CAST NEWSLETTER

COMPUTING AND SYSTEMS TECHNOLOGY DIVISION

American Institute of Chemical Engineers

VOLUME 4: NUMBER 1 JULY 1981

CHAIRMAN'S MESSAGE

As a means of easing into our Spring break in late February (since spring breaks late in Ann Arbor, if at all, February is as good a time as any for a spring vacation). I spent two days cleaning my office. Not one of those "get to the bottom of the 'in' box" cleanups, but a genuine "clear out the 60's and 70's" cleanup; all this to make room for a new desktop microcomputer.

First, the large bookcase. One after another (over 100) obsolete titles into the trash: Programming the Datatron, The IBM 1130 Computer, A Primer for the MAD language, Interpreting IBM 704 Core-Memory Dumps (nonstalgia is obviously not what it once was, but I decided to keep the last one for the 1990 cleanup). Only the several FORTRAN for ???? still might be considered "current" (fill in the ????; "ever" will probably do).

Next, an 18 amplifier (with 54 large vacuum tubes) analog computer of uncertain vintage hidden under a table, into the hall. It was still there one week later, unscavenged, with components not even worth the taking.

Then to some old cabinet drawers. There I found, among other memorabilia, (1) my K&E log-log duplex decitrig sliderule and (2) a full box of still sticky bandaids with a 59¢ pricetag attached (how long since you've seen a cent sign?).

I showed the sliderule to my sophomore class in material and energy balances. They were quite impressed that one could multiply using just two sticks, but not at all impressed with the three digit accuracy (after one gets used to ten digits, three somehow seem inadequate, even if the other seven digits mean nothing). No one had the foggiest notion of why a sliderule worked. In response to my question about logarithms, one wise guy responded that a logarithm was what one got when he pushed the "log" button on a calculator! Oh well.

Seeing my old sliderule reminded me that I had not used it even once, since the day I bought my first hand calculator (for $400!). That calculator, in turn, fell to disuse once a keystroke-programmable calculator was in hand. And since Christmas, when I bought one of the new pocket computers (programmable in floating-point BASIC) as a present for myself, I have completely abandoned the calculator too.

To the point. Surely there are few areas, technical or otherwise, where the most-used tools and reference works replace one another as quickly as in computing. And with the impact of inexpensive microprocessor/microcomputer computing capability, the pace is quickening. The message is clear; those who don't do their very best to keep up, risk falling behind rapidly. That's what CAST is really all about; to serve as a vehicle for exchanging information among computer-oriented chemical engineers about what's happening, and what's likely to happen; in short, keeping up.

Although only in our fourth year, CAST is well established as a viable division of the Institute, with over 700 members. We have a very strong record of AIChE meeting programming. In 1981 alone, our division is sponsoring 26 technical sessions (7 at Houston, 7 at Detroit, and 12 at New Orleans), with between 125 and 150 papers. Last June, CAST and the Engineering Foundation cosponsored the first "Foundations of Computer Aided Process Design" conferences at Henniker, New Hampshire. The meeting was

CHAIRMAN'S MESSAGE (cont'd)

cochaired by Dick Mah and Warren Seider, and attracted 125 participants from all over the world; the Proceedings are now available from The Engineering Foundation. In February of this year a similarly successful one week conference, "Process Control", was held at Sea Island, Georgia. Tom Edgar and Dale Seborg cochaired the meeting; again more than one hundred participated. I've had many comments from attendees of these conferences to the effect that "it was the best meeting I ever attended". The format of these conferences is clearly a successful one; similar programs, sponsored by our three programming areas (10a - systems and process design; 10b - systems and process control; 10c - computers in management and information processing) would seem to bear repeating on say a triennial basis. Rex Reklaitis is just concluding the collection and review of papers on "computer graphics in chemical engineering", a joint CAST/CACHE project. The papers will be published as an issue of Computers in Chemical Engineering (Dick Hughes, editor) later this year.

Special recognition for the success of our programming activities must go to Dick Mah, our programming board chairman. He has done an outstanding job for us; thanks, Dick.

I'm sure that Dick and the new slate of area chairmen, Warren Stewart (10a), Alan Foss (10b) and Rex Reklaitis (10c) will continue to produce technical sessions of outstanding quality for our membership.

The awards activity is well established, and this year is being handled by Dave Himmelblau. We hope, before the year is out, to submit to the membership a plan for a student award, probably for computing work at the graduate level; the award could serve to complement the existing AIChE Contest Problem awards for undergraduates.

