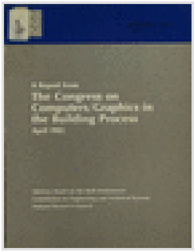

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The report presents material from the second Congress on Computers/Graphics in the Building Process held in April 1983. The Congress was co-hosted by the Advisory Board on the Built Environment of the National Research Council and the National Computer Graphics Association--in conjunction with the World Computer Graphics Association. The purpose of the congress was to involve invited federal agency personnel in a series of interagency user committee meetings, and in technical sessions where experts presented papers on computers/graphics in the design, construction and management phases of the building process. The report contains selected abstracts of these papers. It also reports on the recommendations that emerged from these first meetings of interagency federal user committees. The text of the keynote address on the past and future promises of computer technology is given.

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A Report from

The Congress on Computers/Graphics in the Building Process

April 1983

Washington, D.C.

Advisory Board on the Built Environment
Commission on Engineering and Technical Systems
National Research Council

NATIONAL ACADEMY PRESS
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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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This report was prepared as part of the technical program of the Federal Construction Council (FCC). The FCC is a continuing activity of the Advisory Board on the Built Environment, which is a unit of the Commission on Engineering and Technical Systems of the National Research Council. The purpose of the FCC is to promote cooperation among federal construction agencies and between such agencies and other elements of the building community in addressing technical issues of mutual concern. The FCC program is supported by 14 federal agencies: Department of the Air Force, Department of the Army, Department of Commerce, Department of Energy, Department of Health and Human Services, Department of the Navy, Department of State, Federal Emergency Management Agency, General Services Administration, National Aeronautics and Space Administration, National Endowment for the Arts, National Science Foundation, U.S. Postal Service, and the Veterans Administration.

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INTRODUCTION

Sponsorship

On April 4-8, 1983 the second Congress on Computers/Graphics in the Building Process was held at the Washington, D.C. Convention Center. The congress was co-hosted by the Advisory Board on the Built Environment (ABBE) of the National Research Council and the National Computer Graphics Association in conjunction with the World Computer Graphics Association.

The congress provided an opportunity for invited persons from federal agencies to meet with members of other agencies, professionals in practice, and experts from the computer community. The congress attracted over 2600 people of which 550 attended the tutorial and/or technical sessions. Of these, approximately 200 were federal personnel invited by ABBE's Federal Construction Council. The Federal Construction Council provided partial support for the planning of the congress, with individual registration fees and corporate exhibit fees providing support for the operation of the congress.

ABBE's Committee on Computers/Graphics planned the technical portion of the congress, invited the speakers, and organized special federal user group meetings for agency personnel. This committee included experts from universities and industry, as well as liaison representatives from federal agencies. The World Computer Graphics Association arranged all non-federal registrations, planned the tutorial sessions, and managed the five-day event. The National Computer Graphics Association's principal responsibility was to organize and manage the exhibits. Twenty-seven companies and organizations participated as exhibitors at the congress.

Purpose

Federal agencies that design, construct, manage and operate buildings are rapidly finding that there is an increasing advantage in converting their existing procedures to ones that are computer based. Because it is technically possible to represent a building as a collection of images or drawings that can be input to a computer display and manipulated as computer data, a number of agencies are beginning to require their architectural and engineering consultants to provide computer-based documents. This has required most agencies to form user committees to manage the transition from existing manual practices to those which are computer based. Agencies are also finding it necessary to provide technical information and training for their staff, including briefing sessions for upper management. In a field that is changing as rapidly as computer graphics, it is difficult, even for those who are reasonably well-informed, to keep abreast of changing opportunities.

The Congress on Computers/Graphicss in the Building Process emphasized the federal users of computer-based systems. Invited agency representatives met in ten special topical sessions to discuss the need for and nature of establishing federal user groups for computer-based design and engineering. The recommendations that emerged from these sessions will form the basis of future ABBE activities in this field.

Organization

Invited federal personnel were joined at the congress by building design practitioners (architects and engineers), computer experts, representatives of computer companies, and other professionals. Participants from the private sector represented many of the organizations that provide computer-related support required by federal agencies. The interaction of the public and private sectors at the congress contributed to a better educated and more capable support community.

The general theme of the sessions in the congress was on methods for improving the building process through computers and computer graphics applications. Tutorial sessions--intensive application and educational workshops--were held on the first two days of the congress and were sponsored by the National Computer Graphics Association. The remaining three days consisted of technical sessions, exhibits and the special federal user group meetings. The keynote address was delivered by James H. Burrows, Director of the Institute of Computer Sciences and Technology of the National Bureau of Standards.

A LOOK AT THE PAST AND THE FUTURE PROMISES OF COMPUTER TECHNOLOGY

The Keynote Address

by

James H. Burrows
Director
Institute for Computer Sciences and Technology
National Bureau of Standards
Washington, D.C.

April 6, 1983

I am glad to be here and to speak briefly to you at this, the second International Congress on Computers and Graphics in the Building Process.

Today, I thought I would try to put some perspective on the developments in the computing field, then give you some advice and issue a challenge.

When I was a child, and after radio, flying, and driving automobiles had become commercial, if not universal, my Dad commented he was born 30 years too soon. I was almost 30 before I entered the computer field, and I also have the feeling that I was born 30 years too soon. However, I'm not sure Pac Man is really an improvement over pinball machines and punchboards. It only costs more.

When I entered computing I did it in a big way, joining the team at MIT's Lincoln Labs that was building the Semi-Automatic Ground Environment, SAGE. We had a computer of 32 bit word length, although only 16 bit arithmetic and no floating point. We had 100 remote displays within the building and could accept inputs from about 20 radar sites--from more than 100 operators in several identical centers hundreds of miles away. Fifteen to 20 teletype input/output devices entered flight plans, and so on. The bare computer cost $6-15 million depending on whether it was simplex or duplex.

The physical size, power and heat dimensions of the machine are hard to believe. The machine had 8K-32 bit words of main memory, 32K bytes of main memory. I could stand between the two shower stall size boxes holding that memory. Today most machines in the $200-$500 range have more memory, and the computers supporting rudimentary CAD/CAM have more computing power than that vacuum tube behemoth that supported SAGE.

What I am going to discuss initially will promise no relief from the current exponential technology spiral in the next ten years.

Technological changes driving down the costs of computing have sparked enormous growth in the use of computers. Today, microprocessors are finding their way into a wide range of devices from the automobile to electronic games to intelligent computer terminals, personal computers and mainframes. With the increased use of computers, there has been a tremendous increase in the types and amount of information that are being recorded and used. Managing and using new technologies and information resources effectively will be challenges in the years ahead.

I believe that we can expect continuing developments in the future, driven by advances in very large-scale integrated electronics circuitry. Hardware developments will continue to be the most dramatic, but I believe that we will see significant improvements in software and data base technologies also.

Advances in integrated circuit and computer technology are often measured by the density of components on a chip and the number of operations per second that can be performed. Circuit densities of 64,000 components or more per chip are available in the market place today. A 32-bit microprocessor announced recently has chip complexity of 450,000 transistors. By 1986 we can expect densities of up to 1,000,000 components per chip for logic. This complexity has been achieved by shrinking the size of the individual components. With the dense packing of circuits comes improved reliability, primarily through the elimination of connections. Today's circuits are 10,000 times more reliable than they were 25 years ago. A designer of one of the larger IBM compatible machines expects his next machine to run half a year between scheduled preventive maintenance.

In the area of processing speed, some of today's large computer systems are approaching 100 million instructions per second. The Cray Company has announced a machine of 300 million floating point operations per second. This machine is scheduled for the late 1980s. The practical limits facing integrated circuit technology development are mostly the problems associated with heat dissipation as circuit densities increase. Secondarily, there are problems with the inherent propagation delays between components within the chip (limited to the speed of light).

Many of these advances are possible because of computer technology and automated design, manufacturing, and testing techniques. Automated design of chips with 5,000 to 30,000 gates is now possible, and larger designs can be done semi-automatically. The cost of logic and storage components also continues to drop while speed and complexity increase. Because of their small size per memory bit, their high speed, and their low manufacturing cost, semiconductor memories are used almost exclusively and are expected to continue to be used through the 1980s. A VAX 780 power machine will be on your desk in 1990 at a cost of less than $5,000.

Our estimates of the user costs in cents per 1,000 bits show continued reductions. For example, fast semiconductor random access memory costs 300 millicents per bit today. In ten years, that cost will be in the range of 20-40 millicents per bit.

Magnetic disks will continue to improve as mass storage technologies improve. Flexible disks, for example, are in widespread use for both information storage and information transfer. Low-performance flexible disk drives for the standard 5 1/4 inch disks are very inexpensive, and the more recent 3 inch disk drives may do even better. The technology of flexible disks is behind that of rigid disks, but it is improving. Because of their cost per bit advantage over solid-state alternatives, they will continue to be used for on-line files. Buffered disks, using a semiconductor or bubble technology, are likely to be used in large systems with large files and high activity.

