creighton University, and both M.S. (Mathematics) and Ph.D. (Applied Mathematics) from Iowa State University. At the University of Pittsburgh, from 1963 through 1980, he taught courses spanning mathematics, computer science, and chemical engineering; he directed 6 Ph.D. theses and served on over 30 Ph.D. committees. He is a member of SIAM, ACM, AIChE, IAMCS, IEEE, the American Mathematical Society, IMA (British), Sigma Xi, the National Speakers Association, and, of course, Toastmasters International. One supporting letter commented: "A highly uncommon dimension of George is made up by his professional and speaking skills . . . He is one of the most effective speakers I've known..."

The award nomination statement of qualifications included the following:

Dr. George D. Byrne is one of those rare scientists who has established a symbiotic relationship in two major technical fields, mathematics and chemical engineering, and this has yielded unique contributions to both fields... CAST should recognize those individuals who have established a bonding of the two fields that are so vitally important to the continued growth and enrichment of our profession.

Probably the most lasting contributions that George has made have dealt with the development of new mathematical software tools. EPISODE and DISPL are probably the most widely used and well known of the various tools George has developed. These tools were spawned from collaborative efforts with other top mathematicians such as Alan Hindmarsh, Gary Leaf, Mike Minkoff, and Peter Brown. George, Alan, and Peter have recently released a new ordinary differential equation solver called VODE.

The Institute of Mathematics and its Applications recently elected George as a Fellow, following his highlighted presentation at their conference on numerical ODEs at Imperial College last summer... The paper deals with computational experiments with VODPK, a Krylov variant of VODE. With these new methods, reductions in storage requirements of 9:1 and improvements 5:1 in execution speed have been observed for heat and mass transfer and kinetics-diffusion-convection problems.

Other supporting letters stated:

"The application of numerical methods and software to the solution of difficult problems in chemical engineering has always been a prominent part of George's work. Various kinds of chemical kinetics models have provided the main motivation for most of the work that he has done on or with stiff ODE solvers, PDE solvers, and DAE solvers... At Exxon, George has contributed fundamentally to the solution of numerous chemical engineering problems...These include: (a) a thermal DeNOx process model, involving kinetics simulation and parameter fitting; (b) an amine stripper, involving 1-D transient reaction-diffusion-convection simulation; and (c) fixed-bed reactor simulations involving DAE formulations and solution."

"George's published work is highly regarded both by his colleagues in the numerical mathematics field and by people in other disciplines. His list of publications includes at least 34 that are in refereed journals and conference proceedings. Over the years, the content of George's papers has shifted from abstract numerical analysis to studies of methods in applied situations, but with the latter resting on a sound analytical base. One of our most recent joint papers, an invited survey of stiff ODE methods and software, on which George was the lead author, has received considerable acclaim and around 100 reprint requests to date, from all over the world. Another measure of the quality of his work is the popularity of the software and he has written (or coauthored). One sequence of ODE solvers that he and I wrote has been requested by hundreds of people."

"As a pioneer in the field he and A. C. Hindmarsh developed the well-known EPISODE software package for the efficient solution of systems of ordinary differential equations. EPISODE was distributed to over 125 central computing sites world-wide by the National Energy Software Center, and is used in broadly distributed commercial simulation tools. It is heavily used by chemical engineers because it can handle chemical kinetics leading to systems of stiff equations. A knowledgeable member of our staff remarks that this integrator is so robust and efficient that it has no competitor."

"At Exxon George has contributed to many diverse programs of chemical engineering numerical analysis resulting in methods used in the development of new processes and products. One outstanding example concerns the Exxon Thermal DeNOx process for smoke stack gas scrubbing which employs injected ammonia. Optimization was used to adjust chemical kinetics rate coefficients so that ODE solutions agree with laboratory and field data. The ability to use this code to simulate new operating conditions has permitted novel applications of the technology in using unconventional fuels in waste disposal incinerators, e.g., burning rubber tires, while obviating need for expensive pilot plants. To date 60 NH_3-NOx plants have been commercially commissioned and more are planned."

"In addition to his project contributions, George continues to be active, as he has been for many years, in training others and disseminating the methodology of numerical computation in his field–through workshops, seminars, and presentations, each year. His dedication to his profession is very great. In personal affairs, George is a highly ethical, princely individual and one who is never too busy to help a colleague..."

The Ted Petersen Student Paper Award Goes to R. (Krish) Krishnamurthy

The Ted Peterson Student Paper Award is given to recognize an outstanding published work, performed by a student, in the application of computing and systems technology to chemical engineering. This award, sponsored by ChemShare and IBM, consists of $500 and a plaque. The award will be presented at the CAST Division Award banquet at Chicago AIChE meeting this fall.

Krish Krishnamurthy, the award winner, is a Lead Engineer at The BOC Group, Inc. in Murray Hill, New Jersey. Krish, who performed his award-winning research while a graduate student of Ross Taylor at Clarkson University, was cited "for the development and application of a complete, mass-transfer rate-based model of multicomponent staged separation processes."

The award nomination provided the following identification and evaluation of the accomplishments of the nominee:

Computer-aided design and simulation of multicomponent separation processes normally is carried out using the very well-known equilibrium stage model. Briefly, this model includes the assumption that the streams leaving a particular stage are in equilibrium with each other. However, in actual operation, columns do not usually operate at equilibrium.

The conventional way of dealing with departures from equilibrium in multistage towers is through the use of stage and/or overall efficiencies. There are many different approaches to defining and calculating efficiencies, and there is no consensus on which is best. For multicomponent systems, the efficiencies of different components may not be the same.

Equilibrium stage calculations also provide the conventional route to designing packed columns. In place of a stage efficiency, the "Height Equivalent to a Theoretical Plate" (HETP) is used. HETP's suffer from many of the same shortcomings that plague stage efficiencies; they are not the same for different components in a multicomponent mixture, for example.

Beginning in 1980, R. (Krish) Krishnamurthy began the implementation of a model of multicomponent separation operations that considers them to be the rate processes they really are. The model that Krish implemented avoids all a priori computations of stage efficiencies (for tray columns) and HETP's (for packed ones). Material and energy balance equations are solved simultaneously with properly formulated models of mass and energy transfer in multicomponent systems.

Krish's first paper describing the model was published in 1985. This paper was soon followed by other articles showing that the nonequilibrium model was capable of true predictions of both tray and packed column performance, in columns ranging from laboratory to commercial scale.

Although models based on mass-transfer principles are not new, Krish's model was designed to appeal to computer simulation specialists. This approach must have worked, because his paper attracted attention almost immediately. In 1988, less than four years after Krish's first publication on this subject, a nonequilibrium model has been implemented by Aspen Tech, Inc., one of the leading flowsheet simulation companies... In a paper published in Chemical Engineering Progress in October 1989, J. D. Seader wrote: "The model and algorithm for implementing it could be the beginning of a new era in tray-type separator design and simulation."

One supporting letter stated the following:

"Following a plea in 1980 by the late Professor H. Sawistowski for a replacement of the equilibrium-stage approach and its accompanying plate efficiencies for plate columns and HETPs for packed columns, R. Krishnamurthy and Ross Taylor began the development and experimental verification of a rigorous and robust algorithm for a transport-rate model of continuous, steady-state, separation operations having countercurrent contacting of fluid phases. Incorporated into this algorithm, the first of its kind, were reliable methods for computing multicomponent transport coefficients; rigorous expressions for fugacities, enthalpies, and densities; and robust methods for converging the large set of highly nonlinear equations..."

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Articles

Chemical Process Engineering at Cray Research

by Stephen E. Zitney, Richard D. La Roche, and Robert A. Eades
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Supercomputers are transforming R&D activities in the chemical process industry (CPI). Companies in the pharmaceutical/biotechnology industry are using supercomputers to better focus and accelerate their R&D efforts in designing new drugs, vaccines, and herbicides. Large-scale molecular simulations of drug-enzyme complexes are used by researchers both to learn how a drug works on the molecular level, and to identify which of the many candidate compounds shows the most promise of being an effective drug. Further studies, requiring synthesis of the compound and experimental testing, can then be focused upon the most promising candidates.

The chemical and materials based industries are using supercomputers in a similar manner to obtain molecular based properties about their products and processes. Thermodynamic data, such as heats of formation and heat capacities, are being calculated on supercomputers, providing information which can often be too costly or time consuming to determine by experimental measurement. The molecular interactions involved in catalytic processes are being studied on supercomputers, yielding knowledge about chemical processes that are typically unobtainable by experimental means. Supercomputers are also being used to study the impact of chemical products on the environment, such as in the modeling of the global warming potential from chlorofluorocarbons. Polymer flows are being modeled using computational fluid dynamics methods to better understand and design injection molding processes.

More and more companies in the CPI are making the strategic decision to implement supercomputing as an integrated part of their R&D activities. Table 1 shows Cray Research's customers in the CPI, along with chemistry related research institutions. Cray Research also has nearly 30 customers in the petroleum industry, many of which are running chemistry and chemical engineering codes along with their traditional seismic and reservoir simulation applications. In addition, approximately 35 companies are using Cray Research systems for chemistry/chemical engineering at university and NSF-sponsored supercomputer centers.

Table 1. Cray Research's Customers in the CPI

Installation	Customer	Machine
1986	Dupont	CRAY 1/A
	NCI	CRAY X-MP/28
1987	Scripps	CRAY X-MP/14se
	Dupont (upgrade)	CRAY X-MP/28
1988	Exxon R&E	CRAY X-MP/14se
1989	Monsanto	CRAY X-MP/116se
	Sumitomo	CRAY X-MP/116se
	Scripps (upgrade)	CRAY X-MP/116se
1990	Eli Lilly	CRAY-2S/2-128
	DuPont (upgrade)	CRAY Y-MP4/332

During the second half of the 1980s, CPI application programs for supercomputers have improved substantially in functionality and performance. Industry standard codes in the areas of molecular dynamics, quantum mechanics, computational fluid dynamics, and structural analysis are available and optimized for supercomputer systems. The increase in the number of high-performance application codes has generated a growing interest in using supercomputer simulations for industrial research.

Surprisingly, until recently, there has been relatively little work done to develop or optimize application codes for large-scale chemical engineering design and optimization on supercomputers. However, initiatives at Cray Research, along with leading CPI companies, software vendors, and academic research groups, are signaling an end to this trend. We will discuss some of the chemical engineering design tools that are currently being tailored to run on Cray Research supercomputers and focus on the center of this application area, the process simulator.

Traditional sequential-modular simulators solve the material and energy balances of multi-component, multi-unit processes at steady state. The most widely used application codes in this area are PROCESS and PRO/II from Simulation Sciences and ASPEN PLUS from Aspen Technology.

These modular codes are reliable and robust design tools with a long history of industry use and acceptance.

The CRAY version of PROCESS is currently running at about a dozen Cray Research customer sites. Version 4.0 is available from Simulation Sciences for running under both the COS and UNICOS operating systems.

DuPont recently conducted an evaluation of PROCESS running on a VAX 8800 as compared to running on a single processor of their CRAY X-MP/28. In the October 1989 issue of Chemical Engineering Progress, Haley and Sarma reported that a single cpu CRAY X-MP increased performance on an average of 8 to 10 times over the VAX 8800. The minimum ratio of CRAY to VAX performance was 1.9 and the maximum was 67.9. A cost analysis showed that the CRAY X-MP supercomputer was the more cost-effective solution.

For DuPont users, the average cost per run on the CRAY X-MP computer is about half as much as on the VAX. It is important to point out here that many of the important PROCESS routines could have run significantly faster if they were optimized or redesigned for vector and multiple cpu operation. However, those involved in the project from DuPont, Cray Research, and Simulation Sciences chose not to pursue this since the follow-up to PROCESS, namely PRO/II, was due out in the near future.

PRO/II version 2.0.1 is already available for use on several personal computer platforms. In preparation for later CRAY releases, version 2.0.1 was ported to the CRAY X-MP and CRAY Y-MP running UNICOS.

In June 1990, Cray Research obtained PRO/II 2.5.0 from Simulation Sciences. This is the pre-release of the official version 3.0.1, which will be released simultaneously for mainframe computers and CRAY supercomputers during the fall of this year. Cray Research plans to pursue a highly optimized version of the PRO/II simulator.

Cray Research has ported ASPEN PLUS 8.2-6 to the CRAY X-MP, CRAY Y-MP, and CRAY-2 supercomputers. The code is currently running at three Cray Research customer sites for four customers. The "official" ASPEN PLUS shell scripts are available on Cray Research UNICOS systems. These scripts are now in place for all variations of ASPEN PLUS runs (edit runs, user databanks, reusable load modules, etc.).

On the standard suite of 49 test problems from Aspen Technology, the unoptimized ASPEN PLUS 8.2-6 code was an average of 14 times faster on one processor of a CRAY Y-MP system than on a VAX 8530 mainframe. The speedups typically ranged between 12 and 17, but were as high as 25 and 32 for two of the test cases. It is important to note here that these 49 problems test various features of the ASPEN PLUS code and are not necessarily very computationally intensive.

Optimization work at Cray Research is well under way on the critical sections of ASPEN PLUS, which mainly include thermodynamic and equation solving routines. To date, over 20 routines have been optimized for vector operation. Six large ASPEN PLUS problems with VAX solution times ranging from 12 minutes to 4.5 hours have been obtained from Aspen Technology and a customer for use in Cray Research's optimization efforts. The speedup figures for the unoptimized and optimized CRAY Y-MP versions over the VAX 8530 version are given in figure 1 for the six large flowsheeting problems.

ASPEN PLUS Optimization

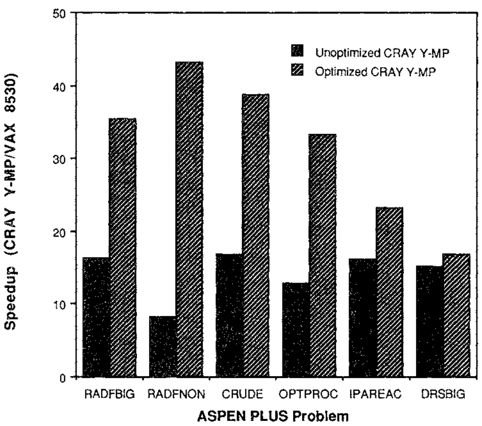

Figure 1

Figure 2 demonstrates the impact of redesigning solution algorithms to fully exploit advanced computer architectures. Two large reactive distillation problems, RDIST1 and RDIST2, required about 90 minutes each to solve on the VAX 8530. A large portion of the total computation time was spent in the Harwell MA28 subroutine, which is a general sparse linear equation solver. This traditional solver was replaced with a new frontal solver. The motivation here is that the frontal routine exploits vector computer architectures by treating parts of the sparse matrix as full submatrices, thereby allowing arithmetic operations to be performed with full-matrix code (without indirect addressing). Using the frontal code, the total time required to solve these two problems in ASPEN PLUS was drastically reduced to only 1 minute for RDIST1 and 30 seconds for RDIST2. As a result, an engineer can now run this distillation model many times a day, instead of only once or twice. A more detailed discussion on the use of the frontal code with ASPEN PLUS will be presented by S. E. Zitney at the AIChE 1990 Annual Meeting in Chicago. This paper will be part of the Symposium on Parallel Computing sponsored by Area 10C of the CAST Division.

Frontal Code for Aspen Plus

CPU Time Comparison

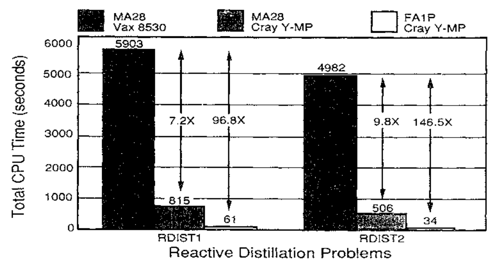

Figure 2

Aspen Technology also produces Model Manager, a graphics front-end for the ASPEN PLUS program. With Model Manager, engineers can receive expert-system assistance to construct a rigorous flowsheet model. Later this year, a workstation version of Model Manager will be released.

Similarly, Simulation Sciences plans to release an X-windows version of their PRO/II graphics package. This will enable the use of graphics workstations for the visualization of the flowsheet design process, coupled with the high-speed solution of the process simulation equations on a CRAY Y-MP. The result being a Network Supercomputing Environment which increases the abilities of chemical engineers to solve critical chemical process problems.

As noted above, chemical engineering computing is centered around the process simulator, but other related application areas include the simulation of physical systems (e.g., reaction kinetics modeling), linear programming (e.g., process scheduling), and dynamic simulation (e.g., startup and shutdown evaluation). Cray Research is also working to provide high-performance solutions for these important design activities.

SIMUSOLV, from the Dow Chemical Company, is an integrated, multifunctional software package for developing and using mathematical models of physical systems. This code can be used to model problems in such diverse fields as process engineering, toxicology, pharmacology, chemical kinetics, environmental sciences, and agriculture. In early 1990, Cray Research obtained the SIMUSOLV code for porting and has begun to optimize it for CRAY system architectures.

The General Algebraic Modeling System (GAMS) family of software is a complete system for modeling and solving optimization problems. A CRAY UNICOS version is supported and distributed by the GAMS Development Corporation. The system consists of: GAMS modeling language and execution system, and solvers for linear, nonlinear, mixed-integer, nonlinear-mixed-integer and nonlinear network mathematical programming problems. GAMS can be used in such CPI application areas as: process scheduling, retrofitting, batch processing, heat exchanger network synthesis and production, and distribution planning.