Another potential CAST activity is the publication of a Division directory; we have discussed this in our Executive Committee meetings, but have not come to a final decision because of apparent high costs.

If you have any suggestions for new activities or Division directions, please drop me or any of the directors a line. Be assured that your suggestions will receive a hearing by the Executive Committee (we meet at most of the Institute meetings).

Finally, let me close with a big Thank You! to Pete Hanik, who has served as our newsletter editor for the past two years. His newsletters have contained just the right blend of news, announcements, and food for thought. Pete is stepping aside, but will remain active in Division and Institute affairs. Ed Gordon, of the Fluor Corp. in Irvine is our new Newsletter Editor. He will welcome contributions from members, and will, I'm sure, continue with the tradition of newsy and interesting Newsletters.

I hope to see all of you at the Detroit and New Orleans meetings. -- *Brice Carnahan*

REPORT OF THE PROGRAMMING BOARD

Changes in programming area chairmenship
Area 10a. Jim Douglas will be on sabbatical leave to England in May. By mutual agreement Warren Stewart of the University of Wisconsin, the current Vice-Chairman, will assume Area 10a Chairmanship.

Area 10b. Ed Bristol has stepped down as Vice-Chairman of Area 10b to take on the chairmanship of a Process Control committee in a reorganized AACC. Irv Rinard, Halcon Research and Development, 2 Park Avenue, New York NY 10016 (212/689-1222), will take over as the new Vice-Chairman and serve as the AIChE program delegate to the 1982 AACC (new name for JACC).

Area 10c. Mike Tayyabkhan has completed his term as the first Chairman of Area 10c. G.V. (Rex) Raklaitis of Purdue University has agreed to serve as the new Area 10c Chairman. Paul Horvath will continue as the Area 10c Vice-Chairman.

We wish to thank Jim, Ed, and Mike for their contributions and services to the CAST Division programming and offer our congratulations and welcome to Warren, Irv and Rex.

Montreau 1979

The recent issue of Computers in Chemical Engineering contains a large collection of important papers.

FOCAPD July 80

Proceedings in two volumes published by Engineering Foundation distributed by AIChE. Volume 1 covers nonlinear algebraic equations, nonlinear programming, ordinary and partial differential equations, flowsheeting programs. Volume 2 covers thermophysical and transport properties, modeling and analysis of multi-staged towers, modeling and anlysis of chemical reactors, process synthesis. $30 per volume. $50 per set (2 volumes) AIChE members $40 per set.

Process Control January 1981

The Engineering Foundation held a conference on Chemical Process Control in Sea Island, Georgia during January 18-23, 1981. The 119 participants were about evenly divided between academic and industrial practitioners. The attendees included nine people from Europe, two from Japan and one from People's Republic of China.

Dale Seborg (Univ. California, Santa Barbara) and Tom Edgar (Univ. Texas, Austin) served as the co-organizers of the conference. The other members of the Organizing Committee and the sessions that they arranged are described below. Financial support was provided by grants from the National Science Foundation and the Engineering Foundation. The CAST Division was a sponsor of the conference but was not asked to provide financial support.

A review of this conference is the "Feature Article" for this Newsletter.

Houston April 1981

Many fine papers were presented and are available on Microfiche. The cost is $1.50 per microfiche for AIChE members and $3.00 for non-members. Payment must accompany all orders and your check should be payable to AIChE.

Session 49 Optimization Theory and Applications
a,c,d: Fiche 27

Session 50 Modeling of Process Systems
a,b,c,e: Fiche 21

Session 51 Synthesis and Design of Plant Utility and Energy Recovery Systems
c,d: Fiche 37; b: Fiche 38

Session 52 The Evolving Structure of Computer Control for Industrial Processes
d: Fiche 19

Session 53 Computerized Cost Estimation
b,c: Fiche 34

Session 54 Production Planning for Multi-Product Plants
a,b,d,e: Fiche 15; f: Fiche 16; c: Fiche 35

FUTURE MEETINGS
Detroit August 1981

User group for ASPEN is being formed. Robert A. Knudsen and Leonard A. Fabiano are leading the group which is scheduled to meet in the Windsor Room at the Detroit Plaza Hotel from 5:30 - 7:30 on August 17, 1981. Call (215) 359-2139 or 350-2120 for more information.