Input technologies have changed very slowly, and not much change is anticipated for the next five years. The operator at the keyboard will still be the principal mode of capturing information, although this technique is probably not the most natural way for people to interact with computers. However, improved keyboards are appearing in which numerical key fields and special control keys complement the traditional alpha/numeric key arrangement. These capabilities increase productivity and operator comfort. Also, touch screen capabilities are making it easier for people to use computers. More natural input using voice, for example, will develop slowly. Voice input systems still have very limited vocabularies, and continuous speech recognition systems are not expected during this decade.

Output technology has changed the user-computer interface significantly. Estimates are that between 5 and 10 million workers use video display terminals today, perhaps 4 percent of the work force. By 1990 one out of five workers will use a computer work station. The cost of standard terminals is expected to be in the $50 to $100 range in the next few years. Special terminals with color options and high resolution are expected to cost between $1,500 and $2,000 by 1985. Flat-panel displays using plasma technology have been around for some time, but they are expensive and have poor resolution. Large-area displays based on this newer technology are expected to be commercially available before 1987 at prices in the $200 to $300 range.

The growing interest in graphics display for computer-aided design and animation has led to the creation of three-dimensional perspective images, mostly through improvements in software for providing shading. However, progress toward true three-dimensional displays is much slower. Considerable research and development work is underway in Japan. In general, however, the transmission and reproduction of three-dimensional images has, to date, not permitted practical solutions because of the complexity involved and the volume of information required in the recording storage.

Other output technologies are also improving, particularly voice synthesis, and impact and non-impact printing terminals.

Declining costs have characterized hardware development over the past 25 years. Studies by IBM show that since 1950 the overall costs of small, general purpose computers (as defined by the instructions executed per second) have been decreasing at a rate of about 25 percent per year. The rate of decrease for larger general purpose computers has been about 15 percent per year. Computers are also decreasing in size. Some experts predict that a five-million-instructions-per-second computer will fit into a three-inch cube by 1990.

Software has evolved more slowly and has lagged behind hardware in sophistication, performance capability and reliability. Over the years, software has accounted for an increasing portion of the total costs of system development. The systems and applications programming account for about 85 percent of total system cost. Applications programming is by far the largest portion of all programming costs. Software development and maintenance continue to be labor intensive and complex with perhaps two-thirds of all programmer time spent on maintenance and modification of existing software.

Promising developments in software will help users make better use of computers and permit programmers to become more productive. The operating system interfaces of large systems are beginning to disappear from the user's view. These are being replaced by easier-to-use, more logical interfaces in the higher-level support software systems such as compilers, data-base management systems, and job scheduling systems.

Another trend in software is the development of software tools that improve programmer productivity. Software products that perform input, processing, and output are available in the market place. These products will gradually replace today's programming languages for most applications. They will require more hardware resources as a trade off for their user friendliness, but these resources will be available and inexpensive.

We can also expect improvements in file management. By 1987 four related, but distinct, kinds of products should become generally available:

1. Data-base management software that provides extracts of operational data bases for decision support and multiple user view of data;
2. File searchers for limited collections of data and text;
3. Storage hierarchy managers that provide access and control for large data bases resident in multi-level hardware hierarchies; and
4. Read-only systems using video disks with text and image capabilities.

With the development of user-friendly systems and with greater familiarity with computer systems on the part of the users, non-computer professionals will take a larger role in developing their own systems and solving problems without the services of the computer professional.

The other major technology that influences our future use of computers is communications. The telephone network that currently connects telecommunications and computer equipment and services was developed for voice transmission. We can expect in the 1980s and 1990s that integrated digital communications links for the transmission of facsimile, voice, and data will become available.

The increased development of computer graphics systems is apparent. Improvements in software for graphics, along with decreased costs of hardware, are making graphics systems widely available for a broad spectrum of applications such as design, instruction, business, and entertainment. Not long ago, graphics systems were one-of-a-kind systems. They were awkward to use and would usually occupy an entire room. The CRT technology for graphics display is being constantly improved, and the limitation of two dimensions is currently being investigated.

In the graphics area standards will play an important role in facilitating the exchange of data, drawings, and associated records. The American National Standards Institute is conducting work on extending results to three dimensions while polishing and simplifying the draft international standard, Graphics Kernel System (GKS) of the International Organization for Standardization (ISO). The Air Force sponsored a project in the aircraft industry that NBS coordinated to produce IGES, the Initial Graphics Exchange System, a standard data base format for exchanging design data between design systems.

One waste evident today is our inability to exchange and use data between activities without bringing it out of the machine to paper and re-entering from paper (whether manual or automatic). There have been some developments where a document that is machine produced is both human readable and, through special symbolic areas, also machine readable. The merchandise product code now used by retailers is such an example. In this case the numbers and the special code both appear.

I'd like to get to my advice now. First, it is clear that the underlying support technology is increasing in capability and is decreasing in cost. The false start that occurred in the 1960s in the use of computers in the building process is past. There are clearly cost-effective uses today, and they should be encouraged.

Many of the future benefits discussed at this conference are downstream from design and drafting. These need a data base from which to start; regenerating from scratch is not cost effective.

Many of the uses are islands of capability not connected to other uses. This may be appropriate for initial development, but loose federations of applications look feasible and cost effective.

No other field will supply the one missing element to the construction industry. That is a coherent process and data model, tightly integrated or not, that will allow the flow of data between and among the several participants. This is of paramount importance for the long-range health of the field. However, "analysis paralysis" will set in if you wait for the ultimate, and no progress will be made.

From just a perusal of the conference program, it is clear to me that the issues are joined, and that progress is under way. I think I'm correct when I tell my son I was born 30 years too soon, although I must agree that I am living in an interesting time.

Thank you.

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TUTORIAL AND TECHNICAL SESSIONS

Tutorial Sessions

A program of tutorial sessions was offered by the National Computer Graphics Association on April 4th and 5th, the first two days of the congress. Tutorials were independent, educational sessions that offered an in-depth examination of special areas of computers/graphics applications in the building process. Each three-hour session was accompanied by resource materials that were prepared by the instructor.

The tutorials were developed based on suggestions by the ABBE Committee on Computers/Graphics, a survey by the World Computer Graphics Association of user interests, and on suggestions by 1982 congress participants.

The tutorial sessions were:

1. "Getting Started in Computer Graphics: What's It All About?"
   Joel T. Orr
   Orr Associates, Inc.
   Danbury, Connecticut

2. "Computer-Aided Cost Estimating in Practice"
   Michael Dell'Isola
   Smith, Hinchman & Grylls Associates, Inc.
   Washington, D.C.

3. "An Introduction to Computer Use for Architects"
   Natalie Langue Leighton
   Skidmore, Owings & Merrill
   New York, New York

4. "Facility Management: Developing Management Tools"
   John R. Adams
   Facility Management Institute
   Ann Arbor, Michigan

5. "CAD/CAM Graphics in the Building Process"
   Eric Teicholz
   Graphic Systems, Inc.
   Cambridge, Massachusetts

6. "CAD System Selection, Evaluation and Effective Use"
   William Beazley
   Brown and Root
   Houston, Texas

7. "Low-Cost CAD Systems for the Design Office"
   Eric Teicholz
   Graphic Systems, Inc.
   Cambridge, Massachusetts

8. "Computer Graphics for Management: Tools to Get New Projects Approved and to Manage the Construction Process"
   Alan Paller
   AUI Data-Graphics, Inc.
   Washington, D.C.

9. "Advanced Applications: Case Studies of Computer Applications in Architectural Practice"
   William Mitchell
   Graduate School of Architecture and Urban Planning
   University of California, Los Angeles

Technical Program

The technical portion of the congress consisted of 45 sessions spread over the final three days of the congress, April 6th through 8th. The sessions were organized and conducted by ABBE's Committee on Computer/Graphics. Fifty-two experts from universities, industry, and federal agencies participated as speakers or panelists in the program. The sessions consisted of presentations, panel discussions, and question and answer sessions.

The technical program was open to all registered congress participants--invited federal personnel, private practitioners, industry and university representatives. While the focus of the technical program was oriented to the needs of federal users, it was also designed to be of general interest to the non-federal personnel present. Agencies that use the services of private professionals can benefit from having those professionals well-informed on this developing technology.

The program was organized around three themes: the use of computers/graphics in building design; the use of computers/graphics in managing the building process during construction; and the use of computers/graphics in the management of facilities. The sessions were equally divided between sessions that were of interest to those technically involved with computers and their use, and sessions that were of interest to the managers of organizations that are, or will soon become, users of computers/graphics systems.

Selected summaries of presentations are found in Appendix I. Appendix II lists the names and addresses of speakers and panelists. A listing of the design, construction and management sessions follows.