Cray Research is also investigating equation-based methods for solving chemical process simulation problems. The equation-based methods differ from traditional modular simulators in that they do not proceed sequentially from process unit to process unit in arriving at a final solution but instead treat the entire chemical process as one large equation set that is solved simultaneously. This approach allows for the efficient solution of problems involving dynamic batch and cyclic processing, startup and shutdown studies, control and operability studies, and operator training. Most importantly, the equation-based approach to process flowsheeting appears to be very amenable to the vector and parallel processing capabilities of Cray Research computer systems.

There are many exciting challenges and opportunities for supercomputing simulations in large-scale chemical process synthesis/retrofitting, design/optimization, and operations/control.

For example, there can be an enormous set of alternatives for the synthesis of a grassroots process design. The search space for a retrofit design can be even larger. But, with the development of more powerful mathematical programming techniques, combined with increasing supercomputer power, it will become feasible to rigorously model, optimize, and automate the synthesis process. It is clear that there is profit to be gained by optimizing processes to run at some optimal point, but optimization is rarely performed on a whole process in the CPI. We expect that the ability to run large supercomputer simulations may bring process optimization, even optimization of entire plants having several different processes, into the arena of common industrial practice.

Connectivity between heterogeneous hardware is essential for developing an integrated process engineering environment. As network supercomputing makes it possible, on-line use of supercomputer simulation models will help to ensure more efficient plant operation, both during normal operating conditions, and during changeovers and upsets. Cray Research will be continuing its efforts in meeting these challenges in order to bring these benefits to the CPI. In the near term, we foresee that the continued improvements in chemical engineering software for supercomputers will make process engineering on Cray Research systems a true partner to experimental efforts and pilot plant studies as the CPI strives to develop chemical processes that are more efficient, less costly to operate, and environmentally sound.

We are always interested in hearing from others who are interested in supercomputing for chemical engineering. If you have any questions or comments, or would like further information on the work being done at Cray Research, please contact one of the authors.

Biographical Sketch of Stephen E. Zitney, Richard D. La Roche, and R.A. Eades

Stephen E. Zitney, Ph.D., joined the Industry, Science & Technology Department of Cray Research in June 1989 as a Senior Chemical Engineer. He earned his B.S.Ch.E. degree at Carnegie-Mellon University. and his M.S.Ch.E. and Ph.D. degrees from the Univ. of Illinois at Urbana-Champaign. At Cray Research, he is involved in bringing the power of advanced architecture computing to the chemical process industry through the conversion, algorithmic analysis, optimization, and enhancement of large-scale, chemical engineering codes. His research interests include process synthesis, design, optimization, control, and scheduling. Phone: (612) 683-3690, FAX: (612) 683-3099, Email: sez@gravity.cray.com

Richard D. La Roche, Ph.D., joined Cray Research in May 1990 as a Senior Chemical Engineer with the Industry, Science, and Technology Department. He received a B.S. degree in Chemical Engineering from Montana State University and worked for two years with Dow Chemical before returning to graduate school. He earned his M.S. and Ph.D. degrees in Chemical Engineering from the University of Illinois at Urbana-Champaign. Dr. La Roche joined the faculty at Penn State University in 1987 as an Assistant Professor of Chemical Engineering. He main-

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Robert A. Eades, Ph.D., is the Manager of Chemistry Applications in the Industry, Science & Technology Department at Cray Research. Dr. Eades earned his Ph.D. in Physical Chemistry from the University of Minnesota at Minneapolis. He held positions at Argonne National Laboratory and Allied-Signal prior to his joining Cray Research in 1987. His interests and efforts at Cray Research are focused upon the development and application of computational methods to solve industrial based R&D problems in the fields of chemical engineering, chemistry, life sciences, and materials science. Phone: (612) 683-3669, FAX: (612) 683-3099, Email: eades@gravity.cray.com

The TI 500 Series Programmable Logic Controllers: Merging of TUTSIM Dynamic Simulation With APT Control System Design

by Karl E. Rony (Texas Instruments Incorporated) and Peter R. Rony (Virginia Tech)

A basic question associated with the design of programmable logic controller (PLC) software is when to test the controller program logic (a) at startup, or (b) during the development of the code? For alternative (b), appropriate software or hardware tools must exist both to simulate the process and to execute the simulation and controller codes while they communicate with each other.

The objective of this article in CAST Communications is to introduce divisional members to both a new controls hardware platform–the Texas Instruments TI545 programmable logic controller (PLC)–and two software tools:

- High-level, sequential and continuous control design software: Texas Instruments Application Productivity Tool (APT).
- Dynamic simulation software external to the controller: Real-time TUTSIM with a user-block driver for the TI 500 Series controllers.

In combination, the above hardware and software provide, we believe, state-of-the-art capability in the implementation of inexpensive, midrange programmable logic controllers for the control of chemical processes. APT should be of particular interest to chemical engineering software designers because it is a complete, effective implementation of object-oriented programming (OOP) in a chemical engineering process context.

In this article, we will briefly summarize the characteristics of the hardware and software–TI545 controller, APT, and TUTSIM–and then illustrate their use in the creation of a preliminary control system design for a simple blending process [2].

In addition to their applicability for the design of industrial processes, we believe that the above hardware and software have important implications for chemical engineering controls education, specially in undergraduate controls and unit operations laboratories, where sufficient time may be available for a small-scale design project involving a process controlled by a PLC.

Limitations of space assigned to a feature article in an issue of CAST Communications means that neither the figures (some of which are not large enough) nor the accompanying text will be able to convey–for two different software packages and one new hardware platform–the amount of information that was successfully conveyed for a single software package in a previous issue of the newsletter [1]. To rectify this deficiency, interested readers are invited to request supplementary information, including half-page copies of several of the figures, from one of the coauthors (KER) at Texas Instruments Incorporated in Johnson City [3].

I. The Design Problem

The approach to unfamiliar applications software is usually facilitated by well characterized problems that are used to test the characteristics of the software. This technique was used by Kuenker and Blau in their discussion of Simusolv [1]. Because of the variety of software tools involved, we have selected the blender unit of a three-component blender/packaging process. As illustrated in figure 1, water (H_2O), an aqueous suspension of component A, and a dilute aqueous polyelectrolyte suspension agent B are added to the blender tank, where they are mixed and heated. The solution is cooled and then transferred to a packaging unit (not shown in the figure). Details of the non-steady-state simulation of the blender process will be provided in Section IV of this article.

II. Hardware and Software Tools

TI545 Programmable Logic Controller Platform [3]

The TI 505 System–a complete midrange control solution–consists of a backplane powered by a TI Model 545 Controller, which provides 0.78 ms/K relay-ladder logic (RLL) execution, large memory (96K), and 64 preconfigured regulatory control loops. To illustrate the TI 505 System I/O capability, a combination 8 input/4 output analog module uses surface-mount technology to combine on one printed-circuit board the following functions that normally require multiple packages: 15-bit analog input resolution; eight differential, isolated input channels; front-panel user calibration; selection of seven voltage ranges on each input channel, from 0 to ±50 mV all the way up to 0 to ±10 V; four individually isolated (1500 RMS) analog outputs; and 12-bit analog output resolution.

Priced at $2700 for the controller and a powered backplane, the TI545 is the newest member of the TI 500 Series of controllers, which also includes the TI530T, TI560, TI565, and TI565T.

The TI545 controller, as well as the entire 505 I/O system, is UL Listed, CSA Certified, and Factory Mutual approved for Class I, Division 2 Hazardous Locations. The TI545 is manufactured in Johnson City, Tennessee, which received the 1989 Electronics Factory Automation Award for Manufacturing and the 1989 Taguchi Award by the American Supplier Institute Incorporated for the successful promotion of Taguchi Methods to improve quality and reduce the cost of American products.

A Philosophy of Controls System Design [2]

John Arnold, one of the primary designers of the APT software, has developed, based upon his experience with APT, a systematic approach to the design and development of a controlled process. This approach includes the following elements: (a) partitioning the process into functional areas; (b) identifying equipment areas (shared equipment and processes); (c) telescopic focusing (changing focus readily from system view to detailed view); (d) top-down design; (e) bottom-up implementation; (f) incremental development; and (g) testing as part of the development process. His bottom-up implementation methodology includes three levels:

Level One Control: Manual operation and process safety.

Level Two Control: Set of objectives control that imposes operational goals onto the level-one control system, and provides a primitive operator connection (interface primarily through the development system).

Level Three Control: System merging and expansion, building of the complete control solution, exceptions handling, reports and operator transactions; actual order and activities become fuzzier.

These three levels are further subdivided into a set of thirteen layers:

Layer Zero: I/O definition and naming convention determination.

Layer One (optional): Dynamic simulation of the process.

Layer Two: Discrete device definition.

Layer Three: Equipment protection via interlock logic.

Layer Four: First-level continuous control defined.

Layer Five: Translation of first-level control into operator station.

Layer Six: Procedural control.

Layer Seven: Structural control.

Layer Eight: Objective control.

Layer Nine: Merging with operator interface.

Layer Ten: Structural displays.

Layer Eleven: Simplify operator interactions.

Layer Twelve: Operator messages and recipes.

Layer Thirteen: High-level exception handling.

The authors of this article subscribe to this methodology and have applied the lower four layers to the blender process of figure 1.

Application Productivity Tool (APT) Controller Design Software [3,4]

APT is an object-oriented, program (OOP) design tool that permits a process control design problem to be solved by using a structured, modular, top-down approach. Modular design involves breaking a large control design problem into smaller, more manageable pieces. Each subproblem is solved independently, with the subsets integrated to provide the total control-design solution.

A basic philosophy of APT is that the control-design solution should reflect the natural organization of the physical plant. In arranging the physical layout of the plant, design engineers usually subdivide the process into unit operations (mixers, reactors, etc.). While we design each unit independently, we also consider the overall requirements of the integrated process. Process control engineers can use a similar approach and divide the control solution along natural equipment boundaries. For example, in figure 1 the overall control requirements are to

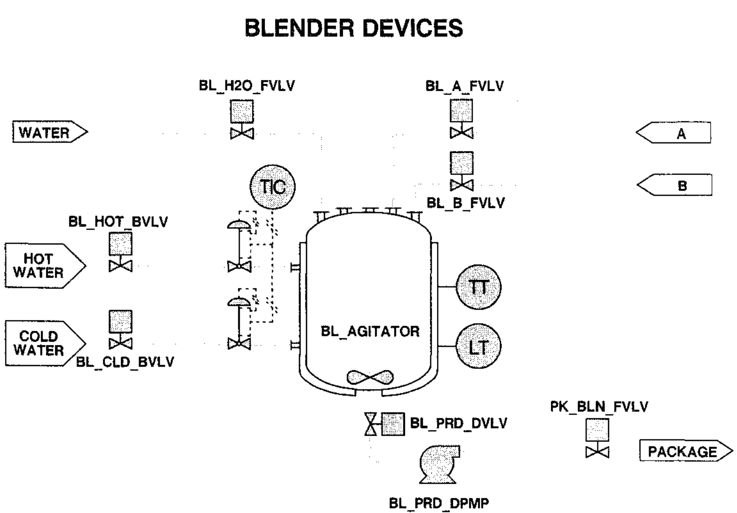

Figure 1

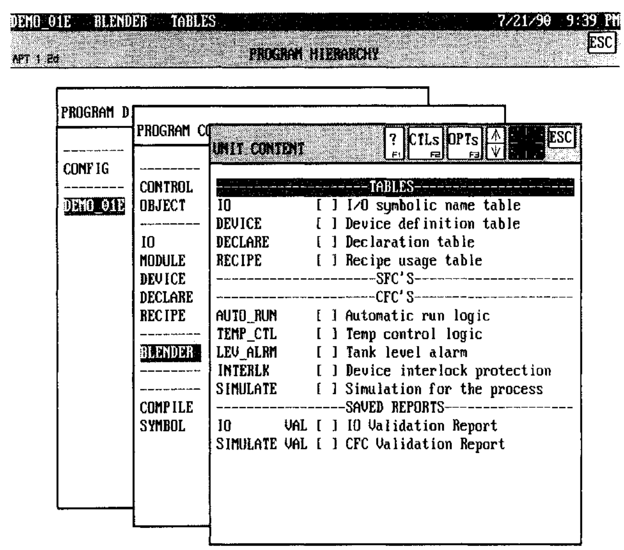

Figure 2

move ingredients into a blender tank, mix them, and then transfer the mixture to a packaging system, which represents an entirely separate equipment area (called a Unit in APT). Each equipment area (Unit) has its own requirements that can be determined independently; integration requirements make it also necessary to consider the interconnectivity of the total solution. A successful modular design partitions the problem according to what is needed solely for each unit operation, and what is needed to interconnect the Units.

The APT hierarchy consists of three levels: the Program Directory Level, the Program Content Level, and the Unit Content Level. The Program Directory Level contains a list of all programs. A program in APT is that portion of the process that can run on a single controller. At this level, we work with entire programs (add, copy, delete, restore, archive, compile, download, debug, description, etc.).

The Program Content Level contains a list of all Units that are identified to be a part of a single program. This level of the hierarchy also includes a means of identifying devices (for example, pumps, motors, and valves), I/O signals, and ingredients that need to be accessed by more than one Unit, or area of equipment; such ingredients, I/O signals, and devices are considered to be global to the entire process. At this level, we work with tables, Units, and recipe templates for the program (add, edit, copy, delete, etc.).

The Unit Content Level contains the definition of the actual control processes, including sequential and continuous procedures as well as special procedures to handle emergency conditions. This level also includes a means of identifying devices, I/O signals, and ingredients that are local to each Unit. Sequential control of the process is defined in one or more Sequential Function Charts (SFCs); continuous control is defined in one or more Continuous Function Charts (CFCs). Figure 2 illustrates the three-level APT hierarchy.

The APT program, a major contribution to software for the CPI, requires approximately 13–14 Megabytes of hard disk space on an IBM-class personal computer, preferably one that contains a 386 or 386SX microprocessor.

TUTSIM Block-Diagram Simulation Language [5]

TUTSIM, an acronym for Twente University of Technology SIMulation program, is a high-level, block-diagram language that basically functions as an analog-computer-on-a-PC. Engineers from the late 1950s through early 1970s may recall that an analog computer was usually programmed from a block diagram sketch and a list of equations representing the system to be modeled; the analog computer solved the problem by substituting functional, analog-electronic hardware circuits (based upon operational amplifiers) for real functions.

TUTSIM re-establishes the analogy between real-world systems and a computer modeling language. Ninety-three defined blocks from SUM, GAIn, MULtiply, DIVide, and INTegrate through X,Y FuNCtion, Laplace functions, logic blocks, Z-transform blocks, and thermodynamic property blocks combine the convenience of the analog computer with the accuracy and speed of personal computers, specially those that employ an arithmetic coprocessor chip (8087, 80287, 80387). A very valuable block is the SYC (synchronization) block, which synchronizes the TUTSIM simulation time base to the real-time clock within the personal computer. During a simulation, the output of SYC can be monitored to determine how well the synchronization is proceeding.

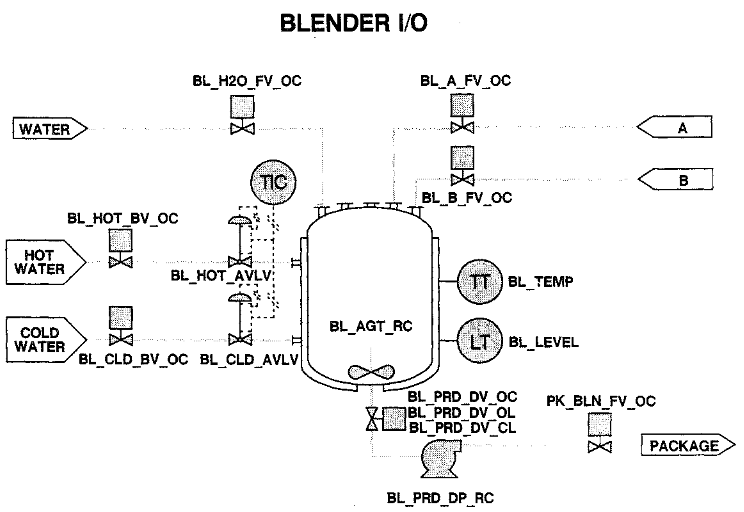

Figure 3

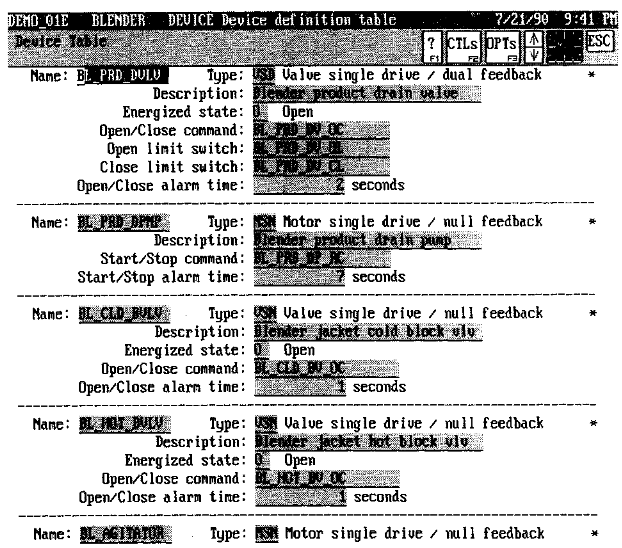

Figure 4

The wide variety of TUTSIM blocks allow a user to describe virtually any mechanical control, process control, or differential equation, continuous or discrete. Of considerable importance, non-linear differential equations are generally no more difficult to model than linear differential equations.