Session 22
Chemical Engineering in the Manufacture of Computer Components PART I

Large Computer System and Some of Its Components. P-W CHIANG, AMDAHL CORPORATION, SUNNYVALE, CA. Paper No. 22a

Current Trends in the Fabrication of Integrated Circuits Used as Computer Components B.E. DEAL, FAIRCHILD CAMERA AND INSTRUMENT CORPORATION, PALO ALTO, CA Paper No. 22b

Manufacture of High Purity Silicon
J.K. TRUITT (SPEAKER) AND M.S. BAWA, TEXAS INSTRUMENTS INCORPORATED, DALLAS, TX
Paper No. 22c

Production of Ultra Pure Water
Y.J. LAO, (SPEAKER), EAST CAROLINE UNIVERSITY, GREENVILLE, NC AND P-W CHIANG, AMDAHL CORPORATION, SUNNYVALE, CA Paper No. 22d

Dielectric Isolation Techniques for Integrated Circuit Manufacture
J.P. SHORT, HARRIS SEMICONDUCTOR, MELBOURNE, FL Paper No. 22e

CHEMICAL ENGINEERING IN THE MANUFACTURE OF COMPUTER COMPONENTS. PART II, Session 23

M.T. Tayyabkhan, Chirman Mobil Research & Development Corp. Princeton, NJ

D. R. Mason, CoChairman Florida Institute of Technology Melbourne, FL

Advanced Device Isolation For Very Large Scale Integration. B. POGGE, I.B.M., EAST FISHKILL, NY Paper No. 23a

Process and Materials Engineering for Silicon Device Fabrication
L.F. THOMPSON, BELL TELEPHONE LABORATORIES, MURRAY HILL, NJ Paper No. 23b

Plasma Etching of Thin Films in the Fabrication of Integrated Circuits
D.W. HESS, UNIVERSITY OF CALIFORNIA, BERKELEY, CA Paper No. 23c

Chemical Vapor Deposition for Very Large Scale Integration in Microelectronics
W.C. BENZING, APPLIED MATERIALS, INCORPORATED, SANTA CLARA, CA. Paper No. 23d

Disposal of Hazardous Waste Generated in the Manufacture of Computer Components
D.R. MASON, FLORIDA INSTITUTE OF TECHNOLOGY, MELBOURNE, FL Paper No. 23e

Some Chemical Engineering Problems In Processing III - V Semiconductor Materials
T. ANDERSON, UNIVERSITY OF FLORIDA, GAINESVILLE, FL Paper No. 23f

ENGINEERING PRODUCTIVITY AND THE COMPUTING ENVIRONMENT OF THE 1980's , Session 24

H.D. Spriggs, Chairman Union Carbide Corporation South Charleston, WV

B.F. Dickert, CoChairman Union Carbide Corp. South Charleston, WV

Effective Computing in R&D and in Engineering
N.E. RAWSON, INTERNATIONAL BUSINESS MACHINES CORPORATION, Paper No. 24a

Computer Planning in a Research and Engineering Environment
L.A. BARNSTONE (SPEAKER) AND J. MICHLIN, EXXON RESEARCH AND ENGINEERING COMPANY, FLORHAM PARK, NJ Paper No. 24b

Data Acquistion Analysis and Computing in a Research Laboratory
E.A. ABRAHAMSON, E.I. DUPONT DE NEMOURS & COMPANY, WILMINGTON, DE Paper No. 24c

The Development of a Large-Scale Interactive Computing System in a Research Environment
J.G. STEWARD, AMOCO PRODUCTION COMPANY, TULSA, OK Paper No. 24d

Features of VAX/VMS and Their Use in Real Time Laboratory Applications
D.H. KIRKWOOD, DIGITAL EQUIPMENT CORPORATION, MARLBORO, MA Paper No. 24e

ENGINEERING PRODUCTIVITY AND THE COMPUTING ENVIRONMENT OF THE 1980's PART II Session 25

H.D. Spriggs, Chairman, Union Carbide Corp. South Charleston, WV

B.F. Dickert, CoChairman, Union Carbide Corp. South Charleston, WV

Better Tools for Scientific Computations
J.C. PORTER, INTERNATIONAL BUSINESS MACHINES CORPORATION, WHITE PLAINS, NY Paper No. 25a

ASCEND I & II: Friendly Interactive Flowsheeting Systems
D.R. BENJAMIN, M.H. LOCKE (SPEAKER) AND A.W. WESTERBERG, CARNEGIE-MELLON UNIVERSITY, PITTSBURGH, PA Paper No. 25b