DESIGN SESSIONS

Session Number	Title	Speaker(s)
1D	Impact of Computers on Design Services Procurement[1]	David Skar David Wolfberg
2D	Computer Aids for Engineering Analysis and Design[2]	Ronald King Reg Monteyne David Sides Daniel Raker
3D	Recent Breakthroughs in the Computerization of Architectural Design, Graphics, Automated Drafting and Project Management[1]	Fred Stitt
4D	Quality Control of Contract Drawings Produced by Computer-Aided Methods[2]	Neal Davis
7D	State of the Art and Capabilities of Drafting Systems[1]	Eric Teicholz
12D	Quality Control of Specifications Using Computer-Aided Methods[2]	Dana Smith Charles Carroll
15D	Implementing Computer-Aided Design--The Revolution in Operating Procedures[1]	Lee Emberley Duane Koenig
18D	Planning and Implementing a Large-Scale Computer Graphics System at a Government Organization--The NAVFAC Approach[2]	George Bartsiotas
21D	The Impact of Computer-Aided Design on Management of Design Organizations[1]	James Ingram Graham Copeland
22D	Computer-Integrated Design Process[2]	Edwin Collins
25D	Two Case Examples of Computer-Aided Design in the Design Firm[1]	Douglas Stoker Pete Lage

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[1]Management-oriented sessions
[2]Technology-oriented sessions

DESIGN SESSIONS (Continued)

Session Number	Title	Speaker(s)
26D	Automated Support of the Review Process--Design Versus Criteria[2]	Steven Fenves Leonard Lopez
28D	Computer-Integrated Design Process: Functional Programming and Conceptual Design[2]	Gary Silver Charles Eastman
29D	How Does the Small Design Firm Acquire Computers/Graphics Capabilities?[1]	Charles Richardson
30D	Computer-Aided Activities in Support of the Planning Process[1]	Tom Kenney Ken Crawford Bruce Dains
34D	Use of Microcomputers in the Building Process[2]	Littleton Daniel
37D	Interactive Computerized Topology for Designers[2]	James Corbett
40D	Developing and Responding to RFP's for Computer-Aided Graphics Services[1]	Duane Koenig Ronald King
41D	Computer-Integrated Design Process: Problems and Potential[1]	Daniel Rehak Harold Borkin
42D	Current Research and Development on the Use of Computers for Cost Control and Estimating[1]	Brian Bowen
43D	Systems Interfacing: Format, Outputs and Interaction[2]	Bradford Smith
44D	Wrap-up Panel: Computers/Graphics in the Management of the Building Design Process[1]	Harold Borkin Brian Bowen Lee Emberley Duane Koenig
45D	Wrap-up Panel: Computers/Graphics Technology in the Building Process[2]	George Bartsiotas Edwin Collins Neal Davis

[1]Management-oriented sessions
[2]Technology-oriented sessions

CONSTRUCTION SESSIONS

Session Number	Title	Speaker(s)
9C	Computer-Aided Construction Management: Industry's Viewpoint[1]	Neal Mitchell
10C	Computer-Aided Interference and Conflict Avoidance During Construction: The Last Chance[2]	Wallace Wright Pete Lage
13C	Computer-Aided Construction Management: Government's Viewpoint[1]	Lee Garrett John Madsen
14C	Computer-Aided Engineering Support During Construction[2]	Frank Hutchinson Daniel Borda Daniel Rehak
23C	On-Site Computer/Government Contract Administration[1]	Thomas Nowak
24C	Computer-Aided Support of Quality Control, Value Engineering and Other Activities[2]	Martin Markowicz
27C	Management and Control of Data Bases Used for the Computer-Aided Support of the Construction Process[1]	Daniel Drake
38C	Wrap-up Panel: Computers/Graphics in the Building Construction Process	Littleton Daniel Lee Garrett Frank Hutchinson Neal Mitchell

[1]Management-oriented sessions
[2]Technology-oriented sessions

MANAGEMENT SESSIONS

Session Number	Title	Speaker(s)
6M	People, Spaces and Inventory: Using Computers/ Graphics in Facilities Management[2]	David Armstrong
11M	What is Facilities Management? Who are the New Professionals?[1]	Jim Steinmann Melvin Schlitt
16M	Facilities Management: The Need for Integrated Facilities Data Bases[2]	William Mitchell
19M	Costs and Benefits of Computer-Aided Facilities Management[1]	Jeffery Hamer
20M	Case Study in Facilities Management[2]	Michael Dembo Ronald Brown
32M	Facilities Management Operational Issues[2]	Carlos Higashide
35M	Case Study in Facilities Management[1]	Thomas Northam
36M	The Use of Computers in Facilities Planning, Modeling and Financial Management[2]	Jim Steinmann
39M	Wrap-up Panel: Computers/Graphics in Facilities Management	Ronald Brown Michael Dembo Jeffrey Hamer Carlos Higashide Melvin Schlitt Jim Steinmann

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[1]Management-oriented sessions
[2]Technology-oriented sessions

4

FEDERAL USER GROUP SESSIONS

Federal user group sessions were held on the mornings of April 7th and 8th of the congress. These sessions were organized for invited federal users and managers of computer-based systems. Nearly 200 federal agency personnel participated in the eight sessions (see Appendix III for names of attendees). The purpose of these first-ever meetings of interagency personnel was to discuss in an informal manner the need for and the nature of establishing interagency user committees.

Seven of the user group sessions dealt with special interest topics and were designed for those members of federal agencies who were experienced users of computer-based systems. The special interest topics were:

- Computer graphics library--details and drafting symbols;
- Expansion of computers/graphics use among contract architectural and engineering firms;
- Managing a CAD installation in the government;
- Engineering analysis programs;
- Integrating CAD systems into the design process;
- Data exchange standard; and
- Problems with justification for and acquisition of computers/graphics systems within the federal government.

In addition, a general session was held each morning to discuss the potential need for and nature of federal user committees. This session was designed for federal managers and potential users and addressed the question: Do we want to have user groups in the future? Lee Garrett, the chairman of the ABBE committee, led both general sessions.

Summary of General Sessions

Participants at the general sessions of the federal user group meetings endorsed the concept that interagency user committees of federal personnel involved with computer-based systems and construction programs should continue beyond the initial efforts established at the congress. Efforts to organize such user committees should include consideration of every agency in the Federal Construction Council that is currently using computer-based systems or that is considering the use of such systems.

In addition, the private sector should be involved at some point in the development of such user groups. This could involve private sector companies providing exhibits at user group meetings for hands-on applications of state-of-the-art hardware and software. This involvement of private sector companies would be one step removed from sales demonstrations; it would involve companies agreeing to demonstrate applications in an educational mode.

Participants agreed with the concept that user committees should be organized along the lines of "special interest" areas. User committees should be organized across agency lines according to subject areas. The special interest topics for federal user groups at the congress are examples of possible subject areas for such committees.

For user committees to be effective, they should address development of new concepts, new tools, and new processes. User committees should go beyond simply addressing the automation of current practices.

Participants felt strongly that user committees must have agency management behind the effort, both in terms of the initial formation phases of such committees and throughout the life of the committee.

Summaries of Special Interest Sessions

The following section summarizes the federal user group sessions that dealt with special interest topics. Each moderator posed three questions to the group for discussion. They were:

1. Under this subject, what are the areas of common concern for each agency represented here?
2. Is there a need for some type of joint activity among the agencies represented here?
3. What form should such activities take?

As can be seen from these questions, the special interest user groups were not designed as technical discussions of the topics involved. They were meant for discussion among participants about the need for some type of organizational activity on the topic. Session moderators report their findings below.

Computer Graphics Library

This session was moderated by Neal Davis, U.S. Army Corps of Engineers, Huntsville, Alabama.

1. Areas of common concern: Under the subject of computer graphics library, the principal areas of common concern are details, symbols, text and levels or layers.

2. Need for joint activity: Participants voiced a need for a users group among agencies on this subject.

3. Form of activity: Although no plan was articulated by participants, there was agreement that there should be one lead agency with representatives from each other interested agency.

Expansion of Computers/Graphics Among Contract Architectural and Engineering Firms

This session was moderated by Ron King, General Accounting Office, Washington, D.C.

1. Areas of common concern: The consensus of the five agencies represented in this session--U.S. Army Corps of Engineers, Naval Facilities Engineering Command, U.S. Air Force, United States Postal Service, and Veterans Administration--was that there are a number of areas of common concerns including:

- Specifications;
- Standards;
- Cost estimating;
- Standard details;
- Policy of passing work around;
- Six percent limitation on design fees;
- Fee structure;
- Contract documents; and
- Data sources and pooling of data.

2. Need for joint activity: There was unanimous agreement that there was a need for some joint activity among agencies. At some point this activity should involve the private sector and the policy making agencies of the government such as the Office of Management and Budget.

3. Form of activity: It was less clear what form such activities should take. The Federal Construction Council was discussed as a possible forum, but all construction agencies are not members. It was felt that different types of activities may be necessary. Initially, a forum to define the specifics of the problems is needed.