OrCAD Computer-Aided-Design (CAD) Software [5]

OrCAD/SDT III is an electronic design automation tool that is widely used for the capture of electrical schematic designs. In its common application, OrCAD/SDT III comes with 6200 unique library parts in over 40 integrated-circuit libraries. Structured design features within OrCAD/SDT III provide a hierarchical approach to organizing designs that contain up to 4000 sheets through the strategy of partitioning the design into smaller, more manageable sections. Over 200 hierarchical levels simplify complex tasks. With over 30,000 packages sold, OrCAD is the defacto industry standard for easy-to-use schematic capture.

TUTSIM Products markets TUTSIM/OrCAD interface software that permits the creation of hierarchical TUTSIM block diagrams and simulation models for direct input into TUTSIM using OrCAD/SDT III. Several such diagrams will be illustrated in this article. The TUTSIM/OrCAD interface includes a complete block library of all individual TUTSIM blocks, an OrCAD-to-TUTSIM conversion program, and a TUTSIM-to-OrCAD conversion program for parameter changes and plotblock scaling.

III. Real-Time TUTSIM for the TI545 Controller

TUTSIM User-Defined Block Option [5]

Tutsim Products markets special software, the "User-Defined Block Option," that provides almost unlimited extensibility to the block-diagram functions of TUTSIM. This "Option" allows a user to create a new type of TUTSIM block–USA/USR–that may add functions such as memory access to I/O hardware boards or, alternatively, may act as windows and linkages to complex code sections that are not limited to simple math functions. With USA/USR blocks, different displays, recording devices, or I/O devices may be addressed and incorporated into the TUTSIM model simulation.

To create a new TUTSIM block diagram function, a user completes a C or FORTRAN source-code skeleton that is then compiled into a file, USRBLK.EXE, that executes in parallel with the main TUTSIM executable file TUTEXEC.EXE on an IBM-class personal computer, preferably one equipped with a math coprocessor. In late spring and early summer 1990, one of us (KER) developed a special version of USERBLK.EXE that could directly communicate with the memory locations within a TI545 programmable logic controller.

Why generate a special version of USERBLK.EXE? We wanted to merge a successful simulation package, TUTSIM, with the TI545 in order to eliminate the digital switches and analog dials currently used in a $5000 Texas Instruments hardware simulator for the TI 500 Series of controllers. We assumed that all of the hardware I/O was disconnected and that USERBLK.EXE was not executing on a running process. USERBLK.EXE has not entered TI's quality control environment yet, so it is still a preliminary software product, for simulation and evaluation purposes only.

Once USERBLK.EXE has received proper TI testing, it could conceivably be used as part of advanced control schemes on an operating process that requires significant computations while the process is running. TI offers a special I/O module called the Expert Solutions Processor (ESP) module,

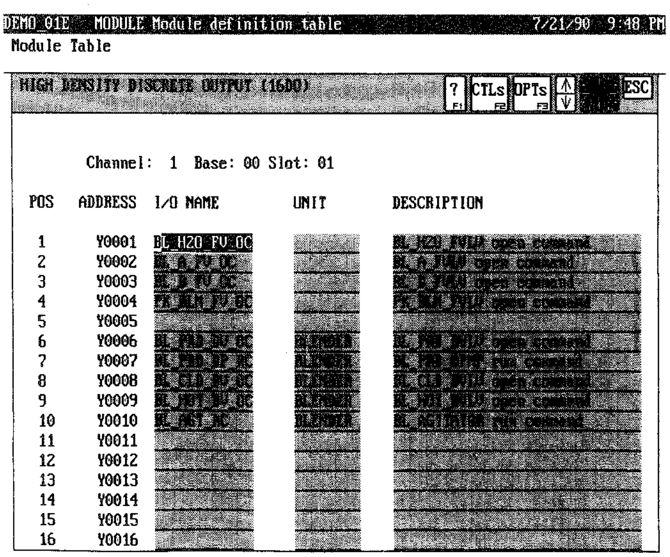

Figure 5

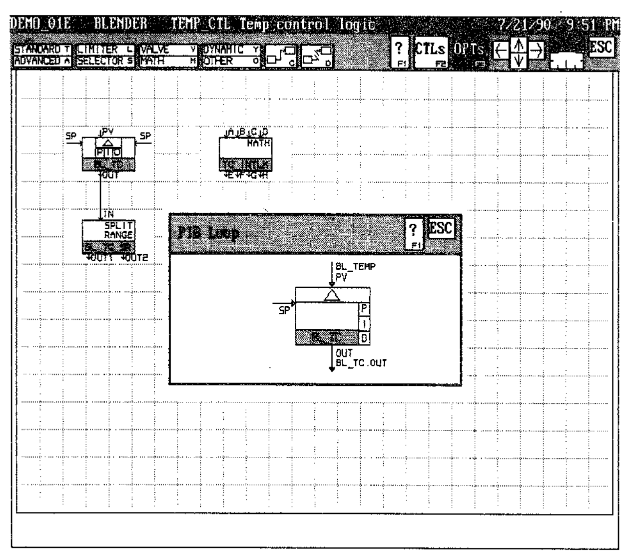

Figure 6

which is an IBM-compatible personal computer board located directly on the TI Series 500 I/O backplane. The ESP I/O module with the optional C run-time library has excellent communication speeds for a PLC, namely, 480 words (max) or 2048 discrete bits (max) per scan of the PLC, where a scan can be as fast as 20 to 100 milliseconds.

USRBLK.EXE for the TI 500 Series Controllers

In this version of USRBLK.EXE, a special Texas Instruments TUTSIM block was defined: USA/USR. The USA version had two parameters and three inputs, and the USR version, three parameters and three inputs. The first parameter, PARAM1, was an integer code that corresponded to the type of memory location selected within the TI 500 Series controller. The second parameter, PARAM2, was the integer code that corresponded either to the read-from-PLC or write-to-PLC operations. The third parameter, PARAM3, was the initial value for the USR block. The TI 500 Series PLC memory address types specified by PARAM1, the read/write functions specified by PARAM2, and the three types of USA/USR block inputs are summarized in table 1.

The ability to develop this Texas Instruments version of USRBLK.EXE had its origin with Chris Manhard in the Texas Instruments APT development group. Chris had a proprietary C test program, with an associated C-language library, that communicated with the TI 500 Series controllers. The program permitted him to test controller communications through the use of command line prompts. We stripped the user input section from this C test program, added it to the USRCODE.C skeleton provided by Tutsim Products, compiled the result into an *.OBJ file, and finally, linked the object file to TI proprietary *.OBJ files to produce USERBLK.EXE.

When TUTSIM and the USRBLK.EXE version for the TI 500 Series were executed, two independently clocked computers–the TI 500 Series controller and IBM-class personal computer–needed to be synchronized. Several independent clock rates were involved: (1) the communication clock rate (as high as 19200 baud) between the personal computer and the TI 500 Series controller, (2) the TUTSIM iteration clock rate (typically longer than 0.2 sec) on the personal computer, and (3) one or more clock rates that triggered the USA/USR-block exchange of information with the TI 500 Series controller. To accomplish this synchronization, information transfer with the USA/USR block was triggered by the rising edge of an input clock pulse, which was usually produced by a CLK simulation block.

In our opinion, the development of USRBLK.EXE for the TI 500 Series represents a modest breakthrough in the use of real-time TUTSIM within industry and academia. USRBLK.EXE, in conjunction with TUTEXEC.EXE, is the first customized version of TUTSIM that exchanges information, in real time, with a programmable logic controller. In the specific context of the TI Series 500 hardware and APT software, real-time TUTSIM with our USRBLK.EXE driver provide, for the first time, an opportunity for a control system designer to segregate the design process into: (a) a control design strategy, applied to (b), an independently developed process simulation.

Alternatively, both the process simulation and the control design strategy could be contained within the compiled APT program that is downloaded to the TI 500 Series controller; however, such a simulation cannot be segregat-

$$dV/dt = F_{H2O} + F_A + F_B - F \quad (1)$$

$$dVT/dt = (F_{H2O} + F_A + F_B)\,T_i - FT - UA\,(T-T_j)/\rho\,C_p \quad (2)$$

$$dV_j T_j/dt = U_j A_j (T-T_j)/\rho_j C_{pj} - F_j (T_j - T_{ji}) \quad (3)$$

where

V is the blender volume, m^3

V_j is the jacket volume, m^3

T is the blender temperature, C

T_j is the jacket temperature, C

T_{ji} is the inlet jacket temperature, C

T_i is the inlet temperature of water, solution A, and solution B, C

F_{H2O} is the inlet water flow rate, m^3/s

F_A is the inlet aqueous solution A flow rate, m^3/s

F_B is the inlet aqueous solution B flow rate, m^3/s

F is the outlet flow rate, m^3/s

F_j is the jacket flow rate, m^3/s

$\rho\,C_p$ is the product of the density and heat capacity of the blender inlet and outlet flow streams, $J/m^3\,C$

$\rho_j\,C_{pj}$ is the product of the density and heat capacity of the jacket flow stream, $J/m^3\,C$

UA is the product of the blender tank heat-transfer coefficient and heat exchanger surface area, $J/s\text{-}C$

$U_j A_j$ is the product of the jacket tank heat-transfer coefficient and heat exchanger surface area, $J/s\text{-}C$

Figure 7

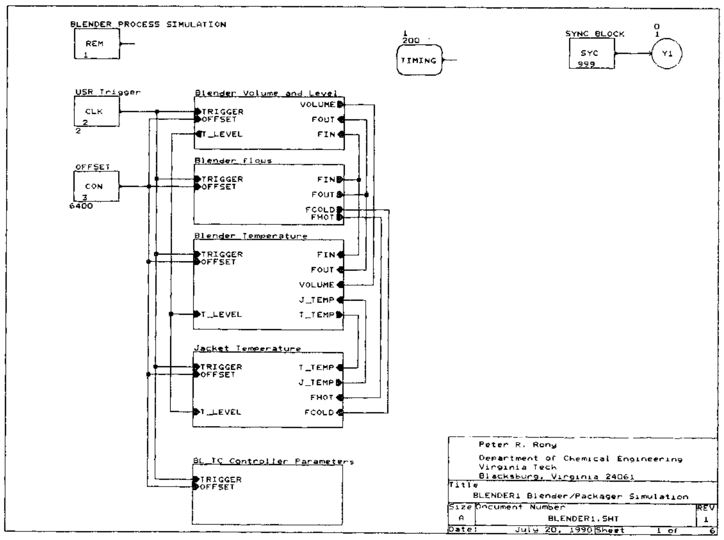

Figure 8

ed unless a second TI 500 Series controller is employed.

IV. Blender Simulation and Continuous Control System Design: OrCAD/TUTSIM and APT

DEMO_01E APT Controller Program

In the control system development sequence that we describe in this article, the first step of the sequence consisted of using the Application Productivity Tool (APT) software to develop the blender regulatory-control strategy in its simplest implementation: a single PI loop plus an analog alarm. Space is not available to teach the APT design process for BLENDER, but perhaps figures that depict selected APT-generated reports will give a flavor for this object-oriented control design software.

At the APT Program Directory level, the regulatory control strategy was given a program name, DEMO_01E, and a description. At the Program Content level, BLENDER was defined as a Unit, one of what ultimately would be several independent Units–for example, BLENDER, PACKAGE, and STORAGE–for the process. Also at the Program Content level, four global devices were defined in the Device definition table–BL_H_2O_FVLV, BL_A_FVLV, BL_B_FVLV, AND PK_BLN_FVLV–and both discrete and analog I/O points were named and described in the Module definition table. The first three devices were made global in anticipation of defining separate Units for each of the feed tanks.

Once entered into the Module definition table, each I/O point was automatically entered by the APT program into the appropriate global or unit I/O symbolic name table. Most of the design work occurred at the Unit level. Figure 1 depicts the device names for the BLENDER Unit; figure 3, the blender I/O commands the depicted devices; figure 4, an excerpt from the BLENDER Unit Device definition table; and figure 5, a portion of the Module definition table. The information given in figure 5 is significant, because it defines and summarizes the controller memory types and addresses needed by the TUTSIM simulation program.

Five Continuous Function Charts were created (figure 2):

AUTO_RUN	Automatic run logic
TEMP_CTL	Temperature control logic
LEV_ALRM	Tank level alarm
INTERLK	Device interlock protection
SIMULATE	Use of 32-discrete-input hardware simulation board

A total of nine Continuous Function Blocks (CFBs) were used in these CFCs: one PID CFB, one Split-Range CFB, one Analog-Alarm CFB, one Interlock CFB, and five Math CFBs. The Interlock and Math CFBs contained APT Math programs; the remaining CFBs consisted of pre-defined forms. Figure 6 illustrates the CFB icons used in the TEMP_CTL Temp control logic CFC: a PID loop CFB, a split-range CFB, and a Math CFB. We can zoom an individual icon, as has been shown for the PID loop.

The APT entries at the Unit Content level completed the APT design process for the BLENDER unit. All during the information-entry process, tables, CFCs, Units, and finally, the entire DEMO-01B program, were "validated" to check for information-entry errors. The validation capability of APT, specially its ability to check for errors in small segments of the overall design, is outstanding. Validation reports can be saved or printed to facilitate the process of error checking. Once validated, DEMO_01E was compiled and then downloaded for execution on a TI 500 Series PLC, in our case, the TI545.

BLENDER1.SIM OrCAD/TUTSIM Simulation Program

A sketch of the blender Unit is given in figure 1. Under the assumptions that the jacket and the reactor are both perfectly mixed, the volume of the jacket and all physical properties are constant, the densities and heat

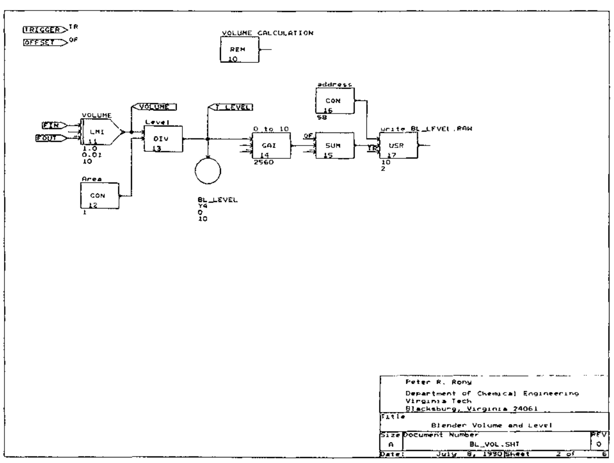

Figure 9

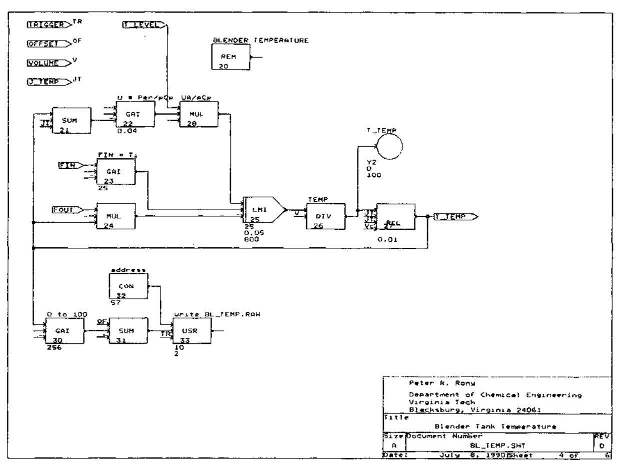

Figure 10

capacities of all inlet and outlet streams are approximately the same, and heat losses are absent, the model equations are given in figure 7. For further details, contact KER [3].

A similar process example, a continuous stirred-tank reactor simulation, is discussed in Chapter 9 of Smith and Corripio [6]; this well-documented example was used by these authors to demonstrate different approaches to the computer simulation of dynamic process models. Our article adds yet another approach (TUTSIM) to controls process simulation, one that we believe is both simpler and more intuitive. Further, this approach now lends itself readily to the development of testable control design software when a TI 500 Series controller and APT software are used concurrently.

Equations (1) through (3) in figure 7 were simulated by a TUTSIM model, called BLENDER1.SIM, that contained 62 blocks. To save space, the TUTSIM listing of BLENDER1.SIM is not published here; it is contained in the supplementary package of information available from KER [3]. An undergraduate student who has taken a one-semester analog controls course would be capable of developing and testing such a TUTSIM model.

We used CAD software to create and document the TUTSIM block-diagram simulation model for the blender. OrCAD/SDT III (see Part II) was applied to the task of simulating the system, including the exchange of values of twelve variables contained in the global and BLENDER I/O symbolic name tables, BL_LEVEL.RAW, BL_TEMP.RAW, BL_CLD_BV_OC, BL_HOT_BV_OC, BL_CLD_AVLV, BL_HOT_AVLV, BL_PRD_DV_OC, BL_PRD_DP_OC, PK_BLN_FV_OC, BL_H2O_FV_OC, BL_A_FV_OC, and BL_B_FV_OC between the BLENDER1.SIM program and the corresponding APT program, DEMO_01E, running in the TI 500 Series controller.