The Use of Data Bases in Engineering Design - Experiences to Date and Some Thoughts for the Future
D.H. CHERRY, J.C. GROGAN, G.L. KNAPP AND F.A. PERRIS SPEAKER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, RUNCORN CHESHIRE, ENGLAND Paper No. 25c

Conversational Access to Process Engineering Programs
M.J. WILLS, C-E LUMMS, BLOOMFIELD, NJ Paper No. 25d

PDMS: Engineering Design by Computers
D.J. LAWRENCE, C. CHANEY AND R.C. GUZMAN (SPEAKER) COMPEDA, INCORPORATED, PARAMUS, NJ Paper No. 25e

THERMODYNAMIC AVAILABILITY ANALYSIS-PART I Session 26
R.A. Gaggioli, Chairman, Marquette University Milwuakee, WI

Y.A. Liu, CoChairman, Auburn University, Auburn, AL

Strategic Use of Thermoeconomic Analysis for Process Improvement
M. TRIBUS (SPEAKER) AND Y.M. EL-SAYED, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MA Paper No. 26a

Chemical Process Design Based on the Structured Process Energy-Exergy-Flow Diagram
M. ISHIDA (SPEAKER) AND H. OAKI, TOKYO INSTITUTE OF TECHNOLOGY, TOKYO, JAPAN
Paper No. 26b

Multiobjective Optimal Synthesis
L.T. FAN (SPEAKER) AND J.H. SHIEH, KANSAS STATE UNIVERSITY, MANHATTAN, KS Paper No. 26c

THERMODYNAMIC AVAILABILITY ANALYSIS - PART II

R.A. Gaggioli, Chairman, Marquette University, Milwaukee, WI

S.P. Singh, CoChairman, Institute of Gas Technology, Chicago, IL

Calculation of the Availability of Petroleum Fractions
E.D. GROSSMANN (SPEAKER), DREXEL UNIVERSITY, S.V. SMITH AND J.C. SWEENEY, ARCO, PHILADELPHIA, PA Paper No. 27a

Exergetic View of Absorption Heat Pumps
K.F. KNOCHE AND D. STEHMEIER (SPEAKER), RWTH, AACHEN, WEST GERMANY Paper No. 27b

Available Energy Analysis of a Sulphuric Acid Plant
K. RAVINDRANATH (SPEAKER) AND S. THIYAGARAJAN, LARSEN & TOUBRO LIMITED, BOMBAY, INDIA
Paper No. 27c

Exergy Analysis of the Nuclear Coal Hydrogasification Process
G. TSATSARONIS (SPEAKER) AND P. SCHUSTER, RHEINISCH-WESTFALLISCHE TECHNISCHE HOCHSCHULE, AACHEN, WEST GERMANY Paper No. 27d

Thermodynamic Availability Analysis in the Synthesis of Energy - Optimum and Minimum-Cost Heat Exchanger Networks
F.A. PEHLER (SPEAKER) AND Y.A. LIU, AUBURN UNVIERSITY, AUBURN, AL Paper No. 27e

Peltier Effect Diffusion-Separation Concept and Availability Potentials
M. MECKLER (SPEAKER, MECKLER SYSTEMS GROUP, ENCINO, CA AND R.W. FARMER, ARIZONA STATE UNIVERSITY, TEMPE, AZ Paper No. 27f

THERMODYNAMIC AVAILABILITY ANALYSIS-PART III

R.A. Gaggioli, Chairman, Marquette University, Milwaukee, WI

Y.A. Liu, CoChairman, Auburn University, Auburn, AL

S.P. Singh, CoChairman, Institute of Gas Technology, Chicago, IL

Finite Time Constraints and Availability
B. ANDERSON, R.S. BERRY, M. RUBIN (SPEAKER) UNIVERSITY OF CHICAGO, CHICAGO, IL
Paper No. 28a

Thermodynamic Availability Analysis Applied to Systems with Solar Energy Inputs
R.H. EDGERTON, OAKLAND UNIVERSITY, ROCHESTER, MI Paper No. 28b

Reversibility of Combustion Processes
H.J. RICHTER, DARTMOUTH COLLEGE, HANOVER, NH
Paper No. 28c

Exergy Analysis of Fuel Utilization in Heating Furnaces
E.S. GESKIN, REVERE RESEARCH INCORPORATED, EDISON, NJ Paper No. 28d

Exergy and Essergy Analysis in Process Design and Synthesis
R.B. EVANS (SPEAKER) W.A. HENDRIX, P.V. KADABA W.J. WEPFER, GEORGIA INSTITUTE OF TECHNOLOGY, ATLANTA, GA Paper No. 28e

New Orleans No. 81

At this point we still have 12 confirmed sessions. It is shaping up to be the largest program that we have ever fielded at an AIChE national or annual meeting.