Managing a CAD Installation in the Government

This session was moderated Robert Tilley, Veterans Administration, Washington, D.C.

1. Areas of common concern: There were no specific areas of common concern voiced.

2. Need for joint activity: Because CAD vendors have their own user groups, participants did not see any need for joint activity in this area.

Engineering Analysis Programs

This session was moderated by Fred Stahl, National Bureau of Standards, Washington, D.C.

1. Areas of common concern: Areas of common concern include languages, data portability, and validity and maintenance of engineering software systems.
2. Need for joint activity: Participants voiced a need for some type of interagency activity in this area.
3. Form of activity: There should be a joint committee of responsible federal agencies. Private concerns including manufacturers should be included in some manner. In addition, consideration should be given to a central clearinghouse (for more than federal agencies) for specifications, symbols, and user information.

Integrating CAD Systems into the Design Process

This session was moderated by Thomas Kenney, U.S. Army, Washington, D.C.

1. Areas of common concern: Common concerns among those present include the lack of exchange between systems including attributes, and planning and specifying what is required from a system.
2. Need for joint activity: Participants voted yes.
3. Form of activity: User committees should be established. These should consist of federal agencies with representation by the American Institute of Architects and selected computer manufacturers. It was felt that federal agencies must come together to force the computer industry to address problems in this area.

Data Exchange Standard

This session was moderated by Janet Spoonamore, Construction Engineering Research Laboratory, Champaign, Illinois.

1. Areas of common concern: Concerns include the types of data being transferred in terms of structure and content. Management commitment was seen as crucial.
2. Need for joint activity: Participants voted that some type of activity is needed.
3. Form of activity: Establishment of an IGES subcommittee should be considered.

Justification/Procurement of Computers/Graphics Systems

This session was moderated by Larry Kaetzel, National Bureau of Standards, Washington, D.C.

1. Areas of common concern: Common concerns include:

a. The availability of specifications (American Institute of Architects, Construction Specifications Institute) to other agencies, specifically those in the Federal Construction Council;
b. Justification for and approval of consultants to specify ADP resources; and
c. Standardization of computer resources such as software.

2. Need for joint activity: Yes, although justification and procurement vary widely among the agencies represented.
3. Form of activity: Activities may include:

a. Distribute federal guide specifications or make them better known to federal agencies;
b. Encourage user interactions, meetings, and distribution of lists of attendees to these federal user groups; and
c. Collaborate among other user groups especially the groups on data exchange standard and computer graphics library.

APPENDIX I

PRESENTATION SUMMARIES

CAN WE REQUIRE COMPUTER GENERATED CONTRACT DOCUMENTS?

DAVID J. SKAR
DIRECTOR, ENGINEERING SYSTEMS MANAGEMENT DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
ALEXANDRIA, VIRGINIA

While in its infancy, computer technology is beginning to emerge as a powerful tool in the building design industry. Today, applications are available to support the principle phases of the design process. Analysis programs are used by most engineering disciplines. Computer graphics can be used to generate final drawings. Word processing efficiently produces specifications. Systems are used to prepare cost estimates.

Major design and construction benefits can be achieved by using proven construction details and standard formats. However, in seeking to provide competitive advantages for their products, vendors often use unique procedures that make it impractical to automatically transfer results between design applications developed by different vendors. For example, a construction guide specification library maintained on Vendor A's word processing equipment cannot be effectively used on Vendor B's equipment. Furthermore, computer graphics equipment required to realize the benefits of reusing standard symbols and details may be too expensive for a small architectural engineering firm.

This presentation will cover these issues and others that must be considered before Federal construction agencies, such as the Naval Facilities Engineering Command, can require computer generated contract documents.

"COMPUTER AIDS FOR MECHANICAL ENGINEERING DESIGN AND ENERGY ANALYSIS"

Reg Monteyne, P. Eng.
Vinto Engineering Ltd.
Edmonton, Alberta, Canad[a]

The use of computer programs in the production engineering office produces a better product and leads to improved profits. In deciding to automate design tasks one must know what software is available, how to evaluate this software, and what specific tasks can be assigned to the software. Our firm uses computer programs in three main functional areas: 1) Heating and Cooling Load Calculations; 2) Duct System Analysis; and 3) Energy Simulations.

Programs we are familiar with in these categories are:

Design Program

Heating/Cooling

- APEC HCC III
- APEC HCCJR
- Carrier Load Estimating

Duct

- APEC Superduct II
- Carrier Duct

Energy Program

Level One

- ABC
- SEA
- Carrier OP

SUMMARY (Continued
SESSION 2D
Reg Monteyne

Level Two

- Meriwether
- EP

Level Three

- APEC ESP II
- TRACE
- BLAST
- DOE II

Energy Analysis programs are divided into 3 levels of complexity, from simplified methods to complex calculation procedures.

The contribution to total cost of an energy analysis is estimated to be 35% computer costs and 65% people costs. Efforts to reduce people cost are achieved through using programs which have comprehensive documentation and have competent technical support to field user inquiries. Programs which are not supported and updated on a continuing basis should not be used.

The technical capabilities of main programs are virtually equal. In our experience it is the ease of use of programs which separates the good from the mediocre.

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RECENT BREAKTHROUGHS IN THE COMPUTERIZATION OF ARCHITECTURAL DESIGN, GRAPHICS, AUTOMATED DRAFTING AND PROJECT MANAGEMENT

Fred A. Stitt, Architect. Editor/Publisher--Guidelines.

Although architectural computerization is in its infancy, a remarkable computer-aided synthesis of all major aspects of design practice is already under way.

The synthesis can be visualized as a network or web of software modules that include: the Scope of Services checklist; pre-design and plan programming criteria; building and zoning code criteria; spatial allocation and schematic design; financial feasibility study; preliminary construction cost estimating; design development and production drawing budgeting and scheduling; design development decision checklist and job record; working drawing planning checklist and decision record; consultant coordination criteria and checklists; working drawing construction detail files; working drawing notation and keynote files; outline specification files; final construction cost estimating; shop drawing coordination and checking; layering of base and overlay sheets in design and production drawings; division of repetitive data and coordination of computer graphics, paste-up graphics, and overlay reprographics; documentation control and checking; post-construction occupant survey; post-construction design and construction services.

Much of the foregoing is now available as software. The rest is all under development and should be available in 1983-84. Most will be available for the small microcomputers, all will be provided for use with minicomputers with graphic capabilities and mainframes.

It will be possible for the design team and client to proceed, through interaction with the machine, step-by-step through every decision that is made in the design/production/project management process. Each decision made, whether tentative or definite, initiates a search for all data relevant to that decision including other decisions that may be affected by it. Reasons for decisions are also recorded at the time made and revisions in decisions call forth the entire string of implications of such revision. A total documentation of the entire design and management process is created and updated reports regarding any aspect of the design, project management, or later facilities management will be available upon demand at any time. Most significantly a large amount of decision making that traditionally has been made at different times by different people (often in conflict with one another) can now be made in a single stroke and objectified and quantified in its repercussions both in text print-out and computer graphics.

QUALITY CONTROL OF CONTRACT DRAWINGS PRODUCED BY COMPUTER-AIDED METHODS

Neal G. Davis, PE
U.S. Army Corps of Engineers
Huntsville Division

The Huntsville Division (HND) has been using a Computer Aided Design and Drafting (CADD) system since 1978 for the preparation of construction documents. The system is used to efficiently input, store, manipulate and retrieve both graphic and non-graphic data. Projects range from site development drawings to architectural building design documents.

Procurement, Installation and Initial Production. Significant productivity increases using CADD have been established and well documented. To achieve these increases, a large commitment of resources by top management must be applied at the procurement, installation and initial production of a CADD system. It is very difficult and time consuming in the Federal Government to obtain approval and install a highly productive CADD system. Many times the system is outdated by rapidly changing state of the art before it has achieved the high productivity ratio.

Quality Control. The best quality control may be achieved by the forced standardization of CADD drawing document elements, which helps to insure a better construction document package, and better coordination between disciplines and drawings.

In the building design process, a CADD system is faster and more accurate in performing tedious, repetitive and time consuming tasks, freeing the user for more creative design. The user develops more interest and better morale which results in a better design.

Data Exchange Between Different Systems. The Corps of Engineers is transferring data between CADD systems using the Standard Interchange Format (SIF). Translators were developed to interchange data between the Corps used CADD systems of Applicon, Auto-Trol, Intergraph, GDS and Sketch.

In addition to SIF, the National Bureau of Standards has approved the Initial Graphics Exchange Specifications (IGES). Both standards require a tremendous effort of communication standardization and software translator development for successful data transfer between different systems.