Figures 8 through 12 illustrate the hierarchical, OrCAD approach to the generation of the BLENDER1.SIM simulation model for the system in figures 1 and 7. Figure 8 represents the highest level of the hierarchy, which includes schematic blocks for the non-steady-state total mass balance (top block, Eq.1); the non- steady-state energy balance for the blender tank (third block, Eq. 2); the non-steady-state energy balance for the jacket (fourth block, Eq. 3); and the calculation of blender flow information (second block). The ten USR blocks in figure 12, each associated with a block or analog valve, can be understood with the help of figure 5 and table 1.

The unusual feature that distinguishes figures 8 through 12 from a traditional process simulation in a high-level language is the USR block, specially those in figure 12. Not only have we simulated the transient mass and energy balances, we have also incorporated the behavior of the valves and pump in our model. The flows of H_2O, A, B, cold water, or hot water will not occur unless the respective valve receives an open command from the TI545 controller. This may seem to be a small accomplishment, but it becomes important when the batch process control strategy incorporates automatic sequencing through the use of Sequential Flow Charts (SFCs), which determine the timing of the valve behavior. All of the I/O points can be simulated in the TUTSIM model, and the testing of the controller strategy can be relatively complete. Nine-hundred ninety-nine (999) TUTSIM blocks are sufficient to simulate an entire midrange process.

A reader who is familiar with the TUTSIM block diagram language would observe two recognizable features of the language in the OrCAD figures 9 through 12: (1) all values of the block parameters are provided below the lower-left-hand corner of each block, (2) a comment can be provided above each block.

The use of OrCAD increases the time associated with the creation of a TUTSIM model, but offers the academic and industrial advantages of more effective process model documentation, communication, and maintenance. In

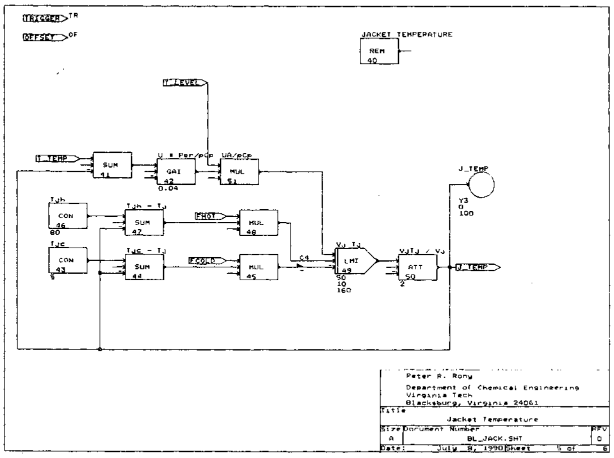

Figure 11

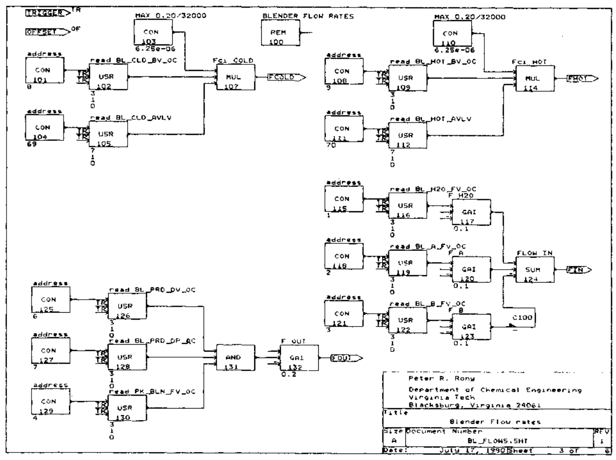

Figure 12

an academic environment, the cost of OrCAD/SDT III is prohibitive for an individual student; unfortunately, an attractively priced, restricted, student version tailored specifically to the TUTSIM block diagram language does not exist.

V. Sample Results

In the control system development sequence that we describe in this article, the blender process (figure 7) was simulated in TUTSIM. In the TUTSIM simulation program, called BLENDER1.SIM, USR-block "hooks" were provided to the memory locations of the TI 500 Series PLC that executed the desired control strategy.

The next step in the development sequence consisted of using the Application Productivity Tool (APT) software to develop a regulatory control strategy in its simplest implementation: a single PID loop (for the tank temperature), a single analog alarm (for the tank level), and a few interlocks. It is important to reiterate that the design of this simple regulatory control strategy was done at a high level, without the use of relay ladder logic (RLL), at best a difficult and inconvenient low-level language for chemical engineers. APT program DEMO_01E was compiled into TI545 object code that was immediately downloaded into the controller without conversion into RLL. Relay-ladder-logic diagrams could have been reverse generated (using Texas Instruments software, TISOFT) for use by plant technicians, but a discussion of the process for doing so is beyond the scope of this article.

For this article, two tests of the simultaneous execution of the simulation (TUTSIM) and controller (APT and TI545) codes were performed. The first was an isothermal test of the functioning of the blender inlet and outlet flow valves. The second was a closed-loop test of the heating and cooling of the blender tank filled to a height of 1 meter.

At this point, at least three programs–DEMO_01E, APT, and TUTEXEC.EXE/BLENDER1.SIM–were ready for simultaneous execution. The first was located within the TI545 controller; the second and third were located in an IBM PC/AT-class personal computer. As multitasking was not possible, first APT and then TUTEXEC.EXE/BLENDER1.SIM were executed. To start the execution of DEMO_01E within the TI545 controller, we entered the APT "debug" mode of operation, where we were able to "run" the DEMO_01E program. After initializing variables (e.g., the setpoint, proportional gain, integral time, and open/close or run/stop states of the valves and pump), we left APT, entered TUTSIM, and monitored the tank level or temperature as a function of time. To perform a different run, we needed to exit TUTSIM, reenter APT, and repeat the process but with different values for selected variables. It became a nuisance to constantly switch between APT and TUTSIM for each different simulation/controls run. This nuisance was eliminated by using a second communications port on the controller.

Second Communications Port on the TI545: Use of Multiple IBM-Class Personal Computers

The TI545 controller board (Model No. 545-1101) contains two, asynchronous-serial communication ports, an RS-232C port and an RS-422 port. A Metrabyte COM-422 board [7], purchased for $190, permitted two IBM PC/AT-class personal computers to simultaneously communicate with the controller memory. In the absence of DOS multitasking, this is a preferred form of testing. One IBM PC/AT machine executed TUTSIM, while the other executed APT. APT "debug" operation permitted us to change controller and valve variables, while TUTSIM execution permitted us to observe the effects of such changes on tank tempera-

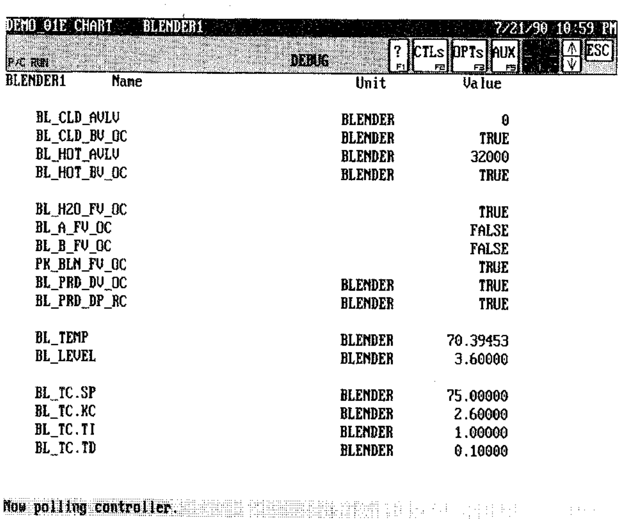

Figure 13

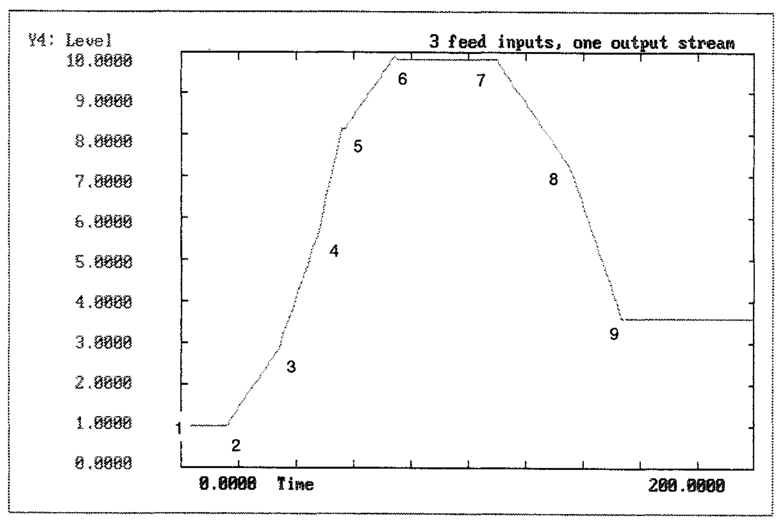

Figure 14

ture and other TUTSIM variables (e.g., jacket temperature, blender tank level, degree of synchronization of the controller and personal computer) as a function of time on a multi-color TUTSIM trend chart.

Use of Discrete I/O Hardware Simulator Boards

The test of the operation of the blender inlet and outlet valves and pump was most conveniently performed with the aid of a 32DI discrete input simulator module (Model No. 505-6010), which was equipped with a set of seventeen switches. Within the SIMULATE Continuous Function Chart, each of eight input switches was programmed in an active MATH CFB to provide the open or run commands for seven valves and one pump. Figure 13, an APT Monitor chart, summarizes the key variables that were monitored during a simulation run. To open the hot-water block valve, SWITCH34 was made TRUE, which made BL_HOT_BV_OC also TRUE.

The valve test was designed to quickly demonstrate that the simulation model, in terms of valves and flow rates, was correct. The manipulation of six input switches produced the run shown in figure 14. Initially, (1) the level was at 1 meter. The (2) BL_H2O_FV_OC, (3) BL_A_FV_OC, and (4) BL_B_FV_OC commands were then set to true TRUE to initiate the filling of the tank at rates of 0.2, then 0.4, and finally, 0.6 meters/second. The (5) outlet flow path was opened to drain the tank at a rate of 0.4 meters/second. (6) BL_B_FV_OC was then made FALSE, yielding a steady-state level of approximately 10 meters. (7) BL_A_FV_OC and then (8) BL_H$_2$O_FV_OC were made FALSE, and finally, (9) the outlet flow path was closed to leave a static tank level of approximately 3.6 meters. This successful test set the stage for valve sequencing in a Sequential Function Chart (SFC), a Layer Six (Procedural Control) activity [3].

Changing Controller Parameters from Either APT or TUTSIM

Figure 15 is a screen capture that depicts the complete story of the behavior of the PID control block, BL_TC, which is an APT object. Associated with this object are both operations and, as shown in the figure, a predefined set of discrete, integer, and real variables. Each variable is represented by a "dot extension," for example, BL_TC.SP for the setpoint, BL_TC.TI for the integral time, BL_TC.KC for the proportional gain, BL_TC.IN for the process variable, BL_TC.OUT for the controller output, and so forth. The BL_TC.IMAN, BL_TC.IAUTO, and BL_TC.ICASC discrete variables indicate whether the controller is set for manual, automatic, or cascade operation. The .HHA, .HA, .LA, and .LLA dot extensions refer to alarm ranges associated with the controller input. Any "dot extension" variable can be used in a mathematical expression present in a CFB or SFC. At this point in the development of the controller strategy, only the .IAUTO, .IMAN, .NRDY, .SP, .IN, .OUT, .KC, and .TI dot extension variables were used; all other variables were ignored.

Figure 16 is a portion of the APT Symbol-Name-to-PLC-Address that provides the specific addresses for some of the dot-extension variables shown in figure 15. BL_TC.SP is real memory address V1., a 32-bit floating-point quantity. PLC addresses V1., V5., and V7. were used as the basis for several additional TUTSIM blocks, shown in figure 17, that permitted both reading and writing the setpoint, proportional gain, and integral time directly from our TUTSIM program, BLEND-

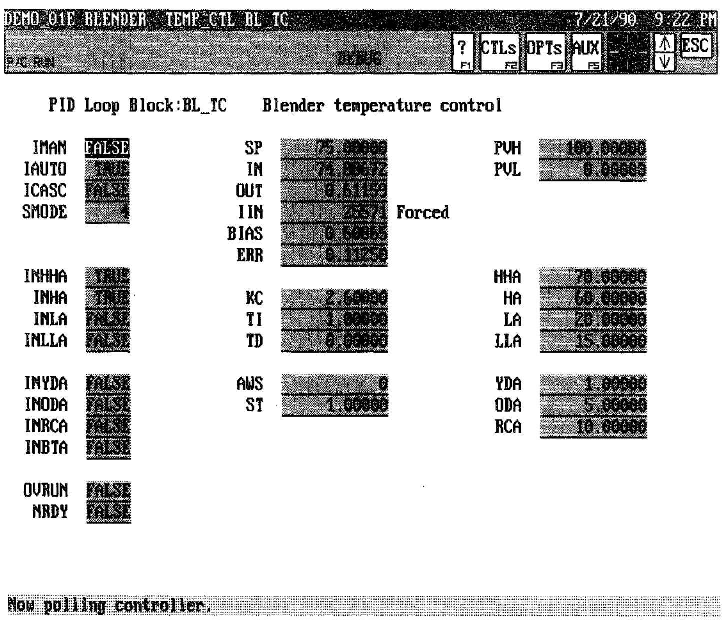

Figure 15

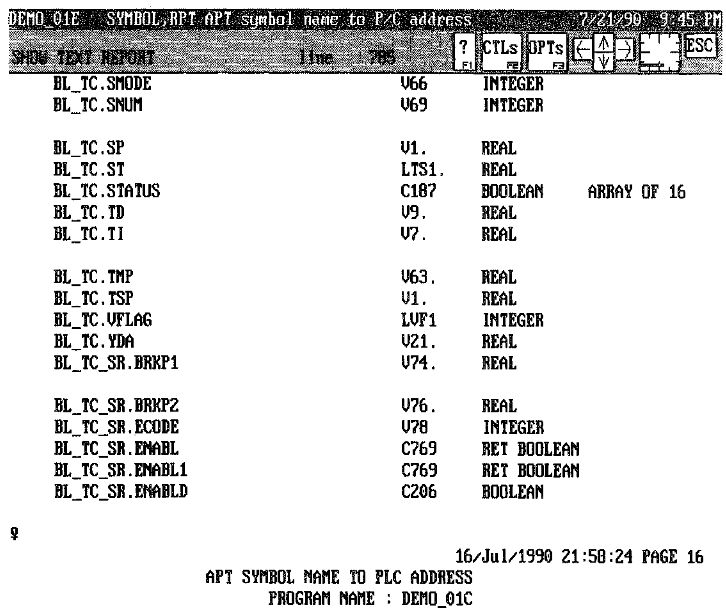

Figure 16

ER1.SIM. This capability to write different values of .SP, KC, and TI allowed us to use the "multi-run" feature of TUTSIM to follow the behavior of the blender tank temperature as a function of four different setpoints (see figure 18), which was part of our test of the closed-loop behavior of the process.

It should be emphasized that, with the above two tests, we report progress only to Layer Four (Level 1) of the control system design methodology recommended by Arnold [2]. We also implemented Layer Five (Level 1), the development of a rudimentary operator station using the Texas Instruments Micro-TISTAR software. [3]

VI. Application to Undergraduate Controls Education

The development and use of the USRBLK.EXE driver for the TI 500 Series of programmable logic controllers provides a bridge in academia between the traditional undergraduate lecture/lab sequence on process control and industrial practice based upon increasingly powerful and cost-effective PLCs. We believe that APT, TUTSIM and the TI545 are, as a group, responsive to the following comments made by Irv Rinard (CUNY) in a recent round table discussion on process control education in the year 2000 [8]:

"Another concern is that the focus of process control has been too narrow. Algorithms and their implementation have received most of the attention. Students go forth only to learn that measurements can be biased, or noisy, or fail altogether; that control valves stick; and that other critical items are either messed up or maxed out. Tuning a loop is more than just determining P, I, and D; it is also zeroing and spanning, fixing and adjusting, and sometimes even rewiring... Along the same lines, students go forth thinking that the regulatory control system is it. They are almost totally unaware that the most important control system in the plant is not the regulatory control system, but the safety system..... What I would like to see is a revision of the entire curriculum to make it more model-based. Students should connect the basic idea of dynamic simulation to the solution of differential equations early on. Then, in the various courses, the appropriate models would be developed as a pedagogical tool..... I have found in teaching process control that modeling is what the students are weakest in."

Jim Doss (Tennessee Eastman), in the same round-table discussion, stated [8]:

"...other digital devices such as PLCs and their use in interlocks are important, combined with discussion on alarms and process safety. Finally, students need to understand the concept of total plant control."

Finally, table 2, "Additional Topics for Undergraduate Process Control," in the same article [8] suggested,

- Alarms
- Computer control systems, data acquisition
- Simulation
- Unit operations controls applications
- Batch sequence control
- Process control data base management

topics which are consistent with the use of APT, TUTSIM, and the TI545 in the undergraduate controls sequence.