The CAST Annual Dinner will be held on November 10, 1981 at the Plimsoll Club in the International Trademart Building All members are invited to attend.

Process Systems Engineering Symposium, Kyoto Aug. 82

AIChE cosponsorship has been approved. First announcement from SCEJ went out in January. Second announcement expected shortly.

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Direct any correspondence or questions concerning the CAST Newsletter to the Editor:

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SECOND ENGINEERING FOUNDATION CONFERENCE ON PROCESS CONTROL

In this review of the conference the name of the organizer is given for each session. This conference was organized by Dale Seborg of U.C. Santa Barbara and Tom Edgar of U. Texas.
The previous conference was held in 1976. Copies of the proceedings for that conference are available as the A.I. Ch.E. Symposium Series Volume 72, number 159. The proceedings for this conference should be available this summer if all goes according to plans.

SYSTEMS SOFTWARE FOR PROCESS CONTROL
Magne Field, AccuRay Corp, Columbus, Ohio

The major problems stem from rapidly changing software and System Design. These changes introduce maintenance costs (costs after delivery of the system) which frequently exceed 10% of the delivered cost of the system per year of use. They typically amount to 40 to 80 percent of the total (life cycle) cost of the system.

Major changes in system design are needed to adequately benefit from the rapidly improving reliability, performance and price of solid state devices. There are often significant advantages to looking at the computer hardware as a single system even though the hardware may be distributed geographically and functionally. Data base validity, integrity, and currency has taken on increasing importance. There is a need to define the optimal role in process control systems for tasks like message switching which might yield word processing capabilities as a low cost byproduct. With the trend towards distributed control and multiprocessing, the control algorithm frequently must initiate a "transaction" requesting another piece of software or hardware to take an action and confirm that the action has been taken.
If we are going to successfully apply Systems Engineering techniques to make modern control systems work well, then it is necessary to clarify the relationships between the various levels of specifications. The definition of the problem to be solved should be contained in the Top Level specification.

The Control System level is a high level statement of what the control system is to. This, in turn, must be translated into a Global Computer System level before it can be broken down into Local Computer level systems based on the allocation of functions: their interfaces and interactions. Finally, the detailed design which can be called the Sequentail processor level covers the actual hardware and operating software.

The ADA programming language is being developed by the Department of Defense to expedite multilevel design efforts. FORTRAN is fine for the Global Computer System level but it usually is inadequate for the lower two levels. Assembly language is all too often used at the bottom level greatly increasing costs and schedule and frequently reducing software reliability. Although Pascal is often used in the lower levels, it is subject to many avoidable problems because it was developed from the bottom up like Fortran. Bill Vaughn of Honeywell emphasized the major benefits expected from the Top Down development approach being taken with ADA. He expects that there soon will be an ADA compiler for the PDP VAX computers and that others will follow in due course.

HUMAN FACTORS IN PROCESS CONTROL
Magne Fjeld, AccuRay

The example of description of an Indian Elephant by a committee of blind men was used quite appropriately a number of times during the conference, perhaps most effectively in the session of Distillation Column Control.

Process Control Engineers usually come into contact with the lower limbs of the elephant (i.e., the four limbs rooted in common sense).

1. When in our work we meet a man/machine interface problem, we like to have quick answers to a number of straightforward questions such as:
   What is a good keyboard for a V.D.U. (Visual Display Unit)? How can trends be combined with process

values? How shall I use color? What is better: a flow graph, a bar graph, or a table?

2. Those active in reliability and safety issues would like to know how to set up the alarm system and how to protect process control from operator errors.

3. There is also an interest in operator behavior. What does the operator look at? What does the operator ignore?

4. Engineers responsible for system implementation would like to know how to train plant people. In particular, they like to have information for designing trainers and simulators.