Advantages. Advantages have been well documented based on cost benefit ratio and/or drawing productivity. Six other areas of justification have been identified. A better quality product can be produced, shorter project span times, integrated data base with the drawings, improved techniques such as changing scale and "what if" exercises, 3-D enhancement, and manpower augmentation due to the fact that qualified engineers and draftsmen are difficult to locate, acquire, and keep.1/

Summary. A better construction document package may be produced because of quality control methods developed while using a CADD system for design and construction.

1/S. H. Chasen and J. W. Dow, The Guide for the Evaluation and Implementation of CAD/CAM Systems, (Atlanta: CAD/CAM Decisions Press, 1981), pp. 30-41.

INTERFERENCE DETECTION USING CAD

Wallace B. Wright
DIS/ADLPIPE, Inc.
55 Wheeler Street
Cambridge, Mass.

Computer Aided Design (CAD) is growing at a rate of greater than 30% per year. It is estimated to be a $10.6 billion dollar industry by 1985.

This talk will address that portion of the CAD industry that is involved in interference detection. However, interference detection is not a stand-alone subject, but should be addressed in the context of one element of an integrated data base system for total design.

A series of graphic examples (transparencies) and costs are presented and briefly discussed. These data are based on actual cases.

Because of the diversity of interest and application, the talk will highlight the following (sometimes subjective) pros and cons of CAD based on the speaker's experience.

CAD HARDWARE AND SOFTWARE

- A lot of people aren't particularly enthused about using a CAD system.
- Make a list of what you want to do and how you want to do it. Compare your needs to CAD capabilities.
- Visit customers of CAD companies that are doing work similar to yours.
- Start a small parallel project using CAD. This can be done by using a computer service bureau or a CAD/CAM center. You pay for usage, no large capital investment is required.

CAD MANAGEMENT

- A complex management function is not necessarily a complex computer function and vice-versa.
- Project size vs. software/hardware capability may provide a series of limitations. Upward compatibility and expansion are a must.
- Review hardware/software vendors for track record to date plus their development plans and schedules.
- The as-built plant versus the design drawings, probably the largest item for direct pay-off during construction. During design, the as-built construction will control the evolving design in the office.

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The Emergence of Facility Management

Melvin R. Schlitt, Associate, Facility Management Institute,
Ann Arbor, Michigan

CHARACTERISTICS OF THE FIELD

- Facility management is an emerging profession. It is a discipline in the midst of defining itself and establishing its basic principles.

- Facility management has generally focused on the "caretaking" of facilities rather than their management in a proactive sense.

- There is a growing realization that facilities costs constitute too great a portion of total organization costs to be casually dismissed.

- The precise manner in which facility management is defined is often specific to a particular organization and depends on a variety of organizational characteristics.

- As organizations grow in size, the way in which facilities are planned, used, and managed evolves and corporate expectations of facility performance expand.

- Although most facilities departments coordinate outside contracting of tasks and services, the facility management function itself should be an internal function.

RESPONSIBILITIES OF FACILITY MANAGERS

- Although no two facilities organizations look or operate exactly the same, there are generic management functions that inevitably occur in all of these organizations.

- At the most general level, facility management can be described as an ongoing process of planning, implementation, and monitoring. Within the three functions of planning, implementation, and monitoring there are seven basic activities: analysis, forecasting, project development, project management, operations, maintenance, and inventory.

- Facilities include the entire range of physical assets of an organization, including land, buildings, rooms, work stations and equipment, and supplies.

COMPUTER NEEDS OF FACILITY MANAGERS

- The results of a recent survey of facility managers' needs for computerization will be presented.

EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT WHAT FACILITIES MANAGEMENT IS BUT WERE AFRAID TO ASK

Jim Steinmann
Steinmann, Grayson, Smylie, Inc.
Los Angeles, California

The term "facilities management" has recently crept into our vocabulary. It is a misused term by those who use it. We have "facilities management" computer systems. We have "facility managers." We have "facility management" courses. And we have "facility management" computer applications. We do not have facility managers. We don't know what they should do. Do we have any idea what facility management is and who facility managers are? ... or should be?

Facilities management must be viewed as the process of applying management sciences to the complete process of programming, planning, designing, developing, constructing, occupying, evaluating, and managing the facilities we use in our work. The emphasis must be placed on the word management. Management entails abilities in planning, directing, organizing, projecting, justifying, observing, and operating. Applying those management skills to facilities creates the field of facilities management. It is more than planning, and having a list of the furniture units.

What then is a facility? It is certainly more than furniture and the space we work in. Facilities are all of the productive resources we have in the work environment that we find necessary to perform our responsibilities. Facilities include the office, factory, warehouse, and even open space within which we work plus the furniture, fixtures, equipment, tools, and environmental support systems we need within those spaces to perform our functions.

Thus, facilities management entails all of the productive environment we have in which to perform our work and requires all management skills to be directed towards the built environment.

To manage facilities effectively we must have products, a process, and qualified personnel. These are the three components of a facility management system. One of the products may be

SUMMARY (Continued)
SESSION 11M
Jim Steinmann

computerization. There is a near infinite need for information to be available to the facility manager. Data can be stored and analyzed on a computer.

Computers can help the facility manager accomplish four tasks: productivity enhancement, sales aids, design enhancement, and decision aids. Unfortunately, too much attention is given to the sales aids and design enhancement areas and far too little attention is given to using computers to increase the manager's ability to make decisions.

The process of facility management is cyclical and must begin with long-range planning, continue through the analysis of alternatives, and exercise certain design, planning and implementation tasks. The process requires a facility manager with very broad experience in many disciplines that is not academically oriented but is only found in the school of experience.

To manage facilities more effectively we need to develop and place qualified facility managers that understand this process, increase management's awareness of the importance of facilities on achieving overall goals and objectives, develop the necessary products (including computer applications) to aid in this management process, and to replace what has been a "reaction" orientation with one that is action oriented.

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QUALITY CONTROL OF CONTRACT DOCUMENTS USING COMPUTER AIDED METHODS

Charles R. Carroll, Jr., FCSI
Bowne Information Systems, Inc.
Washington, DC

A brief review of past history in the development of automation of construction contract documents, particularly specifications. Early activity by the Construction Specifications Institute, leading to the founding of the Construction Sciences Research Foundation, and the Stanford Report, resulting in implementation of COMSPEC/CONCOM. Early efforts limited to time sharing and large computers for access to master specifications, in text form only.

Development and storage of large data bases in central computers. Limited ability to mix text and graphics in storage, or to produce from same output devices.

Changes in recent past due to:

1. Increasing power of mini and micro computers;

2. Development of laser storage and output devices, permitting mixing of graphics and text;

3. Development of imaging devices, permitting economical storage of graphics and full text documents; and

4. Large capacity chip and laser disc storage devices changing methods of distribution of information, for use by construction industry.

Present practices rapidly changing from information distribution by telecommunications to transfer by mag media.

Plans now underway to provide construction industry information on chip and optical disc, with almost no practical limit, except for availability and conversion of information to digital form. Imaging will accelerate conversion of text and graphics to digital form.

Rapid change anticipated from hard copy/microform to digital forms of storage.

Standards, master specifications, standard details and other information used in the construction process will be increasingly accessible and usable for individual projects, resulting in better communication between all groups involved in the construction process.

"QUALITY CONTROL OF SPECIFICATIONS USING COMPUTER AIDED METHODS"

"Naval Facilities Engineering Command Specification Preparation"

Dana K. Smith, AIA
Naval Facilities Engineering Command
Alexandria, Virginia

This presentation is concerned with how the Naval Facilities Engineering Command prepares its construction specifications using a distributed Wang System located at Headquarters and seven Field Divisions around the country. The presentation will describe how the engineer develops guide specifications with all the acceptable options for construction so that decisions can be made at a later time based on the individual region or project.

The benefits of an automated specification system will be presented and comments will be made concerning implementation of systems in your office and what other systems are available.

The presentation will go into detail describing each cycle of the system and how quality is controlled at each level. The equipment used for the system will be described along with the communication network in place to allow transfer of data across country.

The presentation will also indicate areas where improvements can be made in the system, how they affect the quality and what steps are being taken to remedy problems that exist.

The future of the system will be examined. There will be discussion based around how specifications fit into other systems such as graphics design and cost engineering.

COMPUTERIZED ENGINEERING SUPPORT DURING CONSTRUCTION

Frank D. Hutchinson
Gibbs & Hill, Inc.
New York, New York

The advent of CAD will begin to have more and more effect on the historic ways of presenting design/engineering information to the construction member of a design/engineering/construction team. Mr. Hutchinson will summarize the changes that he sees, using CAD systems such as G&H's CADAE system. These changes will include dimensionless engineering drawings; constructor's ability to select information as needed for the construction step underway; availability of analyses to constructor to permit quick checks on the suitability of as-built changes; and quick and accurate means of developing a true as-built drawing.

The major influence of CAD to the contractor will be the tremendous improvement in technical communications among all the members of the design/engineering/construction/operation team.