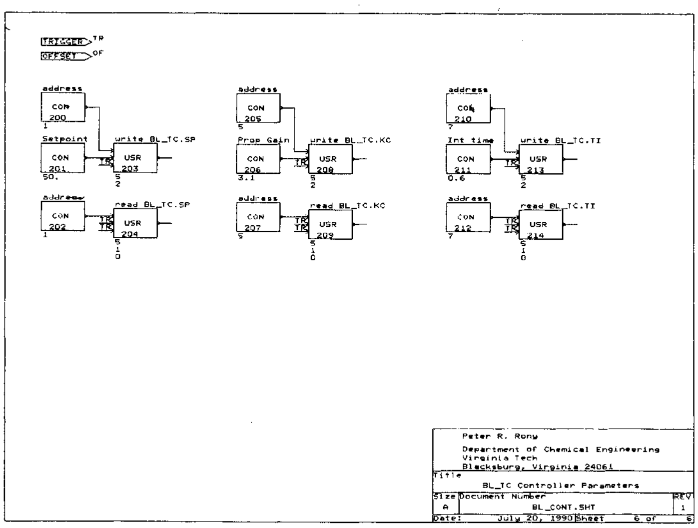

Figure 17

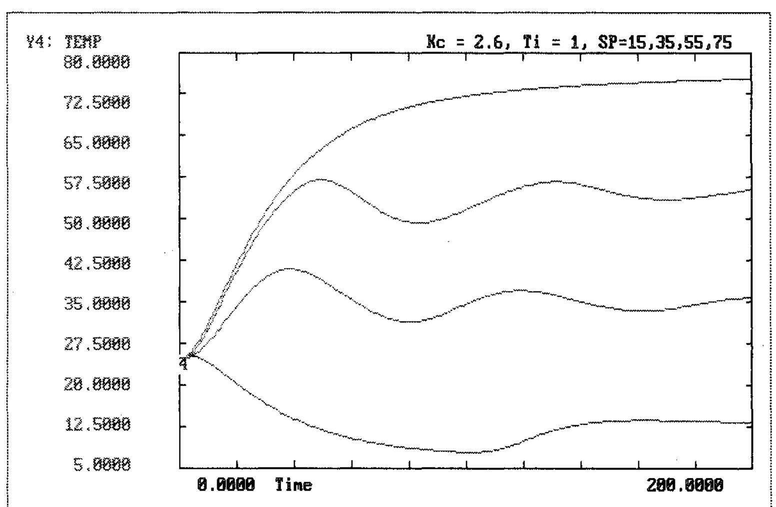

Figure 18

Biographical Sketch

Karl E. Rony received his B.S.ChE in 1987 from Virginia Polytechnic Institute and State University. In February 1988, he joined the Texas Instruments Industrial Systems Division, Johnson City, Tennessee, as a Control Systems Specialist. A member of the APT Development Group, he is proficient with APT, TISTAR, and TUTSIM in the design, simulation, and testing of PLC-based control designs.

Peter R. Rony received his B.S. ChE in 1960 from Caltech and his PhD from the University of California at Berkeley in 1965. During 1980 through 1985, he served as associate editor-in-chief and then editor-in-chief of the IEEE Computer Society magazine, IEEE MICRO. He currently is editor of CAST Communications.

References

1. Kay E. Kuenker and Gary E. Blau, "SimuSolv*: A Computer Program for Building Mathematical Models," CAST Communications 12 (1), 10–21 (March 1989).
2. John A. Arnold, "Process Control Software Design," presentation to Texas A & M, January 16, 1990. Contact John at Texas Instruments Incorporated, Industrial Systems Division, Erwin Highway, P.O. Drawer 1255, Johnson City, TN 37605-1255, (800) 284-9084, extension 2078. John received his PhD in Chemical Engineering Department at the University of Tennessee.
3. For additional information, contact Karl Rony, APT Development Group, Texas Instruments Incorporated, Industrial Systems Division, Erwin Highway, P.O. Drawer 1255, Johnson City, TN 37605-1255, (800) 284-9084, extension 2078.
4. APT Programming Reference Manual, Texas Instruments Incorporated, Industrial Systems Division, Johnson City, Tennessee, Apt-8102, Second Edition (March 1990).
5. For further details, contact TUTSIM Products, 200 California Avenue, #212, Palo Alto, CA 94306, (415) 325-4800.
6. Carlos A. Smith and Armando B. Corripio, "Principles and Practice of Automatic Process Control," Wiley, 1985, pp. 471-491.
7. Keithley/Metrabyte/Asyst/DAC, 440 Myles Standish Blvd., Taunton, MA 02780, (508) 880-3000.
8. Tom F. Edgar, "Process Control Education in the Year 2000: A Round Table Discussion," Chemical Engineering Education 72-77 (Spring 1990).

Figure and Table Captions

Figure 1. The BLENDER unit in the three-component, blender/packaging process. Device names are specified.

Figure 2. The three-level APT hierarchy consisting of the Program Directory Level (highest level), Program Content Level (middle level), and Unit Content Level (lowest level).

Figure 3. The BLENDER unit of Figure 1 with blender I/O signal names specified.

Figure 4. A portion of the Device definition table for the BLENDER unit of figure 1.

Figure 5. A portion of the Module definition table for the DEMO_01E APT program.

Figure 6. The three CFB icons associated with the TEMP_CTL Continuous Function Chart.

Figure 7. The three non-steady state equations, along with variable and parameter definitions, for the blender in figure 1.

Figure 8. The highest level of the OrCAD hierarchy for the design of the TUTSIM blender simulation: overall schematic for the BLENDER1.SIM blender simulation.

Figure 9. The TUTSIM/OrCAD diagram that represents the non- steady-state equation for the blender volume.

Figure 10. The TUTSIM/OrCAD diagram that represents the non- steady-state equation for the blender temperature.

Figure 11. The TUTSIM/OrCAD diagram that represents the non- steady-state equation for the jacket temperature.

Figure 12. The TUTSIM/OrCAD diagram that represents the blender flow streams.

Figure 13. APT Monitor chart, obtained during "debug" operation.

Figure 14. Testing of the operation of the blender tank inlet and outlet flow valves and pump. This quick and simple test confirms that the valve-and-pump simulation is correct.

Figure 15. APT PID loop chart, obtained during "debug" operation.

Figure 16. A portion of the APT Symbol-Name-to-PLC-Address table provides information on the controller memory types and addresses. Such information is needed for the TUTSIM USR blocks, such as those in figure 17. Additional TUTSIM blocks provide read/write capability for the PLC variables BL_TC.SP, BL_TC.KC, and BL_TC.TI.

Figure 17. The TUTSIM/OrCAD diagram that provides read/write capability for BL_TC controller parameters such as the setpoint, proportional gain, and integral time.

Figure 18. Closed-loop testing of the operation of the blender cold- and hot-water streams. The proportional gain was 2.6, the integral time was 1. min, and the four setpoints were 15 °C, 35 °C, 55 °C, and 75 °C.

Table 1. Documentation for USRBLK.EXE: TI 500 Series Controller memory address types, read/write functions, and types of inputs for the USA /USR blocks.

PARAM1: Types of address

1 C read/write (Boolean variable)

2 X read/write (Boolean variable)

3 Y read (Boolean variable)

4 V read/write (16-bit integer)

5 V. read/write (32-bit floating point)

6 WX read/write (16-bit integer)

7 WY read (16-bit integer)

8 C read/force write (Boolean variable)

9 X read/force write (Boolean variable)

10 WX read/force write (16-bit integer)

PARAM2: Read/write functions

1 Read value from TI 545 PLC location IND_INPUT[1] and stuff in USR_OUTPUT

2 Write value IND_INPUT[2] to TI 545 PLC location IND_INPUT[1] (USR_OUTPUT = 0)

PARAM3: Initial value

The USR block can accept an initial value.

Inputs:

Must be in proper sequence, like the DIV block.

Input1 IND_INPUT[1] Integer value of address type specified in PARAM1

Input2 IND_INPUT[2] Value of TUTSIM variable to be written to PLC

Input3 IND_INPUT[3] USR/USA block trigger input; the USR block triggers on the positive edge of a logical clock pulse; the USA block triggers on a logic 1 level.

Note: The difference between the USA and USR blocks is important. USR is a TUTSIM history block that requires an initial condition, which is the first value that is output by the block. USA is a TUTSIM algebraic block, which is not a history block. History blocks execute in parallel, while non-history blocks execute in the order of the block diagram.

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Communications

Listening In

by Peter R. Rony

John Hassler (University of Maine), who monitors USENET via BITNET, sent the following information on July 11, 1990, excerpts of which we are publishing as an example of the vitality of electronic communications in the field astronomy. Some of this information was subsequently published in the July 20, 1990 issue of Science magazine ("Hubble: It Could Have Been Worse," page 242).

Like John, I admire the immediacy associated with the astronomy community. Do engineers tend to be more isolated in their activities and less likely to participate in electronic conferencing and bulletin boards? I doubt it. But neither do I have a good, recent example of this type of immediacy in chemical engineering.

"HST Status Report"
Number 60
July 09 1990

Current Status and Summary

"This past weekend has been rather quiet at HST. Since my last report we finished Bootstrap Phase B part 5f and started part 5g. The biggest event of the past few days occurred yesterday evening and today: a successful series of FOC exposures. Stars were seen with good S/N and excellent overall data quality. Very preliminary analysis suggests that significant coma was NOT seen in the images, suggesting that the primary mirror is the source of the spherical aberration (see below). Another piece of good news regarding the characterization of the HST wavefront: modifications to the procedures for how we have been using wavefront sensors (WFS) 2 and 3 have produced the first good data from these sensors since launch. The only piece of bad news was that some WFPC images were lost do to a series of operations events that could have been avoided. This and the safing event of last Thursday has people taking a long hard look at real time operations procedures."

PCS

"The only news on the PCS front regards the day/night terminator instability fix. A meeting has just concluded discussing current expectations for the new control law. Optimism is still high that they can meet pre-launch specs, but I have noted that they have backed off a bit on how much they can reduce the disturbance amplitude from an informal quote about 2 weeks ago of a 10 to 100 reduction to a current guess of a 5 to 60 reduction factor. The current worst case disturbance is approximately 110 milliarcseconds RMS (2 milliarcsec RMS is the spec value). As of the moment the repair is on schedule with delivery to GSFC in late July/early August."

HST Focusing and Image Quality

"The big news here is the successful series of FOC images: 4 last night and 4 (I think) this afternoon. The images were through a narrow (30 A) H-beta filter of a 12–13 magnitude star near eps Sco. Analysis has just begun, so there are no quantitative results. The images have good S/N and should yield excellent data. The images are quite similar to those taken with the PC: a sharp with a big (approximately 1.5-2 arc second) halo with lots of rings, rays, and the such. A quick look at the data seems to show a stellar image that is similar (in gross detail) to the PC images with no obvious asymmetry (i.e. coma). If this is confirmed with quantitative analysis, it would suggest that the primary mirror is responsible for the spherical aberration. There is also a rumor circulating that suggests a possible origin for the spherical aberration: it has been reported that if the null lens used to test the primary were installed backwards that you would get a degree of spherical aberration similar to what is seen in HST. Obviously, more on this later. The only mirror movements have been to move the secondary to the "zero reference" position–the favored WFPC focus position. More mirror movements will be occurring this week now that we have FOC images....."

Ron Polidan

Process Data eXchange Institute (PDXI)

by John T. Baldwin

The organizing of PDXI, which is supported by CAST, continues *on schedule*. The AIChE Council agreed to the formation of PDXI subject to sufficient membership being acquired, and the By-laws of the organization have been assembled and accepted. With this issue of the *Newsletter*, a copy of a brochure has been included summarizing the proposed activity.

PDXI focusses on a real and readily identifiable problem that is solvable! However, there needs to be wide participation so that the resulting solution will be widely accepted. The membership fee is reasonable at $5,000 per year per company, and the solution should be forthcoming in two years if enough join.

From a technical viewpoint, there is also reason to be involved because the technology of data exchange does impact us but receives limited attention by our profession. The organizing committee delved into the technology enough to set funding requirements and expected timeframe for the solution. During that experience, it was found that the technology of data exchange is progressing, that it continues to have an increasing impact on our daily activities, and that there is a challenge to make good use of the technology.

Finally, there are similar activities in organizations such as IChemE, GPA, NIST, and ASTM. Although none of the other activities address the particular issue being addressed by PDXI, the PDXI effort needs to proceed to ensure that our interests are adequately catered.

Plans are being made for the first PDXI meeting to take place at the Chicago AIChE meeting in November. Contact PDXI at the address and phone number on the brochure to pursue potential involvement.

CAST Experiment – Chicago AIChE Meeting

by Alan Foss, University of California, Berkeley

Many faculty members have developed PC instructional software which is of interest to other academics for potential use in their own classes. To facilitate an information exchange process, CAST will arrange for two or more PC-AT or 386 class machines with hard disk drives and VGA graphics to be used by academics who wish to demonstrate their software. Details of the location and times will be posted on the A.I.Ch.E. notice boards at the Annual Meeting. In the meantime, will interested persons please contact Professor Alan Foss, Department of Chemical Engineering, University of California, Berkeley, CA, 94720-9989, (415) 642-4526. Fax: (415) 642-4778.

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Meetings and Conferences

The following items summarize information in the hands of the Editor by June 30, 1990. The preferred deadlines for the two issues of CAST Communications–called the Summer and Winter issues–will be approximately May 15 and December 15 several weeks after the Spring and Fall AIChE meetings, respectively. These revised deadlines will give CAST division members who are active in CAST programming activities sufficient time after AIChE meetings to send last-minute information to both the Publications Board Chairman (Jeff Siirola) and the Editor of the newsletter (Peter Rony). We prefer that all communications with us be done in electronic form, either with MS DOS formatted diskettes or with messages sent electronically over BITNET. An up-to-date listing of proposed sessions and Calls for Papers will be maintained electronically by the Publications Board Chairman. CAST Division members can always request such information by sending a BITNET message to RONY at VTVM1.

Authors are reminded that under current AIChE meeting policy, the meeting booklet will contain only titles of the papers presented. However, a book of extended abstracts is distributed to attendees at the meeting. Moreover, authors may bring hard copies of their papers for distribution at their session, and hard copies or microfiche may be ordered at or after the meeting.

Please send CAST Division session information, Calls for Papers, and meeting and short course announcements to me by December 15, 1990 for inclusion in the "Winter 1991" issue of CAST Communications. For those members of the CAST Division who are engaged in the presentation of seminars and short courses, an advance (draft) copy of your announcement brochure would be appreciated.

. . . *Peter R. Rony, Editor, CAST Communications*

Process Integration Using Pinch Technology Linnhoff–March, Inc. Chicago

October 2-5, 1990

Houston

October 30–November 3, 1990

Every engineer knows that there is often scope for improvement in process designs. But what about a particular design? Can it be improved? By how much? Until recently, there was no satisfactory answer to these questions. But now, for the first time, there is an entirely fundamental approach that answers the question of how much a process can be improved. The technique is Pinch Technology, which was developed by Professor B. Linnhoff. Pinch Technology provides a clear picture of energy flow in a process, and identifies the most constrained part of the process: the process pinch.

Application of Pinch Technology in a wide range of industries has yielded outstanding results. Engineers report energy cost savings of 15% to 30%, capital cost reduction, improved flexibility and operability, and increased plant capacity. To date, there have been hundreds of successful studies.

This is the standard introductory course in Pinch Technology that Linnhoff-March offers most frequently. It features a combination of lectures and working sessions, and covers energy targeting, heat exchange network design, data extraction, process modifications, and other related topics. The instructors for the course are Mr. M. A. Rutkowski, Mr. J. D. Kumana, Mr. A. P. Rossiter, and Dr. Ravi Nath. For information, please call Linnhoff-March, Inc., 2 Cardinal Park Drive, Suite 205A, Leesburg, VA 22075, (703) 777-4145.

Statistical Process Quality Control (AIChE Course), Tennessee Eastman Co., Kingsport, Tennessee

October 9–10, 1990

Quality improvement in industry involves a management philosophy geared both toward excellence in every detail of operation and a set of statistical tools necessary to achieve excellence through improved quality and increased productivity.

This two-day seminar, presented by Dr. Victor Zaloom, Professor and Head of Industrial and Mechanical Engineering at Lamar University, has been designed for engineers and managers in all aspects of process industry operation, including technical and service departments as well as production and operations. Lectures and video tapes are utilized to present concepts and statistical methods. These presentations are then followed by exercises requiring small group discussion and numerical calculations.

Course Topics:

- Motivation for Quality
- Tools of Statistical Quality Control (SQC)
- Control Charts for Variables
- Control Charts for Attributes
- Special Process Industry Applications
- Quality Circles
- Management Responsibility for Quality Problems and Pitfalls

Course fee is $250 per person. Registration Deadline: September 10, 1990 (if your interest develops after this date, contact AIChE anyway. . . Ed.) For information, contact AIChE Symposium, PO Box 511, Kingsport, Tennessee 37662, Attention Joe Parker.

Chicago AIChE Meeting

November 11-16, 1990

The Palmer House. Meeting Program Chairman: Dr. Charles A. Wentz, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439, (708) 972-7693.

For further information details concerning CAST Division sessions and scheduling, contact Jeffrey J. Siirola (Area Programming Chairman), Research Laboratories – B95, Eastman Chemical Company, P.O. Box 1972, Kingsport, TN 37662, (615) 229-3069.