Human Factors Engineering can give some answers to such questions, based on a long series of experimental results. However, more appropriate anwers, relevant for modern computerized automation technology, require additional research work. John Rijnsdorp of Twente University, the Netherlands pointed out that when the elephant extends its trunk towards us that stands for cooperation between Human Factors and Process Control Engineers, in view of appropriate problem formulation and feedback of practical experience. In this way, the brains behind the upper end of the truck can be put to work for us.
As the upper parts of the elephant are rather far above the ground and the viewing angle is unfavorable, not many people can see what they represent. Therefore, Magne Fjeld has hired four donkeys in order to set up an audible display. It is well known that audible displays have a more forceful impact than visual displays.

The first of Magne's donkeys has made a plea for a thorough study of human error. The second one for deep involvement in task analyzing and its implications for training. The third one is for a sincere application of inderdisciplinary Systems Engineering oriented design. The fourth one is for harmonizing work organization and automation system design.
So far the acceptability of these seemingly far flung ideas is rather doubtful.
Still, John would like to invite everybody to ponder the following questions. Your responses, if any, could possibly be an item for the next conference.

Are you willing to let control and information system design be influenced by consideration of human error idiosyncrasies?
Is there a remote possibility for you to invoice your collegues and your boss to follow and integrated Human Factor and System oriented design approach?
If so, would you also appoint for this?
Can you find the time and the assistance for obtaining a task analysis of the future uses of the system you are designing?
Can you arrange for appropritate training of future users in particular today's operators?
Do you see opportunities for the future user to adapt the system to his/her needs and wishes?
Can you promote a human factor evaluation of your system under actual operating conditions?

ADVANCED STRATEGIES FOR PROCESS CONTROL AND ESTIMATION

Harmon Ray U. Wisconsin

Significant progress in the development of advanced control algorithms has taken place since the first Engineering Foundation Conference on Process Control. Although the industrial rate of adoption of such algorithms has not kept pace with that of the developments themselves, there is evidence that industry is beginning to recognize the power and usefulness of the available theory. In Japan, for example, Dr. Hashimoto has reported that 63 percent of the companies he surveyed are greatly interested in advanced control technology and 83 percent of the actual implementations of advanced control theory were successful. U.S. industries appear to lag somewhat behind those of Japan in the adoption of advanced strategies. Nevertheless, the explosion in semiconductor technology is removing computational limitations to implementations of multivariable control theory.
The only "new" advanced control technique discussed at the meeting was Model Algorithmic Control (Mehra), a promising method that places certain demands on the process operator. It is clear that this method deserves study, in particular careful comparison with other techniques. Although algorithm research and development are con-

tinually needed, this aspect of process control no longer appears to deserve to occupy the position of prominence it has for many years. It would perhaps not be overly optimistic to assert that algorithms currently exist in the literature to solve somewhere over 95 percent of all process control problems. Certain exceptions, such as emergency or event control and the graceful inclusion of state and control constraints into multivariable control algarithms, still exist and are ripe for continued attention, as are the special control problems arising in very nonlinear systems. The major needs in the area of advanced control technology now seem to lie at the interface between design and control. Traditionally, process control has been largely a cleanup operation. It is now evident that the distinction between process engineers and control engineers should be less sharp. Control engineers must enter the project at the design phase. Questions such as:

1) What is the control objective?
2) What variables can be controlled?
3) What manipulated variables do we choose?

need to be addressed at the design stage.

The intervention of control system design at the process design stage underlies the coming shift of process control from a purely defensive field to an offensive, or synthetic, field. Problems such as integrated process operation and information reliability improvement loom important as new areas of endeavor. In short, there was a strong consensus at the Conference that process control will experience a shift from algorithm development to synthesis.

There was considerable discussion concerning the most desirable level of process detail at which to test new algorithms and methods, the single unit or the entire plant. The single unit (distillation tower, reactor) is simpler to handle and is amenable to generalization since the principles are common to most such units. The whole plant is, of course, our business and the control of the entire plant is really the bottom line. Effort on control system design at the plant level is clearly needed and was strongly endorsed by the attendees.

A few final comments reflecting the opinions of the reviewer can be made on the subject of advanced control strategies. The period during which university researchers could afford to focus almost exclusively on advanced algorithm development appers to be drawing to a close. Continued university research on advanced control and the control/design interface will benefit greatly from university/industry interaction. Such interaction, in the form of summer employment for students and faculty, the use of industrial process equipment for control studies and theses suggested by industrial problems is a source of fresh ideas and invaluable experience for the student and professor. A concrete proposal can be offerred. University researchers in process control should attempt to contact industrial laboratories to learn about current and anticipated control problems. Proposals for joint research can be prepared, proposals that include provision for significant feedback on project goals. On the other hand, managers of industrial process control groups should attempt to obtain funds for and encourage such joint research. (The cost of these joint projects is not large, basically modest equipment and student salary support). Experience in other areas of chemical engineering has bourne out the advantages to both university research and industrial development of joint academic/industry research programs.