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Implementing Computer Graphics At A Government Organization
The NAVFAC Approach

George A. Bartsiotas
Program Manager for Engineering Systems
Naval Facilities Engineering Command
Alexandria, Virginia

An agency that is considering the procurement of large-scale computer graphics for its facilities program should be prepared to undertake a major effort that requires the investment of a substantial amount of time, money, and personnel resources. Some of these are: preparation of the system justification documentation required by the regulations and procedures of the various automated systems procurement offices within or outside the particular organization; early identification of the system operational personnel; provisions for training, site preparation, equipment layouts and office space arrangements; and agency-wide visibility efforts by appropriate briefings and presentations that will assure continuous top management support. These are issues that the Naval Facilities Engineering Command (NAVFAC) is currently addressig in its efforts to implement a computer graphics system.

NAVFAC is obtaining a system fo its headquarters, its six Engineering Field Divisions (EFDs), the Naval Civil Engineering laboratory, and the Public Workds Centers (PWCs). Called the Graphics Design System (GDS), it will be fully implemented over the next several months.

For an orderly implementation, GDS hardware and software will be installed at the EFD's over two years. The first system was installed in January 1983 at the Atlantic Division, Norfolk, Virgiania, and another in March 1983 at the Western Division, San Bruno, California. Installation at the remaining EFD's, the PWC's, and NCEL will be completed in 1984. Before the equipment is installed, a Systems Manager, a Systems Engineer, and an Applications Engineer at each field activity will attend training courses and seminars at the vendor's training center. GDS users will be trained on site after the equipment has arrived. The training includes courses on the needs of each A/E discipline and will prepare middle and top level management for a smooth transition to this ew way of doing business. Update courses will inform managers and users of the latest modifications, developments, and productivity enhancing techniques available.

SUMMARY (Continued)
SESSION 18D
George A. Bartsiotas

Most NAVFAC engineers, architects, and technicians are interested in two general bypes of data: design drawings and symbol libraries. Design drawings are controlled by the NAVFAC EFDs. The selection of manual methods or GDS to perform a design will be determined by the EFD on a project-by-project basis. A NAVFAC libraries. These libraries are necessary for the cost effective and efficient use of GDS. Libraries will be updated based on the experience gained with the prototype systems. A quarterly or semiannual validation and update cycle by the Library Standards committee is projected during the installation phase. Approved libraries will be distributed by magnetic media on this cycle. Quality control will be provided by spot checking a random sample of completed project drawings.

The development of GDS should have a major impact not only within government but also in the private sector. NAVFAC is one of the largest design and construction organizations in the world, dealing with more than 1,000 A/E firms annually. Many A/E's are already using computer graphics and the acquisition of graphics equipment is growing rapidly. Recent reductions in computer prices and improvements in software capabilities allow even small A/E firms to purchase in-house turnkey systems. NAVFAC to contract A/E services with firms having computer graphics capabilities. The ability to transmit graphic schematics via telephone with remote interactive manipulation of these schematics will drastically reduce the time that A/E and NAVFAC personnel spend in reviewing/changing drawings and specifications ongoing projects. This interchange, however, requires compatible systems owned by government and indistry. Today, the data bases of graphics systems on the market are not totally compatible. The government has recognized this problem and, with help from industry, has developed the Initial Graphics Exchange Specification (IGES), a tool for passing geometric information between two graphics data bases. However, IGES is still in a conceptual form and further development is required for teu graphical and textual interchangeability of data bases. NAVFAC is supporting the efforts of the IGES Committee to secure public acceptance for these standards and to write a translator that incorporates the IGES concepts for facility design applications. With the expectation that the use of graphics by the A/E community will mature by the time the GDS is fully installed and developed, NAVFAC is monitoring the A/E community to determine when to incorporate graphics capability as a selection factor in the Statement of Requirements published in the Commerce Business Daily. Currently, however, NAVFAC is following the latest computer graphics developments in industry and the A/E community while exploring rhe use of this new tool in its own design process.

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COSTS AND BENEFITS OF COMPUTER-AIDED FACILITIES MANAGEMENT

Jeffrey M. Hamer
The Computer-Aided Design Group
Santa Monica, California

An overview tutorial for management. Realistic ways to determine costs and benefits of computer tools in general and facility/space management systems in particular.

How to get organized and approach the applications, data, software and hardware. Real-world budget numbers and percentages. A logical framework for approaching selection, acquisition, implementation and operation. Education, training and personnel issues.

What is facility/space management? What are all the costs? How to estimate them realistically. What are all the benefits? How to estimate them realistically. People, procedures and data are all-important. Hardware is not. A review of major system components. Typical problems: where do the best laid plans fall down? Historical trends that will and will not continue. An informed guess at the future. How to get started.

CASE STUDY IN FACILITIES MANAGEMENT

Michael M. Dembo
US Army Engineer Division, Huntsville
Huntsville, Alabama

The discussion covers a review of a major master planning project performed by the Corps of Engineers for the US Army Materiel Development and Readiness Command (DARCOM). The project was accomplished with a view towards providing facilities management type information for the Facilities Engineers at Rock Island and Redstone Arsenals in addition to conventional master plan information. Both of these facilities combine military industrial and administrative functions.

The discussion will include analysis of contracting methods required to execute the project, resource requirements, special requirements of the Facilities Engineers and how they were accomplished, data base development, software development, procedures used for control of the project, interfaces between participating agencies, graphics system installation and tie-ins of CAD equipment, and lessons learned.

MANAGEMENT FOR SUCCESS: THE AGRESSIVE IMPLEMENTATION OF CADD SYSTEMS IN AN A/E ENVIRONMENT

Graham Copeland
Tricad, Inc.
Milpitas, CA

The successful implementation of CADD systems is a management issue involving two basic ideas:

- a three-phase implementation process;
- an agressive commitment to identifying and meeting goals.

The three phases of implementation are:

- the phase between ordering the system and its arrival at the user's facility;
- the startup phase;
- the long-term implementation phase.

These phases roughly involve time periods of two/three months, four/six months and six months onwards respectively.

A goal-orientated schedule of implementation must be generated which:

- identifies the System Manager and other crucial roles;
- identifies the Accounting procedures and Organization requirements;
- defines the precise date when traing stops and production begins;
- identifies the procedures for project selection and level of application;
- identifies the dates of short-term and medium-term system expansion;
- identifies the marketing effort.

This schedule is agressively maintained. Its effects on the manual office is monitored. Top management is informed of system performance. A management methodology and standard operating procedure is developed.

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PRACTICAL EXPERIENCE IN THE APPLICATION AND MANAGEMENT OF COMPUTER-AIDED DESIGN AND DRAFTING SYSTEMS IN THE JOHN S. BONNINGTON PARTNERSHIP

E. B. Collins
Architectural Computer Services Ltd.
United Kingdom

This paper describes the experience of a U.K. architectural practice in selecting, installing, operating and managing a computer-aided drafting system, word processing system and more recently a compatible building design system.

The paper describes the office, computer facilities and range of projects which have received support from the system since installation in July 1981. The method of allocating the use of the facilities to a variety of project types is discussed, together with the manner in which the facilities are costed. The practice provides consultancy services in a number of disciplines and the way in which the systems are used for co-ordination are reviewed with resulting benefits and comparisons made with the 2D drafting and 3D design system.

On-Site Computer
Government Contract Administration

Major Thomas Nowak
U.S. Army Corps of Engineers
Dayton, Ohio

The U.S. Army Corps of Engineers provides design and construction management expertise to such Federal agencies as the Department of the Army, Department of the Air Force, Environmental Protection Agency and other foreign governments upon request. This multi-billion dollar construction program translates into a heavy managerial workload at the lowest level of the Corps, the Area Office. The Area Office staff acting in the role of the "owner", must control such administrative issues as review and approval of shop drawings, issuance and timely resolution of change orders, maintaining a quick response time to Contractor letters and requests for information and verifying the status of the Contractor's scheduled work. As the representative of the Contracting Officer, the Area Engineer must have access to valid and sufficient quantities of information to make such decisions as to whether or not the Contractor deserves additional performance time because of change order issuance or disruptions to the work.

In concert with the U.S. Army Corps of Engineers, Construction Engineering Research Lab (CERL), the Wright-Patterson Air Force Base Area Office, Louisville District, U.S. Army Corps of Engineers, has been conducting a two year field test to determine if the "owner" should have an in-house mini computer to manage office administrative issues and to provide more cogent information to support the decision making process. The computer being tested is a Digital Equipment Corporation PDP 11/23 with proprietary, off-the-shelf software from Structural Programming, Inc., Sudbury, Mass. The computer allows the user to perform three types of software applications. They are:

1. Network Analysis (Critical Path Method of Project Scheduling) - The Contractor's schedule is maintained in the computer and updated as project work progresses. Access to the official network schedule permits detection of progress slippage, in-house analysis of potential time extensions prior to change order negotiations and provides other types of useful information to the owner.