The CAST Division is planning the following sessions at the Chicago Annual meeting.

Area 10A: Systems and Process Design

1-2. Process Synthesis I and II.

3-5. Design and Analysis I, II, and III.

6. Modeling and Simulation for Process Design.

7. Batch Process Engineering.

8. Design for Process Innovation.

Area 10B: Systems and Process Control

1-3. Recent Advances in Process Control I, II, and III.

4. Nonlinear Control.

5. Model Predictive Control.

6. Artificial Intelligence/Neural Networks in Process Control.

7. Process Control Education in the 1990's.

8. Industrial Challenge Problems in Process Control.

9. New Concepts in Dynamic Simulators.

Joint Area 10B and Area 15C Session

1. Modeling and Control of Biochemical Processes.

Area 10C: Computers in Operations and Information Processing

1-2. Advances in Optimization I and II.

3-4. Parallel Computing I and II.

5. Visualization of Chemical Engineering Systems.

6-7. Application of Neural Networks in Process Engineering.

Area 10D: Applied Mathematics and Numerical Analysis

1. Mathematical Analysis of Complex Systems.
2. Applied Mathematics and Numerical Analysis.
3. Chaos in Deterministic Systems and Applications in Chemical Engineering.
4. Novel Applications of Mathematics in Chemical Engineering.
5. Recent Developments in Numerical Methods for ODE/DAE/PDE Systems.

Computer Process Control IV (CPC-IV)
South Padre Island, TX
February 17–22 1991

About Previous Conferences:

The first Chemical Process Control Conference (CPC-I) was held in Asilomar, California in 1976, the second (CPC-II) in Sea Island, Georgia in 1981, and the third (CPC-III) again at Asilomar. These conferences were sponsored by the AIChE and NSF, and they brought together participants from industry, government, and universities to discuss and critique the current state of process control. Some 15 foreign countries were represented by participants in the first three Conferences. These meetings have come to be regarded as milestones in the process control field. They have not only served to highlight recent developments, but they have had a decisive impact on research efforts in the succeeding years. They have helped to narrow the gap between process control theory and application.

About the CPC-IV Conference:

As a continuation of the traditions of the first three conferences, CPC-IV will focus on advances that have taken place recently in the process control field. These will be put in perspective and used to define the practical needs and intellectual challenges of the next decade. Thus, the theme of the conference will be "Future Needs and Challenges in Process Control." The specific goals of CPC-IV are as follows:

1. To gain an appreciation of the state of process control practice in each of the process industries, and to obtain from industry a list of future needs and challenges for the research community.

2. To present an overview of the state of the art in each of the important areas of process control theory and practice, presented in a way that is understandable to the non-specialist and industrial practitioner.

3. To provide a forum for in-depth discussions between university researchers and industrial practitioners on the practical challenges in this field and the extent to which current research directions are satisfying perceived needs.

4. To allow the industrial practitioner a better understanding of the new tools available from the research community in order to stimulate wider implementation where these are useful.

5. To stimulate the research community to adjust research directions through (a) a better understanding of perceived needs and challenges from the process industry, and (b) a tutorial introduction to intellectual concepts in other areas of process control research.

Based on the experience from past CPC meetings, we expect to have a group of participants that is about 70% from industry and 30% from universities. Thus, we should have the right mix to achieve the stated goals.

All conference sessions will be held during mornings and evenings, leaving the afternoons for informal discussions and recreational activities. To provide an atmosphere for active participation and substantial discussion, the number of attendees will be limited, with selection made on the basis of involvement in the field of process control.

Location of the Conference:

The conference will be held at the Sheraton South Padre Island Beach Resort, (800) 222-4010, on South Padre Island, Texas. Situated on the south end of Padre Island, near the Mexican border, the location offers sunshine, beach, swimming, fishing, sailing, golf, and tennis. The hotel is approximately 40 minutes by car, limousine, or taxi from the Harlingen airport, which has frequent flights from Houston and Dallas.

Accommodations and Meals:

Arrangements have been made for special room rates beginning at $60 per night for a room with two beds. There is a conference meal package ($282), which includes 3 meals a day and all social functions.

CPC-IV Program:

Sunday, February 17

Keynote Talk – "The Best of the Best in Advanced Process Control," by J. F. Swallow (A. T. Kearney, Inc.)

Monday, February 18 (a.m.)

Present Status and Future Needs – The View From Industry (Session Chairman, W. D. Smith, Jr., DuPont)

"The View from Japanese Industry," by I. Hasimoto (Kyoto) and S. Yamamoto (Yokogawa Elec.)

"The View from European Industry," by H. Shuler (BASF), F. Allgower, and E. D. Gilles (Stuttgart)

"The View from North American Industry," by J. Doss and J. Downs (Tennessee Eastman)

Panel Discussion

Monday, February 18 (p.m.)

On-Line Sensors and Data Analysis (Session Chairman, D. E. Seborg, Santa Barbara)

"Multivariate Statistics in Process Control," by J. MacGregor (McMaster)

"Application of Neural Nets to Sensors and Data Analysis," by M. Piovoso and A. Owen (DuPont)

Panel Discussion

Tuesday, February 19 (a.m.)

Dynamic Process Simulation, Modelling, and Identification (Session Chairman, S. B. Jorgensen, T. U. Denmark)

"Dynamic Process Simulation–Recent Progress and Future Challenges," by W. Marquardt (Stuttgart)

"An Industrial Perspective on Dynamic Flowsheet Simulation," by E. Vogel (Tennessee Eastman)

"Qualitative Process Modelling," by K. Hangos (Hungarian Acad. Sci.)

"Advances in Process Identification," by H. W. Andersen, K. H. Rasmussen, and S. B. Jorgensen (T. U. Denmark)

Panel Discussion

Tuesday, February 19 (p.m.)

Model-Based Process Monitoring and Control I (Session Chairman, D. G. Fisher, Alberta)

"Model Predictive Control – State of the Art," by N. L. Ricker (Washington)

"Experience with DMC Inverse for Model Identification," by C. Cutler (DMC Inc.)

"MPC Applied to an FCC Process," by J. M. Caldwell and J. G. Dearwater (Profimatics)

"Beyond the Design of Predictive Controllers," by C. Garcia and B. Ramaker (Shell)

Panel Discussion

Wednesday, February 20 (a.m.)

Model-Based Process Monitoring and Control II (Session Chairman, N. L. Ricker, Washington)

"The Robustness of Model Predictive Controllers," by E. Zafiriou (Maryland)

"Adaptive Generalized Predictive Control," by D. W. Clarke (Oxford)

"Model Preditive Control – The Good, The Bad, and the Ugly," by M. Morari (Caltech)

Panel Discussion

Wednesday, February 20 (p.m.)

Recent Approaches for the Control of Nonlinear Processes (Session Chairman, C. Georgakis, Lehigh)

"The Industrial Importance of Nonlinear Control," by E. Longwell (DuPont) and R. MacFarlane (Amoco)

"The Differential Geometry Approach to Nonlinear Control," by C. Kravaris (Michigan), J. Kantor (Notre Dame), and Y. Arkun (Georgia Tech)

"The 'Direct' Approach to Nonlinear Control," by P. Lee (Queensland) and C. Georgakis (Lehigh)

"The Optimal Control Approach to Nonlinear Control," by J. Rawlings (Texas) and L. Biegler (CMU)

Panel Discussion

Thursday, February 21 (a.m.)

Learning Systems, Adaptive and AI Control (Session Chairman, T. J. McAvoy, Maryland)

"Neural Networks - Overview, Programming, and Adaptation," by J. Hopfield (Caltech)

"Towards Improved Process Supervision - Algorithms and Knowledge-Based Systems," by A. J. Morris, G. A. Mogague, and M. T. Tham (Newcastle)

"Towards the Intelligent Controller - Formal Integration of Pattern Recognition with Control Theory," by G. Stephanopoulos (MIT)

"A Neural Network Methodology for Process Fault Diagnosis," by V. Venkatasubramanian (Purdue)

Panel Discussion

Friday, February 22 (a.m.)

Control Technology in the Year 2000 (Session Chairman: T. F. Edgar, Texas)

"Fuzzy Logic and Its Applications," by L. Zadeh (Berkeley)

"Real-Time Estimation and Control Architectures - The Future," by J. Baras (Maryland)

"Microelectronics Factory of the Future," by G. Larrabee (Texas Instruments)

Panel Discussion: Control Room of the Future

Application Form for CPC-IV Conference:

In order to limit the conference size to preserve an atmosphere for creative discussion, attendance at the CPC-IV Conference will be limited and is by invitation following receipt of this application form. You will be notified whether you will be able to attend the conference. The conference fee of $450 will cover registration and a copy of the proceedings. The meal package is $282 per person (registrant or guest). Please complete and send this application by September 30, 1990 to:

CACHE Corporation
P. O. Box 7939
Austin, TX 78713-7939

Name:

Title:

Affiliation:

Mailing Address:

Telephone:

Conference Sessions of Main Interest:

Main Area of Research Interest:

Houston AIChE Meeting
April 7-11, 1991

Meeting Program Chairman: Dr. John G. Ekerdt, Department of Chemical Engineering, University of Texas, Austin, TX 78712, (512) 471-4689, (512) 471-7060 (FAX).

The CAST Division is planning the following sessions at the Houston National meeting. The overall theme for the meeting will be "Tools for Chemical Engineers in Plant Operations and Maintenance." Deadlines and final call for papers for this meeting appear later in this issue.

Area 10A: Systems and Process Design

1. **Applications of Artificial Intelligence in Process and Product Design.** Babu Joseph (Chairman), Department of Chemical Engineering, Washington University, St. Louis, MO 63130, (314) 889-6076 and Krishna R. Kaushik (Vice Chairman), Shell Oil Company, PO Box 6249, Carson, CA 90749, (213) 816-2276.

2. **Industrial Applications of Optimization.** Emilio J. Nunez (Chairman), Shell Development Company, PO Box 1380, Houston, TX 77251, (713) 493-8866 and David R. Heltne (Vice Chairman), Shell Development Company, PO Box 1380, Houston, TX 77251, (713) 493- 7325.

3. **Process Design and Simulation**. Michael F. Malone (Chairman), Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003-0011, (413) 545-0838 and Peter T. Cummings (Vice Chairman), Department of Chemical Engineering, University of Virginia, Charlottesville, VA 22903-2442, (804) 978-4726.

4. **Retrofit Design Techniques and Applications.** Don R. Vredeveld (Chairman), Union Carbide Corporation, PO Box 8361, South Charleston, WV 25303, (304) 747-4829 and Michael F. Malone (Vice Chairman), Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003-0011, (413) 545-0838.

Joint Area 10A and Area 16B Session

1. **Computer-Aided Engineering / Computer-Aided Design (A Tutorial).** C. K. Breaux (Chairman), ProsysTech, Inc., 7007 Gulf Freeway, Suite 133, Houston, TX 77087, (713) 641-0940.

Area 10B: Systems and Process Control

1. **Intelligent Control.** Ali Cinar (Chairman), Department of Chemical Engineering, Illinois Institute of Technology, Chicago, IL 60616, (312) 567-3042 and William D. McGraw, Aluminum Company of America, Alcoa Center, PA 15069, (412) 337-2755.

2. **Industrial Applications of Process Control.** James B. Riggs (Chairman), Department of Chemical Engineering, Texas Technical University, Lubbock, TX 79409, (806) 742-1765 and Gerardo Mijares (Vice Chairman), M. W. Kellogg Company,

Three Greenway Plaza, Houston, TX 77046-0395, (713) 960-2032.

Area 10C: Computers in Operations and Information Processing

1. **On-line Fault Administration.** David M. Himmelblau (Chairman), Department of Chemical Engineering, University of Texas, Austin, TX 78712, (512) 471-7445 and Venkat Venkatasubramanian (Vice Chairman), School of Chemical Engineering, Purdue University, West Lafayette, IN 47907, (317) 494-0734.

2. **Plant-wide Management Systems.** K. R. Kaushik (Chairman), Shell Oil Company, PO Box 6249, Carson, CA 90749, (213) 816-2276 and A. L. Parker (Vice Chairman), Shell Oil Company, PO Box 10, Norco, LA 70079, (504) 465-7142.

3. **Computer Integrated Manufacturing.** C. E. Bodington (Chairman), Chesapeake Decision Sciences, PO Box 275, San Anselmo, CA 94960, (414) 453-4906 and Rufus A. Baxley (Vice Chairman), Digital Equipment Corporation, 5555 Windward Parkway West, Alpharetta, GA 30201, (404) 772-2121.

4. **Innovative Uses of Spreadsheets in Engineering Calculations.** Randy A. Freeman (Chairman), Monsanto Company - F2WG, 800 N. Lindbergh Blvd., St. Louis, MO 63167, (314) 694-6068 and Bruce M. Vrana (Vice Chairman), E. I. DuPont de Nemours & Co., PO Box 6090, Newark, DE 19714-6090, (302) 366-6211.

5. **Applications of Expert Systems.** James F. Davis (Chairman), Department of Chemical Engineering, Ohio State University, Columbus, OH 43210-1180, (614) 292-0090 and Duncan A. Rowan (Vice Chairman), E.I. DuPont de Nemours & Company, PO Box 6090, Newark, DE 19714-6090, (302) 366-6453.

Joint Area 10C and Area 5D Session:

1. **Applications of Robotics.** Michael Tayyabkhan (Chairman), Tayyabkhan Consultants, Inc., 62 Erdman Avenue, Princeton, NJ 08540, (609) 924-9174 and John Jepsen (Vice Chairman), Clark Materials Handling Co., Route 2, Box 46, Highway 33, Versailles, KY 40383, (606) 873-9973.

Area 10D: Applied Mathematics and Numerical Analysis

No Sessions are planned.

Advanced Process Systems Engineering: Concepts and Practice
Engineering Design Research Center
Carnegie Mellon University
Pittsburg, PA
June 3–7, 1991

This 5-day course stresses the application of recently developed design concepts and optimization-based strategies to practical process problems. Geared to technical managers, industrial researchers and tool developers, this course provides practical information and exposure to powerful modeling tools for process synthesis, analysis, optimization and planning. In addition the course emphasizes systematic solution approaches and provides the necessary background to understand the tools and apply them effectively and efficiently to process problems.

Topics of this course include concepts for process synthesis (heat integration, separation systems, reactor networks), expert systems, modeling environments, flowsheet optimization, mixed-integer optimization models for process synthesis, strategies for retrofit design, differential/algebraic systems, and planning and scheduling of batch processes. Course participants will address these topics through lectures and hand-on workshops making extensive use of powerful computer software. Also, a comprehensive set of lecture notes and handouts will be provided.

The instructors of the course are Professors Larry Biegler, Ignacio Grossmann and Arthur Westerberg. For information please call (412)268-2207, or write to Post College Professional Education, Carnegie Mellon University, Mellon Institute, 4400 Fifth Avenue, Pittsburgh, PA 15213, Attn: Frank E. Nowak, Director.

Fourth World Congress of Chemical Engineering
Karlsruhe, West Germany
June 16–21, 1991

This conference, which will directly follow the exposition ACHEMA '91, will be held under the auspices of the European Federation of Chemical Engineering and is being organized by its German Member Societies with participation by AIChE. The main subject of the Congress will be "Strategies 2000" and will stress the interdependence of strategic societal goals, applications in the process industries, and fundamentals and methods of chemical engineering. Of particular interest to members of the CAST Division might be the sessions on Process Synthesis and Analysis, and Process Control, Simulation, and Optimization. Deadline for submission of proposed abstracts was June 15 1990, but paper selection will not be made until October. For additional information, contact Dr. Verle N. Schrodt, Bureau of Engineering Research, University of Alabama, Box 870201, Tuscaloosa, AL 35487-0201, (205) 348-1591 or (205) 348- 9455 (FAX).

Fourth International Symposium on Process Systems Engineering
(PSE '91)
Montebello, Quebec, Canada
August, 4–9 1991

This conference is being sponsored by the Canadian Society for Chemical Engineering (Systems and Control Division), the National Research Council of Canada (NRC), and the American Institute of Chemical Engineers (CAST Division). It is the fourth in a triennial series entitled PSE, and follows highly successful events in Kyoto in 1982, Cambridge in 1985, and Sydney in 1988.

Following the tradition of the PSE series, the emphasis in 1991 will be on the presentation of new information on either technology or its application. Papers describing applications will be especially welcomed, particularly where they contain detailed information relating to the value of a study.

Seven technical sessions are planned, each to be conducted by a Chairman-Rapporteur, containing presentations of five to six papers with full discussion. Following the successful poster sessions in previous PSE conferences, similar sessions are planned this time. All of the papers to be presented will be refereed and the Conference Proceedings will be published. Conference topics include:

Design

- Flowsheeting
- Steady-State, Batch and Dynamics
- Physical Properties and Data Bases
- Optimization
- Hazards and Reliability

Process Operations

- Identification and Control
- Real-Time Optimization
- Statistical Process Control
- Plant Monitoring and Diagnosis
- Human Factors

Methods and Systems

- Data Bases
- Integrated Process and Systems Engineering
- Computing Environments
- Integrating Marketing and Operations

New Frontiers

- Expert Systems
- Neural Networks
- Education

Thinking of Attending:

If you might wish to attend PSE '91, whether or not you plan to submit a paper, please send in the REGISTRATION OF INTEREST form now to ensure that you receive a copy of the Second Announcement, a form of application for registration, and the detailed program.