COMPUTER - AIDED CONTROL SYSTEM DESIGN (CAD) DEMONSTRATION

Tom Edgar, U. Texas

As part of the Tuesday sessions on advanced control strategies, an afternoon workshop was held to demonstrate several CAD packages for multivariable control developed in the U.S. A Tektronics 4014 graphics terminal was provided so that software could be accessed by telephone. The program developed at the University of Wisconsin has, among other features, the ability to perform multivariable time delay compensation. It provides capability both for time domain (state space) and frequency domain computations. A program developed at the University of Texas is oriented towards frequency response analysis, generating Bode and

Nichols plots as well as the normal Nyquist arrays. Finally, the EASY5 program developed by Boeing Computer Services Company was demonstrated: EASY5 is a generalized time domain simulator and optimal control package. This software has been used in aerospace system design and has some interesting possibilities for process control.

DISTILLATION CONTROL/ENERGY MANAGEMENT
Tom Edgar, U. Texas

Distillation is the reverse of the irreversible mixing of two pure streams and thus extracts its thermodynamic penalty, to the tune of 3% of the total US energy usage. There were four papers presented upon this subject that set the position of distillation control of this time. Page Buckley presented several examples of heat intergration of distillation columns that have been constructed at DuPont. This is quite significant because, due to a variety of practical reasons, heat integration has not grown nearly at the rate that steady state economics indicate is reasonable. Indeed, there were problems that we reported, but solved, to put these projects on-line and the experience base was widened. This was followed by a discussion by Carroll Ryskamp of the methods for avoiding complex decoupling schemes by proper design. Carroll used the physics of the process to describe the reasons for several observed control problems. A very sound technique for avoiding the coupling in dual composition control was presented - called combined reflux and distillate control. Tom McAvoy followed these papers with the results from a study on the problems of extrapolating dynamic behavior from low purity distillations to high purity distillation. These results utilized a simulation of a binary distillation but agreed with observed phenomena for multicomponent applications. The section was rounded out by a survey by Kurt Waller. Although entitled University Research, Kurt included references to several industrial research projects that were appropriate.
The energy management section was begun by George Quentin from EPRI. He described the control analysis of the Gasification/Combined Cycle (GCC) power plant project of EPRI. This plant is likely the new technology that will efficiently convert coal to electrical power. Since the project is such that it is being driven along at a fast pace, it was appropriate that controllability be studied at the indeption by experiment and study. Ron Simpkins presented a planned system for energy management in DuPont. This system was multiprocessor equipment based upon earlier process control computers built by DuPont. The final paper was by Mr. Dick Hanson of a commercial energy management system built by Taylor Instrument. This system is currently being implemented on a series of boilers in a paper mill.

DESIGN OF CONTROL SYSTEMS FOR INTERGRATED CHEMICAL PLANTS
George Stephanopoulos U. Minnesota

Plant Control Summary

There is absolutely no question that the matter of control of an entire plant was seen by all speakers in this session as a central and pressing problem. Indeed, both the industrial practitioner and the academic researcher see progress in integrated plant control techniques as an absolute necessity in coping with more tightly coupled processes, abnormal process conditions, and energy conservation. This seemingly universal interest when coupled with the three papers and three short commentaries made this an exciting and stimulating session.
Manfred Morari identified the key problems in integrated plant control to be:

1) Structuring of control tasks in large-scale systems.
2) Sensitivity reduction used as a control design and tuning criterian.
3) Identification of the fundamental limitations to control quality.
4) Education.

Directions of works now underway that promise progress on the first three of these were seen to be:

1) Plant data estimation, reconciliation, and adjustment.
2) Control methods making use of models, accounting for constraints, and having the potential for changing structures (such as Dynamic Matrix Control and Model Algorithmic Control)
3) Interrelating of process design and control system design. Systems that are resilient in the dynamic and steady state.