2. Data Base Management - This capability allows the improved control of such issues as shop drawing control, change order tracking, status of claims against the Government and other applications premised on large volumes of information.

3. Text Editing - Allows increased flow rate of letters by simplifying the drafting and revision of correspondence.

This session will summarize what the computer is, what the computer can do, application of the system, positive results and a discussion of problems encountered during the field test.

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COMPUTER SUPPORT OF THE QUALITY FUNCTION IN LARGE CONSTRUCTION PROJECTS

MARTIN S. MARKOWICZ
SYSTEM DEVELOPMENT CORPORATION
OAK RIDGE, TENNESSEE

Large Construction Projects involving installation of high technology equipment present problems of management control in terms of size, technical complexity and environmental restrictions. Planning to provide management timely access to information on quality status and adverse trends must begin concurrent with overall project schedule planning.

Successful data management and analysis begins with planning for the sources of data; methods of collection and transfer, and analysis and presentation thereof.

First, the problem of providing quality status, involves finding some ways of measuring quality achievement and providing status indicators of such achievement, i.e., getting the data, analyzing it, and reducing it to a reportable format. Obviously, one cannot report on every item in the plant to the same level of detail; this would serve only to clog the system, create unnecessary expense and frustrate those whose responsibility it is to sort through and trend analyze such information. Therefore, methods must be utilized to sort out the important items on which quality data will provide an indicator of the level of quality achievement in the project as a whole.

By using the technique of risk analysis one can make a subjective analysis, later backed by more objective technical analysis, to determine those important items, areas and processes whose failure would materially affect safety, cost, schedule or "fitness for intended use" (quality). Having prepared such a list of items, one can then specify and implement special actions which will eliminate or decrease the probability of failure or minimize the consequences thereof. The record of accomplishment of these special actions is quality status data which should be tracked by inclusion into a data base which is updated as the actions are completed or changed.

Once decisions are made as to items for which quality-related data should be collected, then decisions can be made as to what kinds of data bases and software programs are needed to collect and analyze such data. Decisions must also be made on the types of reports required, the use of such reports, frequency of such reports and to whom they must be sent.

This paper will amplify on the preceeding points.

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DRAWING SYSTEMS TO SUPPORT DESIGN CONCEPT DEVELOPMENT

Charles M. Eastman
Formative Technologies Inc.
Pittsburgh, Pennsylvania

Current CADD systems, while effective in capturing a completed design concept on computer media, are ineffective in supporting exploratory design development. They offer users a rigid, poorly structured environment, not conducive to creativity and visual problem solving. A new style of drawing system is needed to support creative design. It must be highly flexible, making it exceptionally easy to: alter and edit drawings; to produce design documents; to replicate portions of drawings; and to undertake simple forms of analysis.

The following features outline the design of a new type of drawing system that supports both efficient production of drafted documents and also creative visual and graphic problem solving.

1. It must include freehand drawing and allow the storage and manipulation of such drawings.

2. It must allow easy conversion of freehand drawings into ruled drawings and contract documents.

3. It must support dynamic editing, with accurate dynamic scaling of lengths and locations.

4. It must incorporate powerful structures within the drawing, that allow parts to be copied or edited, singularly or at various levels of aggregation.

5. It must allow all effective means to manage graphic information with multiple displays and continuous pan and zoom.

6. It must allow production of complete drawings without paste-ups or manual composition.

Examples of the use of such features will be discussed and their contribution to design explored.

FUNCTIONAL PROGRAMMING:

HOW THE COMPUTER HELPS DEFINE USER NEEDS FOR CONCEPTUAL DESIGN

Gary H. Silver
Hellmuth, Obata & Kassabaum, Inc.
New York, New York

The most familiar use of the computer for facility programming is to store and organize space use data, and to calculate and tabulate square footages. Six years ago at HOK we wrote an in-house system to do this. It was fairly simple, ran only in batch mode, and was designed to do little more than create very nice space lists. We were happy with it -- for a while.

But we realized that our batch system lacked three features:
1) We had to rely upon others (outside the project team) to process and generate our reports, sometimes resulting in delays.
2) It did not enable us to store and reuse information from project to project.
3) It did not help us analyze such qualitative issues as functional groupings, schematic planning, value engineering and budgeting.

In addition, we did not have any special features to help the client understand the significance of his data, approve it, and - when necessary - make choices.

About eighteen months ago, we started working on an in-house system which would do all this - and do it for both interior design and architectural design over a broad range of building types such as office, R & D, health care and correctional facilities. The system is called HOK SPACE© and has many special features which are still not completed. However the basic system is operational and we have begun to use it on projects.

I'd like to share with you a brief description of HOK SPACE© System features which I think have special significance in conceptual design:

FACTORS - different circulation factors can be used for each organizational group and for each of three different record categories: Personnel, Support and Equipment Records. In addition, add-on factors with adjustable labels can be applied to both project level and group level totals. This flexibility enables us to obtain "space totals" which are tailored to project terminology (eg, "rentable square feet," or "lab modules") and to create different models for testing design assumptions.

SUMMARY (Continued)
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FORECASTING - the SPACE© System will always try to calculate space values where detailed data may be missing. It does this by using several "top-down" indicators which are entered at the outset to act as defaults. This enables the designer to assess detailed facility needs for time periods beyond which a client may be able to provide detailed data. Therefore, a strategy for orderly growth can be formulated in the design.

DATA BASE CATALOG - certain types of information have application over many different projects. The depth of our knowledge increases with each project completed because each project contributes to the data bank. The computer enables us to aggregate this universal information and access and use it easily. I predict that this is the area where we will see the most innovative new applications. A few years from now we will be doing much less "custom" programming and relying more on applicable norms and data bases which we will merge with specifically collected program data. This will not only save programming and design time but reassure the client who wants to know that what he is doing makes sense in the context of his business or institutional category.

Our initial step in this area will be to build catalogs of standard equipment records which contain detailed characteristics and attributes.

ATTRIBUTES - we can assign an unlimited number of attribute codes to any record or organizational group and then sort our records by each of these attributes. This enables us to find out how many and where special needs may exist such as 24-hour air conditioning, plumbing, or heavy structural loading.

INTERACTIVE OPERATIONS - interactivity helps us in at least two ways:

1) Since each project team is responsible for entering its own data and running its own reports, we can more reliably schedule the processing and completion of our projects. Therefore, priority conflicts are minimized.

2) Interactivity also means that we can query the data base and construct custom reports which respond specifically to questions or needs expressed by the client or designer.

ADJACENCY ANALYSIS - like many other programming professionals, we collect information describing the need for groups to be located together, directly from the spokesman of each group. However, we can also collect and process such information from third-party sources (such as senior managers). The resulting "scores" which define adjacency priorities are printed out - both as a listing and as an interaction matrix. Wherever conflicting scores exist for the same relationship, they are "optimized" to a single score.

Making some sense out of the resulting array of scores can be a formidable task on a large or complex project. We are presently adding a system feature which will enable us to CONSOLIDATE scores under any list of specific groups. Therefore, an overview of the relationships between major functional clusters can be quickly and easily seen by specifying a consolidation report for those major groups.

GRAPHIC CLUSTER ANALYSIS - the most logical and useful extension of space and adjacency data is a graphic display which portrays the data in a building context. This is also the initial step in computer aided conceptual design.

HOK is now in the process of adding cluster diagramming, stacking analysis, and block planning features to our SPACE© System. As an initial step we are investigating the purchase of existing software products, because we would prefer to buy something we like rather than write our own. Currently we are evaluating the stack and block programs of an independent consulting firm by using those computer programs on some of our projects. We hope that will work out. However we have the option of looking at other software, or having our own computer group create what we need.

Ultimately our goal is to link our SPACE© System directly to our computer aided design and drafting system - HOK DRAW© . Frankly, we're just beginning to scratch the surface in understanding where that will lead. As we progress, perhaps it would be an appropriate subject for another conference.

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COMPUTER-AIDED ACTIVITIES IN SUPPORT OF THE PLANNING PROCESS

Thomas A. Kenney
U. S. Army Corps of Engineers
Washington, DC

The Corps of Engineers, as a major design and construction agency, must strive to reuse and standardize designs for a wide range of facility types. A system for doing just that, yet allowing enough flexibility for unique user requirements, has been established. The system was first developed for tactical equipment maintenance facilities and is used during various phases of programming, planning and design development. The system is comprised of Tac Shop, a programming tool; a Design Information System (DIS), which selects designs for possible reuse; and the Building Standardization and Design System (BSDS), which is used for early design development.