Timetable for Authors:

December 31, 1990 – Full paper for refereeing

April 30, 1991 – Final manuscript

International Programming Committee: T.F. Edgar, I. Hasimoto, P.L. Lee, M. Morari, E. O'Shima, J.D. Perkins, S. Pierucci, J.W. Ponton, R.G.H. Prince, G.V. Reklaitis, D.W.T. Rippin, R.W.H. Sargent, G. Stephanopoulous, T. Takamatsu, T. Umeda, C.F.H. van Rijn, A.W. Westerberg, and J.D. Wright.

Registration

Name:

Affiliation:

Address:

City:

Province/State:

Country:

Postal Code:

Telephone:

FAX:

I would like to submit a paper:
yes ☐
no ☐

Abstract: attached ☐
to follow ☐

I am considering attending and would like to receive the Second Announcement: yes ☐ no ☐

For additional information, whether you are interested in presenting a paper or attending the conference, contact Gerry R. Sullivan (Conference Chairman), Department of Chemical Engineering, University of Waterloo, Waterloo, Ontario, CANADA, N2L 3G1, (519) 885-2196.

Los Angeles AIChE Meeting
November 17–22, 1991

Meeting Program Chairman: Dr. Richard L. Bell, Department of Chemical Engineering, University of California, Davis, CA 95616, (916) 752-8776.

The CAST Division is planning the following sessions at the Los Angeles Annual Meeting. Deadlines and first cal for papers for this meeting appear later in this issue.

Area 10A: Systems and Process Design

1. **Process Design for Waste Minimization.** Rakesh Govind (Chairman), Department of Chemical and Nuclear Engineering, University of Cincinnati, Cincinnati, OH 45221, (513) 475-5742 and Vasilios Manousiouthakis (Vice Chairman), Department of Chemical Engineering, University of California, Los Angeles, CA 90024-1592, (213) 825-9385.

2. **Information Management Systems for Process Design.** Mark Kramer (Chairman), Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, (617) 253-6508 and Heinz A. Preisig (Vice Chairman), Department of Chemical Engineering, University of New South Wales, PO Box 1, Kensington, N.S.W. 2033, AUSTRALIA.

3-4. **Design and Analysis I and II.** Ross E. Swaney (Cochairman), Department of Chemical Engineering, University of Wisconsin, Madison, WI 53706, (608) 262-3641.

5. **Batch Process Design.** David W. T. Rippin (Chairman), Chemical Engineering Department, Swiss Federal Institute of Technology, ETH-Zentrum, CH-8092 Zurich, Switzerland and Iftekhar A. Karimi (Vice Chairman), Department of Chemical Engineering, Northwestern University, Evanston, IL 60208-3120, (708) 491-3558.

6. **Process Synthesis.** James M. Douglas (Chairman), Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003-0011, (413) 545-2252 and Robert L. Kirkwood, Polymers Products Department, E. I. DuPont de Nemours & Company, Wilmington, DE 19880-0262, (302) 695-3777.

Joint 10A and 10B Session:

1. **Batch Process Synthesis and Control.** Bill Luyben (Chairman) and Michael F. Doherty (Vice Chairman), Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003-0011, (413) 545-2359.

Area 10B: Systems and Process Control

1-2. **Recent Advances in Process Control.** Jeffrey C. Kantor (Chairman), Department of Chemical Engineering, University of Notre Dame, Notre Dame, IN 46556, (219) 239-5797 and Paul Gusciora (Vice Chairman).

3. **AI Applications in Process Control.** Melinda Golden (Chairman) and George Stephanopoulos (Vice Chairman), Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, (617) 253-3904.

4. **Nonlinear Control.** Dale Seborg (Chairman), Department of Chemical and Nuclear Engineering, University of California, Santa Barbara, CA 93106.

5. **Robust Control.** Evangelos Zafiriou (Chairman), Department of Chemical Engineering, University of Maryland, College Park, MD 20742, (301) 454-5098 and Ahmet Palazoglu (Vice Chairman), Department of Chemical Engineering, University of California, Davis, CA 95616, (916) 752-8774.

6. **Statistical Process Control.** John MacGregor (Chairman) and Christos Georgakis (Vice Chairman), Chemical Engineering Department, Lehigh University, Bethlehem, PA 18015, (215) 758-4781.

7. **Control of Discrete Event Processes.** Erik Ydstie (Chairman), Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003-0011, (413) 545-2388 and Ed Bristol (Vice Chairman).

Joint 10B and 10C Session:

1. **Statistics and Quality Control.** Mohinder K. Sood (Cochairman), Mobil R&D Corporation, PO Box 1026, Princeton, NJ 08543-1026, (609) 737-4960, Richard S. H. Mah (Cochairman), Department of Chemical Engineering, Northwestern University, Evanston, IL 60208-3120, (708) 491-5357, and Michael C. Wellons (Cochairman), Mobil R&D Corporation, PO Box 1026, Princeton, NJ 08543-1026, (609) 737-4454.

Area 10C: Computers in Operations and Information Processing

1-2. **Scheduling and Planning of Process Operations I and II.** Iftekhar A. Karimi (Chairman), Department of Chemical Engineering, Northwestern University, Evanston, IL 60208-3120, (708) 491-3558.

3. **Personal Computers in Plant Operations.** Michael T. Tayyabkhan (Chairman), Tayyabkhan Consultants, Inc., 62 Erdman Avenue, Princeton, NJ 08540, (609) 924-9174.

4. **Computer Architectures.** Gary D. Cera (Chairman), Mobil R&D Corporation, PO Box 1026, Princeton, NJ 08543-1026, (609) 737- 5299 and Stephen E. Zitney (Vice Chairman), Cray Research Inc., 1333 Northland Dr., Mendota Heights, MN 55120, (612) 681-3402.

5. **Artificial Intelligence in Process Engineering.** Venkat Venkatasubramanian (Chairman), School of Chemical Engineering, Purdue University, West Lafayette, IN 47907, (317) 494-0734 and Lyle Unger (Vice Chairman), Department of Chemical Engineering, University of Pennsylvania, Philadelphia, PA 19104, (215) 898-7449.

6. **Integration of Methodologies for Process Operations.** Ignacio E. Grossmann (Chairman), Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA 15213, (415) 268-2228 and Mark A.

Kramer (Vice Chairman), Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, (617) 253-6508.

Area 10D: Applied Mathematics and Numerical Analysis

1-2. Complex Chemical Engineering Systems: Chaos, Fractals, and Neural Networks I and II. Julio M. Ottino (Cochairman), Department of Chemical Engineering, Stanford University, Stanford, CA 94305, (415) 723-9596 and Erik Ydstie (Cochairman), Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003-0011, (413) 545-2388.

3. Instabilities and Bifurcations in Chemical Engineering Applications. Ioannis G. Kevrekides (Chairman), Department of Chemical Engineering, Princeton University, Princeton, NJ 08544, (609) 258-2818 and H.-Chia Chang (Vice Chairman), Department of Chemical Engineering, University of Notre Dame, Notre Dame, IN 46556, (219) 239-5857.

4. PDE Simulations in Chemical Engineering. Antony N. Beris (Chairman), Department of Chemical Engineering, University of Delaware, Newark, DE 19716, (302) 451-8018 and Lyle H. Ungar (Vice Chairman), Department of Chemical Engineering, University of Pennsylvania, Philadelphia, PA 19104-6393, (215) 898-7449.

5. Numerical Methods in Ordinary Differential Equations. S. Sundaresan (Chairman), Department of Chemical Engineering, Princeton University, Princeton, NJ 08544, (609) 258-4583 and Joseph F. Pekny (Vice Chairman), Department of Chemical Engineering, Purdue University, West Lafayette, IN 47907, (317) 494-7901.

6. Stochastic Models. Kyriacos Zygourakis (Chairman), Department of Chemical Engineering, Rice University, Houston, TX 77251-1892, (713) 527-8101 x3509 and Robert M. Ziff (Vice Chairman), Department of Chemical Engineering, University of Michigan, Ann Arbor, MI 48109-2136, (313) 764-5498.

For further information details concerning CAST Division sessions and scheduling, contact Jeffrey J. Siirola (Area Programming Chairman), Research Laboratories–B95, Eastman Chemical Company, PO Box 1972, Kingsport, TN 37662, (615) 229-3069.

New Orleans
AIChE Meeting
March 29 – April 2, 1992

The CAST Division is planning the following tentative program at the New Orleans National Meeting:

Area 10A: Systems and Process Design

1. Integration of Process Design, Optimization, and Control. Henry Chien (Chairman), Monsanto Company, 800 N. Lindbergh Blvd., St. Louis, MO 63167, (314) 694-8274.

2. Training Simulators. Robert J. Farrell (Chairman), Department of Chemical Engineering, Polytechnic University, Brooklyn, NY 11201, (718) 260-3628.

3-4. Modeling and Simulation I and II. Babu Joseph (Cochairman), Department of Chemical Engineering, Washington University, St. Louis, MO 63130, (314) 889-6076 and Rodolphe L. Motard (Cochairman), Department of Chemical Engineering, Washington University, St. Louis, MO 63130, (314) 889-6072.

Joint 10A and 10C Session:

1. Optimization of Batch Unit Operations. Lorenz T. Biegler (Chairman), Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA 15213, (412) 268-2232 and Iftekhar A. Karimi (Vice chairman), Department of Chemical Engineering, Northwestern University, Evanston, IL 60208-3120, and S. Macchietto (Vice Chairman).

Area 10B: Systems and Process Control

Area 10C: Computers in Operations and Information Processing

1. Hazard and Operability Analysis. Randy A. Freeman (Chairman), Monsanto Company - F2WG, 800 N. Lindbergh Blvd., St. Louis, MO 63167, (314) 694-6068.

2. Process Data Management and Reconciliation. Mohinder K. Sood (Chairman), Mobil R&D Corporation, PO Box 1026, Princeton, NJ 08543-1026, (609) 737-4960 and Granville E. Paules (Vice Chairman), Mobil R&D Corporation, PO Box 1026, Princeton, NJ 08543-1026, (609) 737-4593.

3. Promise of Integration (Panel Discussion). Jerry Robertson (Chairman) and C. E. Bodington (Vice Chairman), Chesapeake Decision Sciences, PO Box 275, San Anselmo, CA 94960, (414) 453-4906.

4. New Environments for Engineering Computations. Gary D. Cera (Chairman), Mobil R&D Corporation, PO Box 1026, Princeton, NJ 08543-1026, (609) 737-5299 and Alan B. Coon (Vice Chairman), Union Carbide Corp., PO Box 8361, South Charleston, WV 25303, (304) 747-5470.

5. Technologies and Tools in Software Engineering. Stephen J. Zilora (Chairman), Creative Software Solutions, PO Box 192, Flanders, NJ 07836, (201) 927-8233.

6. Technical Desktop Publishing. Peter R. Rony (Chairman), Department of Chemical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 231- 7658 and Richard S. H. Mah (Vice Chairman), Department of Chemical Engineering, Northwestern University, Evanston, IL 60208, (708) 491-5357.

Area 10D: Applied Mathematics and Numerical Analysis

No Sessions are planned.

For further information details concerning CAST Division sessions and scheduling, contact Jeffrey J. Siirola (Area Programming Chairman), Research Laboratories - B95, Eastman Chemical Company, PO Box 1972, Kingsport, TN 37662, (615) 229-3069.

Foundations of Computer-Aided Plant Operations (FOCAPO '92)

Summer 1992

Mark A. Stadtherr (Conference Chairman), Department of Chemical Engineering, University of Illinois, Urbana, IL 61801, (217) 333- 0275 and John C. Hale (Conference Vice Chairman), E. I. DuPont de Nemours & Company, PO Box 6090, Newark, DE 19714-6090, (302) 366-3041.

Miami AIChE Meeting

November 1-6, 1992

The CAST Division is planning the following tentative program at the Miami National Meeting:

Area 10C: Computers in Operations and Information Processing

- Advances in Optimization
- Application of Expert Systems
- Parallel Computing
- Applications of Neural Networks
- Automation

CALL FOR PAPERS

Final Call for CAST Sessions
Houston AIChE Meeting
April 7-11, 1991

The names, addresses, and telephone numbers of the session chairmen 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 should observe the following deadlines which have been established by the Meeting Program Chairman:

August 15, 1990: Submit a letter of intent and title to session chairman.

September 5, 1990: Submit an abstract and Proposal-to-Present Form to the session chairman.

October 1, 1990: Authors informed of selection and session content finalized.

January 1, 1991: Submit an extended abstract to be published for distribution at the meeting.

February 15, 1991: Final manuscript submitted to the session chairman.

Area 10a: Systems and Process Design

1. Applications of Artificial Intelligence in Process and Product Design.

Papers are invited in the areas of expert systems applied to process engineering, knowledge representation, architecture of knowledge- based systems for process engineering, product design using AI techniques, knowledge acquisition, and qualitative process modeling.

Chairman	*Vice Chairman*
Babu Joseph Dept of Chem Eng Washington University St. Louis, MO 63130 (314) 889-6076	Krishna R. Kaushik Shell Oil Company PO Box 6249 Carson, CA 90749 (213) 816-2276 (213) 816-2375 (FAX)

2. Industrial Applications of Optimization.

Papers are sought in all areas of industrial application of optimization techniques. Applications of linear, nonlinear, integer, and mixed-integer programming to the solution of problems in industry are welcome. Of particular interest are those applications that have resulted in significant benefits over the previous method of operation as well as those applications that use particularly innovative approaches.

Chairman	*Vice Chairman*
Emilio J. Nunez Shell Development Co. PO Box 1380 Houston, TX 77251 (713) 493-8866	David R. Heltne Shell Development Co. PO Box 1380 Houston, TX 77251 (713) 493-7325

3. Process Design and Simulation.

Contributions describing studies in chemical process design and simulation are requested. Papers describing new design procedures or their software implementation, new applications of existing tools for process design and simulation are particularly welcome. Priority will be given to topics that are not covered in other sessions on retrofits, artificial intelligence, and optimization.

Chairman	*Vice Chairman*
Michael F. Malone Dept of Chem Eng University of Massachusetts Amherst, MA 01003-0011 (413) 545-0838 (413) 545-1647 (FAX)	Peter T. Cummings Dept of Chem Eng University of Virginia Charlottesville, VA 22903-2442 (804) 978-4726 (804) 924-6270 (FAX)

4. Retrofit Design Techniques and Applications.

The papers in this session should describe design techniques and methodology for retrofitting plants or experiences in process retrofitting and how retrofit techniques were used to identify process improvements. The process improvements achieved might be in areas as improved raw material efficiency, reduced energy consumption, increased capacity, improved product quality, or improved process flexibility. Algorithms and procedures and their embodiment in computer software can be described provided the focus is on the chemical engineering technology or the commercial benefits of using the software and not on the mathematical procedures or the features of the software.

Chairman	*Vice Chairman*
Don Vredeveld Union Carbide Corporation PO Box 8361 South Charleston, WV 25303 (304) 747-4829 (304) 747-5448 (FAX)	Michael F. Malone Dept of Chemical Engineering Univ. of Massachusetts Amherst, MA 01003-0011 (413) 545-0838 (413) 545-1647 (FAX)

Area 10B: Systems and Process Control

1. Intelligent Control.

Papers focusing on the use of expert systems, neural networks, statistical techniques or other approaches in enhancing the effectiveness of the control system through sensor fusion, fault-tolerant control, supervisory control and optimizing control are sought.

Chairman	*Vice Chairman*
Ali Cinar Dept of Chem eng Illinois Institute of Technology Chicago, IL 60616 (312) 567-3042 (312) 567-8874 (FAX)	William D. McGraw Aluminum Company of America Alcoa Center, PA 15069 (412) 337-2755 (412) 337-2005 (FAX)

2. Industrial Applications of Process Control.

Papers are requested on topics relating to the industrial application of advanced process control methods. Desirable areas include nonlinear model based control, predictive model control, adaptive control, robustness, constraint handling, and nonlinear dead time compensation.

Chairman	*Vice Chairman*
James B. Riggs Dept of Chem Eng Texas Technical University Lubbock, TX 79409 (806) 742-1765 (806) 742-1900 (FAX)	Gerardo Mijares M. W. Kellogg Company Three Greenway Plaza Houston, TX 77046-0395 (713) 960-2032

Area 10c: Computers in Operations and Information Processing

1. On-line Fault Administration.

Both theoretical contributions and practical examples are desired. Any theoretical presentation should have practical potential. Examples of fault detection and diagnosis should provide sufficient details so that professionals might use the examples in their own work. Papers will be reviewed by senior researchers in the field, and all authors will be informed of the decision about their paper at the end of the review process. A limited number of papers will be accepted, hence it is advisable to submit your paper as early as possible.

Chairman	*Vice Chairman*
David M. Himmelblau Dept of Chem Eng University of Texas Austin, TX 78712 (512) 471-7445 (512) 471-7060 (FAX)	Venkat Venkatasubramanian School of Chemical Eng. Purdue University West Lafayette, IN 47907 (317) 494-0734 (317) 494-0805 (FAX)

2. Plant-wide Management Systems.

Papers are invited in the areas of information systems for plant operations, plant data management, and optimization and supervisory control in operations. Other aspects of plant data representation and plant optimization may also be included.