The first of these three topics was given an extensive review by Dick Mah. He sees that recent work has clarified the distinctions among subareas. There has been a shift from concentration on calculations to development of fundamentals and investigation of theoretical matters. Matters of measurement placement and inclusion of the several techniques into an overall framework needs more effort.
The interrelation of process design and control was given a lucid account by Jim Douglas. His approach in this is to consider steady-state control relations and process operability at different steady states. This is done by looking at the overall picture, suppressing detail. He identifies key process disturbances, uses approximate static and dynamic models (3 time constants), and seeks the dominant economic determinants on control system structure.
A panel of industrical participants consisting of Irvin Rinard, Joe Shunta, and Tom Marlin added a breadth and depth leavening to these presentations.
The general high level of interest among both industrial and academic participants appears to promise a confluence of opinions, in these two sectors that plant operability is a central issue demanding the best efforts of both sectors.

DISTRIBUTED COMPUTER PROCESS CONTROL
Edgar Bristol, Foxboro Company

The session on distributed computer Process control consisted of two papers and a panel discussion following. "The structuring of distributed Intelligence computer control systems by C. W. Rose was an excellent tutorial paper on the concepts of distributed digital computing. The author dealt with distributed computing systems the way they someday will be built and not as most commercial systems presently are designed. In this regard, a comment raised from the floor during the later panel discussion should be noted, viz. that many of the distributed systems available are actually instrumentation systems rather than distributed computer control systems. The author dealt substantially with the latter case, i.e. with distributed intelligence whose actual location in the network should be transparent to the user. An extended description of the requirements for such systems was given emphasizing reliability, response time and performance, and modularity. Following a discussion of network topologies, the author concluded with an extended introduction to digital communication techniques and protocols.

"An Approach to Digital Process Control" by M. Masak described an industrial computer control system with a geographically distributed, i.e. remote, front-end data acquisition sub-system and dual processors. One of these processors is substantially dedicated to process control functions while the other is used for information handling and displays. The system has been adopted by Chevron for general application within the company, four new systems presently are due for installation in the coming two-year period with a dozen systems already installed.
The distibution of computing functions within the system is a traditional one with important, time-critical duties assigned to the control processor.
The author discussed the application of inferential control, constraint control, measurement redudancy, and adaptive control, all briefly. One unusual feature of the system was the use of process control software (COSMIC) which was developed in-house. At least one questioner indicated slight surprise

at the relatively low total of manpower effort required to develop this system and to replicate it.
The two papers presented in this session, plus the panel discussion and several papers presented earlier on real time applications, furnish a good brief introduction to the field. Nevertheless, it was clear that a proper session on distributed computing will have to wait until commercial systems just coming on the market have arrived and users have had the opportunity to evaluate them in comparison to traditional computer network configurations.

CLOSING REMARKS
(Dale E. Seborg, UC - Santa Barbara)

This conference has provided a unique forum for a beneficial exchange of ideas between industrial practitioners and academics in the area of process control. The 119 conference participants gained an improved understanding of the difficulties associated with the implementation and maintenance of advanced control strategies. They also reached a general consensus that the selection of control algorthms plays a relatively small role in the design of computer control systems for industrial applications.
The conference program emphasized new developments that have occurred since the previous Engineering Foundation Conference five years ago. These recent developments include:
New Control techniques such as Dynamic Matrix Control and Model Algorithmic Control; The availability of Computer Aided Design (CAD) packages;
Important new research topics such as plant control strategies, shortcut design methods, and the control of processes with significant nonlinearities and time-varying parameters.

This conference has demonstrated that there are several reasons why process control continues to be both an important and exciting activity:

1. Significant economic incentives exist for improved control of industrial processes.
2. Inexpensive, reliable computers are available to implement virtually any control strategy that a process engineer can suggest.
3. Academic research in Process Control has been investigated by recent emphasis on challenging new problems motivated by industrial needs rather than by developments in other fields.

CALL FOR PAPERS

The American Automatic Control Council (AACC) announces the first American Control Conference (ACC) June 14-16, 1982, at the Sheraton National Hotel in Arlington, replacing the JACC. The intent of this conference is to bring together the people working in the field of control and related areas.

The ACC will cover all aspects of control systems, from theory to implementation. Topics of interest include, but are not limited to, linear and non-linear systems, large-scale systems, stability, deterministic and stochastic optimization, decentralized control, estimation and tracking, and resource allocation. Possible applications include aerospace systems, energy systems (including power systems), measurement and instumentation, biomedical systems, and socioeconomic and environmental systems. Presentation of recent high-technology control implementations will be encouraged.

The IFAC Symposium of Identification and System Parameter Estimation is scheduled for the previous week, June 7-11.

Deadline for contributed papers is Oct. 1, 1981

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