Chairman	*Vice Chairman*
K. R. Kaushik Shell Oil Company PO Box 6249 Carson, CA 90749 (213) 816-2276 (213) 816-2375 (FAX)	A. L. Parker Shell Oil Company PO Box 10 Norco, LA 70079 (504) 465-7142

3. Computer Integrated Manufacturing.

This session will focus on the use of computers to integrate the planning, scheduling, and control of a sequence of either batch or continuous processes or a combination of the two. For example, papers are invited that cover, but are not limited to: scheduling of product mixing or blending, from raw material to finished product; planning and scheduling of multi-step processes for discrete part manufacture, e.g., printed circuit boards; research results in scheduling or optimization of multi-step production; and fermentation and separation sequences in pharmaceutical manufacture.

Chairman	*Vice Chairman*
C. E. Bodington Chesapeake Decision Sciences PO Box 275 San Anselmo, CA 94960 (414) 453-4906	Rufas A. Baxley Digital Equipment Corp. 5555 Windward Parkway West Alpharetta, GA 30201 (404) 772-212

4. Innovative Uses of Spreadsheets in Engineering Calculations.

This session will cover the use of personal computer spreadsheet packages such as LOTUS 123 (DOS Machines) or Excel (Apple Macintosh) in the completion of engineering calculations. Possible topics include two-phase flow calculations, fluid bed design, reaction kinetics, network pressure drop calculations, physical property calculations, or heat exchanger design. This list is not intended to be all inclusive and represents only a small sample of the possible applications. Authors whose paper is accepted will be required to submit a computer disk that includes the spreadsheet that their paper discusses. Copies of a master disk that included all the spreadsheets presented at the session will be made available at the Houston AIChE meeting.

Chairman	*Vice Chairman*
Randy A. Freeman Monsanto Company - F2WG 800 N. Lindbergh Blvd. St. Louis, MO 63167 (314) 694-6068	Bruce M. Vrana E. I. DuPont de Nemours & Company PO Box 6090 Newark, DE 19714-6090 (302) 366-6211

5. **Applications of Expert Systems.**

This session will focus on expert system applications which have been installed or are commissioned for installation. Of particular interest are papers reporting on not only the methodological development of an expert system, but also the broader implementation aspects of the project. Applications in process operations, design, scheduling, and planning are all welcome. Reports of novel theoretical or methodological developments will also be considered for the session. The abstract should clearly indicate the status of the work, including the degree of completion and whether the approach has been applied successfully.

Chairman	*Vice Chairman*
James F. Davis Dept of Chem Eng Ohio State University Columbus, OH 43210-1180 (614) 292-0090 (614) 292-9021 (FAX)	Duncan A. Rowan E. I. DuPont de Nemours & Company PO Box 6090 Newark, DE 19714-6090 (302) 366-6453

Joint Area 10C and Area 5D Session:

1. **Applications of Robotics.**

Papers are invited that deal with any and all aspects of applications of robotics which could include any or all of the following: surveys, principles and theories, design, case studies, etc. Presentations based on applications in operating plants, industrial laboratories, and university/government laboratories are welcome.

Chairman	*Vice Chairman*
Michael T. Tayyabkhan Tayyabkhan Consultants, Inc. 62 Erdman Avenue Princeton, NJ 08540 (609) 924-9174	John Jepsen Clark Mtls Handling Co. Route 2, Box 46, Hwy 33 Versailles, KY 40383 (606) 873-9973

First Call for CAST Sessions
Los Angeles AIChE Meeting
November 17–22, 1991

Names, addresses, and telephone numbers of the session chairmen 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 should observe the following deadlines, which however, may be changed at any time by the Meeting Program Chairman:

April 1, 1991: Submit an abstract of the proposed presentation to the session chairman.

May 1, 1991: Authors informed of selection and session content finalized.

August 1, 1991: Submit an extended abstract to be published for distribution at the meeting.

October 1, 1991: Final manuscript submitted to the session chairman.

Area 10A: Systems and Process Design

1. **Process Design for Waste Minimization.**

Chairman	*Vice Chairman*
Rakesh Govind Department of Chemical and Nuclear Engineering University of Cincinnati Cincinnati, OH 45221 (513) 475-5742	Vasilios Manousiouthakis Dept of Chem Eng University of California Los Angeles, CA 90024-1592 (213) 825-9385

2. **Information Management Systems for Process Design**

Chairman	*Vice Chairman*
Mark A. Kramer Dept of Chem Eng Massachusetts Institute of Technology Cambridge, MA 02139 (617) 253-6508	Heinz A. Preisig Dept of Chem Eng Univ. of New South Wales PO Box 1 Kensington, N.S.W. 2033 AUSTRALIA

3-4. Design and Analysis I and II.

Chairman

Ross E. Swaney
Dept of Chem Eng
University of Wisconsin
Madison, WI 53706
(608) 262-3641

5. Batch Process Design.

This session will focus mainly on issues related to the design of noncontinuous or batch plants such as synthesis and sizing of multiproduct and multipurpose plants, design for flexibility, design under uncertainty, scheduling and planning in design, intelligent tools and/or knowledge base for design, task synthesis, retrofit design, flexibility and/or uncertainty analysis of designs, design of intermediate storage, etc.

Chairman

David W. T. Rippin
Chemical Engineering Dept
Swiss Federal Institute of Technology
ETH-Zentrum
CH-8092 Zurich
SWITZERLAND

Vice Chairman

Iftekhar A. Karimi
Department of Chemical Engineering
Northwestern University
Evanston, IL 60208-3120
(708) 491-3558
(708) 491-3728 (FAX)

6. Process Synthesis.

Chairman

James M. Douglas
Department of Chemical Engineering
University of Massachusetts
Amherst, MA 01003-0011
(413) 545-2252
(413) 545-1647 (FAX)

Vice Chairman

Robert L. Kirkwood
Polymer Products Dept
E. I. DuPont de Nemours & Company
Wilmington, DE 19880-0262
(302) 695-3777

Joint 10a and 10b Session:

1. Batch Process Synthesis and Control.

Vice Chairman

Michael F. Doherty
Department of Chemical Engineering
University of Massachusetts
Amherst, MA 01003-0011
(413) 545-2359
(413) 545-1647 (FAX)

Area 10B: Systems and Process Control

1-2. Recent Advances in Process Control.

Chairman

Jeffrey C. Kantor
Department of Chemical Engineering
University of Notre Dame
Notre Dame, IN 46556
(219) 239-5797
(219) 239-8007 (FAX)

3. AI Applications in Process Control.

Vice Chairman

George Stephanopoulos
Department of Chemical Engineering
Massachusetts Institute of Technology
Cambridge, MA 02139
(617) 253-3904

4. Nonlinear Control.

Chairman

Dale Seborg
Department of Chemical and Nuclear Engineering
University of California
Santa Barbara, CA 93106
(805) 893-3411

5. Robust Control.

Chairman

Evangelos Zafiriou
Dept of Chem Eng
University of Maryland
College Park, MD 20742
(301) 454-5098

Vice Chairman

Ahmet Palazoglu
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(916) 752-8774

6. Statistical Process Control.

Vice Chairman

Christos Georgakis
Chem Eng Dept
Lehigh University
Bethlehem, PA 18015
(215) 758-4781

7. **Control of Discrete Event Processes.**

Chairman

Erik Ydstie
Dept of Chem Eng
University of Massachusetts
Amherst, MA 01003-0011
(413) 545-2388
(413) 545-1647 (FAX)

Joint 10B and 10C Session:

1. **Statistics and Quality Control.**

Increasingly tighter environmental regulations will require the process industries to significantly reduce the emission of toxic and pollutant waste products. Statistical and quality control can play a big role in limiting waste product emissions while simultaneously improving product quality. This session will include papers describing both fundamental techniques and industrial applications of statistical and quality control. Papers describing new statistical tools and techniques, applications to new areas, time series models, real-time applications, data reconciliation, multivariate analysis, and interface with data acquisition and data bases are welcome.

Cochairman

Mohinder K. Sood
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Cochairman

Michael C. Wellons
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Cochairman

Richard S. H. Mah
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(708) 491-3728 (FAX)

Area 10C: Computers in Operations and Information Processing

1-2. **Scheduling and Planning of Process Operations I and II.**

These two sessions will focus on the operations of both continuous as well as batch processes. The main topics include, but are not restricted to, sequencing and scheduling in batch plants, resource-constrained scheduling, production planning in batch plants, scheduling/planning in the face of uncertainty, scheduling and planning of multiproduct continuous plants, scheduling in continuous plants, maintenance scheduling, planning/scheduling in refineries, artificial intelligence tools for scheduling and planning, etc.

Chairman

Iftekhar A. Karimi
Dept of Cheml Eng
Northwestern University
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(708) 491-3728 (FAX)

3. **Personal Computers in Plant Operations.**

Chairman

Michael T. Tayyabkhan
Tayyabkhan Consultants, Inc.
62 Erdman Avenue
Princeton, NJ 08540
(609) 924-9174

4. **Computer Architectures.**

Chairman

Gary D. Cera
Mobil R&D Corporation
PO Box 1026
Princeton, NJ 08543-1026
(609) 737-5299

Vice Chairman

Stephen E. Zitney
Cray Research Inc.
1333 Northland Drive
Mendota Heights, MN
55120
(612) 681-3402

5. **Artificial Intelligence in Process Engineering.**

Papers studying the use of Artificial Intelligence in chemical engineering are solicited. Applications of AI to problems of process operations, including fault detection, diagnosis and control are sought, as are methodological contributions such as novel knowledge representation or reasoning techniques.

Chairman

Venkat Venkatasubramanian
School of Chem Eng
Purdue University
West Lafayette, IN 47907
(317) 494-0734

Vice Chairman

Lyle H. Ungar
Dept of Chem Eng
Univ. of Pennsylvania
Philadelphia, PA
19104-6393
(215) 898-7449

6. Integration of Methodologies for Process Operations.

The goal of this session is to examine the potential benefits and the various approaches for combining different types of methodologies for process operations problems. In particular, this session will focus on the combination of AI techniques (e.g. expert systems, qualitative models, neural networks), with mathematical programming (e.g. linear, nonlinear, and integer programming) or with other search techniques (simulated annealing, genetic algorithms, table search). Applications to scheduling and planning, and similar areas will be considered.

Chairman	*Vice Chairman*
Ignacio E. Grossmann Dept of Chem Eng Carnegie Mellon University Pittsburgh, PA 15213 (415) 268-2228 (412) 268-7139 (FAX)	Mark A. Kramer Dept of Chem Eng Massachusetts Institute of Technology Cambridge, MA 02139 (617) 253-6508 (617) 253-9695 (FAX)

Area 10D: Applied Mathematics and Numerical Analysis

1-2. Complex Chemical Engineering Systems: Chaos, Fractals, and Neural Networks I and II.

A large number of recent developments in a variety of areas ranging from mathematics to computer science to theoretical physics indicate that the behavior of many systems that on first viewing appear quite complex can in fact be understood, modelled, and predicted in terms of simple fundamental rules. Papers are sought on applications of some of these developments, for example neural networks, lattice models, chaos, and fractals to systems of interest in chemical engineering.

Chairman	Vice Chairman
Julio M. Ottino Dept of Chem Eng Stanford University Stanford, CA 94305 (415) 723-9596	Erik Ydstie Dept of Chem Eng Univ. of Massachusetts Amherst, MA 01003-0011 (413) 545-2388

3. Instabilities and Bifurcations in Chemical Engineering Applications.

Analytical and numerical studies of stability and bifurcation of nonlinear systems allow us to decipher the underlying chemistry, physics, and geometric symmetries of reaction and transport processes. Successful implementations of these techniques are becoming available, and large scale computing extends their applicability to more realistic models. We solicit papers on the application of these methods to models of chemical engineering processes, with emphasis on pattern formation and selection in distributed systems.

Chairman	*Vice Chairman*
Ioannis G. Kevrekides Dept of Chem Eng Princeton University Princeton, NJ 08544 (609) 258-2818	H.-Chia Chang Dept of Chem Eng University of Notre Dame Notre Dame, IN 46556 (219) 239-5847

4. PDE Simulations in Chemical Engineering.

As chemical Engineering computing is coming of age, the use of multidimensional simulations of systems of partial differential equations is becoming more widespread covering a large variety of applications ranging from free surface flows encountered in coating applications, to non-Newtonian flows and solidification problems encountered in materials processing.

Chairman	*Vice Chairman*
Antony N. Beris Dept of Chem Eng University of Delaware Newark, DE 19716 (302) 451-8018	Lyle H. Ungar Dept of Chem Eng Univ. of Pennsylvania Philadelphia, PA 19104-6393 (215) 898-7449

5. Numerical Methods in Ordinary Differential Equations.

Papers are sought on novel mathematical concepts and algorithmic approaches in the solution of ordinary differential equations; advanced numerical techniques for continuation, bifurcation canalysis, and tracking singularities such as homoclinic and heteroclinic connections; and solution of stiff differential equations. Emphasis will be more on novel numerical methods as opposed to description of examples where known numerical techniques are applied.

Chairman	*Vice Chairman*
S. Sundaresan Dept of Chem Eng Princeton University Princeton, NJ 08544 (609) 258-4583	Joseph F. Pekny School of Chem Eng Purdue University West Lafayette, IN 47907 (317) 494-7901 (317) 494-0805 (FAX)

6. Stochastic Models.

This session will focus on applications of probabilistic concepts to continuous and discrete models of chemical engineering systems. Topics of interest include (but are not limited to) chemical reaction models, percolation processes, population balance models, turbulence, stochastic control, etc.

Chairman	*Vice Chairman*
Kyriacos Zygourakis Dept of Chem Eng Rice University Houston, TX 77251-1892 (713) 527-8101 x3509	Robert M. Ziff Dept of Chem Eng University of Michigan Ann Arbor, MI 48109-2136 (313) 764-5498 (313) 763-0459 (FAX)

Preliminary Call for CAST Session New Orleans AIChE Meeting

March 29–April 2, 1992

Tentative deadlines, based upon the 1991 Houston AIChE Meeting, are:

August 15, 1991: Submit a letter of intent and title to session chairman.

September 5, 1991: Submit an abstract and Proposal-to-Present Form to the session chairman.

October 1, 1991: Authors informed of selection and session content finalized.

January 1, 1992: Submit an extended abstract to be published for distribution at the meeting.

February 15, 1992: Final manuscript submitted to the session chairman.

Area 10C: Computers in Operations and Information Processing

6. Technical Desktop Publishing

Papers are solicited that provide tutorial information concerning current uses of "technical desktop publishing"–namely, the desktop publishing of technical documents that include equations, graphs, tables, and text–in industry, government, and academia. Of special interest is the issue of the standardization of equation capture; electronic communication of manuscripts to publishers and printers; custom publishing systems (e.g., McGraw-Hill) and related marketing issues; corporate practices; the role of professional societies and their journal policies directed toward the electronic communication of manuscripts; and so forth. At least one presentations describing personal experience with technical desktop publishing would be welcome.

Chairman	*Vice Chairman*
Peter R. Rony Dept of Chem Eng Virginia Polytechnic Institute and State University Blacksburg, VA 24061 (703) 231-7658	Richard S. H. Mah Dept of Chem Eng Northwestern University Evanston, IL 60208 (708) 491-5357

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

1991 AWARD NOMINATION FORM*

A. BACKGROUND DATA

1. Name of the Award ______________________ Today's Date __________

2. Name of Nominee ______________________ Date of Birth __________

3. Present Position (exact title)

____

4. Education:

Institution	Degree Received	Year Received	Field

5. Positions Held:

Company or Institution	Position or Title	Dates

6. Academic and Professional Honours (include awards, memberships in honorary societies and fraternities, prizes) and date the honor was received.

7. Technical and Professional Society Memberships and Offices

8. Sponsor's Name and Address

____

____

____

______________________________________ Sponsor's Signature

* A person may be nominated for only one award in a given year.

B. CITATION

1. A brief statement, not to exceed 250 words, of why the candidate should receive this award. (Use separate sheet of paper.)

2. Proposed citation (not more than 25 carefully edited words that reflect specific accomplishments).

C. QUALIFICATIONS

Each award has a different set of qualifications. These are described in the awards brochure. After reading them, please fill in the following information on the nominee where appropriate. Use a separate sheet for each item if necessary.

1. Selected bibliography (include books, patents, and major papers published.)

2. Specific identification and evaluation of the accomplishments on which the nomination is based.

3. If the nominee has previously received any award from AIChE or one of its Divisions, an explicit statement of new accomplishments or work over and above those cited for the earlier awards(s) must be included.

4. Other pertinent information.

D. SUPPORTING LETTERS AND DOCUMENTS

List of no more than five individuals whose letters are attached.

	Name	Affiliation
1.		
2.		
3.		
4.		
5.		

Please send the completed form and supplemental sheets at any time to the CAST Division 2nd Vice Chairman, Professor Ignacio Grosmann, Chemical Engineering Department, Carnegie-Mellon University, Pittsburgh, PA, 15213. Telephone: (412) 268-2228.
BITNET: D391GR99@CMCCVB.Bitnet.
Professor Grossmann will forward your nomination packages to the next CAST Division 2nd Vice Chairman who will be elected this Fall.

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______ I will pay my CAST dues with my annual AIChE dues

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Computing and Systems Technology Division
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