To standardize the criteria used for programming facilities, Tac Shop provides the installation's facility engineer with a space program to match his needs. The first inputs to this program are based on the specifics of the facility, such as the numbers and types of personnel in the facility, the table of organization and equipment (or TOE) number, and any special facility requirements like a paint shop or battery room. The program then provides the user with a detailed breakdown of the square-footage requirements for the facility, including all critical spaces, support spaces, and unassigned square-footage such as circulation space and wall area. The program even provides a breakdown as to how much space is to be provided on the second floor compared to the first floor. The total gross square-foot requirement is the significant figure required at this time for planning and programming. The other information is retained for use during project development. The next input to the program is required to calculate the support facilities on the site. This input is based on the numbers and types of vehicles to be maintained, and the number of companies (or organizational structure) using the facility. The output provides the facility engineer a complete breakdown of support structures required, parking and paving required, and miscellaneous requirements including such items as the linear-foot of fencing.

Once the design district is given a notice to proceed, a search for an existing design, standard design or definitive design will be made in hopes of finding a suitable design to be reused. The Design Information System (DIS) is used for this search. The inputs required are the specifics of the project in terms of the functional space program (provided earlier from Tac Shop), the number of companies, and the organizational structure. The output is a suggested list of previous designs that may be site adapted, site adapted with minor modifications, used with significant modifications, used as a guide or not used. The user can check the appropriateness of an existing design by listing a comparison of his new project and the historical project, or projects. This comparison provides the user with a detailed listing of the variances between the designs, and a list of other factors such as modifications required for seismic, snow or wind loads. If there are no historical designs that are suitable, the user has the option to proceed to the next level, which is the Building Standardization and Design System (BSDS). If this option is desired, DIS provides the user with a list of standard modules that are required.

SUMMARY (Continued)
SESSION 30D
Thomas A. Kenney

The BSDS modules include all the critical functional areas required in a tactical equipment maintenance facility as well as all the support modules. These modules can be used to quickly develop early sketch designs for a wide variety of facility sizes, and configurations. The list of modules provided by DIS ultimately result in a completed sketch design for the specific project (based on a number of quickly developed alternatives). The final sketch design can be further developed using a computer-aided drafting system or by manual drafting.

COMPUTER-AIDED ACTIVITIES IN SUPPORT OF THE PLANNING PROCESS

R. Bruce Dains
Medical Facilities Design Office
U.S. Army Corps of Engineers

ADP SYSTEM USE IN PRELIMINARY DESIGN:

In the last year our Medical Facilities Design Office (MFDO) has begun to use computer tools as standard practice. As a result, project architects and engineers (AEs) hired by the Corps of Engineers to design medical facilities are becoming very familiar with the information produced by the computer, if not with its actual operation. At this time our AEs, while encouraged to use computers, are not required to use a computer-aided design (CAD) system for their design work.

The following presentation describes how the MFDO came to use computer tools (particularly in the early stages of design), some examples of two clinics and a hospital recently designed, and when and how these tools are used in working with project AEs.

Design of medical facilities is unique from other acquisition processes for three reasons. First, the design covers a very wide range of disciplines. Second, design within an individual discipline is normally more complex. Finally, there are more participants and a longer acquisition process than is found in other types of design. In addition, the Corps' district and/or division offices that are involved in design are scattered throughout the country. To address the concern about increased cost of providing medical facilities while providing an acceptable health care capability, a Congressional House subcommittee directed the Department of Defense to study the situation. The MFDO was established following recommendations from this study.

As a new office with the major responsibilities of managing all medical design through the concept phase (35 percent) and monitoring the design through the final phase (100 percent), we looked to the computer for tools. Two tools, BDS/GDS (an integrated CAD system) and DOC-FR (a Corps-sponsored design review system), were found and are providing excellent assistance.

SUMMARY (Continued)
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The first tool is a large integrated architectural design system called BDS/GDS (Building Design System/General Drafting System). We are using it in the early phases of the design process.

Criteria development use centers around entering and maintaining drawings and diagrams which illustrate design requirements in our Corps of Engineers Technical Manual 5-383-2. This is the main document that a medical project AE is expected to use for design guidance.

Preliminary design, however, is the major thrust of the use of BDS/GDS. Through the production of a preliminary design package by a separate MFDO support AE, facility design quality has been improved and the design process has been shortened. On selected jobs, this computer documented package is produced while the project AE is being selected. It provides all the necessary information in an organized manner as well as initial direction for design. Three or more alternative design schemes are produced with merit analysis dealing with measurements, materials, costs, heat, and lighting. Design development is relatively quick and it permits evaluation of a full range of options in siting, circulation flow, layout, energy efficiency, and costing within a shortened time period. The project AE is included in review conferences during the development of the package. Following completion of his selection, he is presented with the full package which gives him a significant head start in the concept design phase.

Over the past year three preliminary design packages were developed by our support AE, Leo A. Daly Co., located in Omaha, Nebraska. This AE firm developed packages for the Camp Humphries and Camp Casey Army Medical Clinics and the Minot Air Force Base Hospital.

An example of the benefits of using these packages was immediately seen when we were able to keep the hospital design from slipping a year in the design program. Although design time was shortened, we were able to analyze many design schemes. This provided the project AE with better design information and allowed him to finish concept design at an early date. This was a direct result of the preliminary design package process that was facilitated by using the BDS/GDS system.

It is expected that as computer tools in the design area become more widespread, a medical project architect will find it even more beneficial to receive the preliminary design package directly in his computer and then proceed with design on his system.

SUMMARY (Continued)
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R. Bruce Dains

The second computer system, DOC-FR (Design Office Computer - Format for Review), provides assistance in handling medical project design review comments. Comments are made by Government professionals reviewing the project AE's design submittals. Developed by our support AE, the system allows design review comments to be entered, stored, updated, and reported. This format, coupled with the AE submittal guide, that indicates what is to be submitted and who is to review it, provides a more comprehensive review. In addition to aiding the organization of the comments for use during review conferences, it greatly assists the review of subsequent project submittals to verify AE response to previous guidance. Immediate access to review comments is available to all involved review agencies. The system also provides a method to enter construction evaluation information and, because of the unique discipline-oriented format, allows comparison to previous project comments.

The system is now being used on two hospital projects. As a result of the demonstrated benefits, it will be expanded to include new medical projects as they come into the design program. In conclusion, I would like to make a few observations about the relationship between architects and the computer applications community.

So far we have seen how the AE can begin to interface at an early stage. DESIGN IS THE ARCHITECTURE KEY WORD.

At present many architects are sitting back and saying "SHOW ME". On the other hand the computer applications community is saying "SEE WHAT WE CAN DO. THESE TOOLS HAVE FANTASTIC CAPABILITIES. FIT YOUR OPERATION TO THEM AND YOU WILL GAIN GREAT ADVANTAGES."

I believe its now time to SWITCH ROLES, and you are beginning to see it here at the conference with many advanced firms showing their systems (maybe not developed in-house, but at least modified to fit their needs). THE ARCHITECTURAL FIRM CAN BE A FORM GIVER IN THE AREA OF AUTOMATED TOOLS. But in order to do so the AE firm must get involved. Get your feet wet, so you can use the skills that are uniquely yours--organizing and interfacing needs with innovative solutions.

COMPUTER-AIDED ARCHITECTURE/ENGINEERING DESIGN SYSTEM

Kenneth H. Crawford
US Army Corps of Engineers
Construction Engineering Research Lab
Champaign, IL 61820

The primary objective of the COMPUTER-AIDED ARCHITECTURE ENGINEERING DESIGN SYSTEM (CAEADS) is to develop automated tools to support the military construction process. CAEADS is being developed by the Construction Engineering Research Laboratory (CERL) in Champaign, Illinois. At its current stage of development CAEADS addresses the following eight areas in the Concept Design Phase:

- Functional Design Criteria
- Architectural Layout
- Site Layout
- Functional Analysis
- Thermal Zoning/Analysis
- Structural Layout/Analysis
- Quantities/Costs
- Drawings

This talk will present the capabilities of the CAEADS system that are now being tested. Plans for future developments of CAEADS will be presented. There will also be a discussion of some of the problem areas encountered in the technology transfer of a system of this magnitude.

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ADVANCED BUILDING MANAGEMENT SYSTEMS

CARLOS S. HIGASHIDE
HONEYWELL COMMERCIAL DIVISION
ARLINGTON HEIGHTS, ILLINOIS

An introductory statement describing Honeywell Commercial Division and the business it is in will be followed by a brief desciption of the Delta 5600 Building Automation System. The main operator interface, the Delta 5600 Color Graphic System is described next. Attention will be drawn to the full graphic nature of the color terminal and an explanation given for full, semi, pixel and character graphics. A detailed description then follows describing the use of color and changing symbol shapes to indicate the status of a point in the system. Further detailed description is given on the following:

1. Standard System Graphics and Symbols.
2. On-line Graphic Construction and ability to create custom symbols.
3. Graphic Test Mode.
4. The ability to issue a command to a point from a graphic.
5. Description of the graphic primitives (minimal set) required to implement the system.
6. Real time bar charts and curve plots.
7. On-line chart and plot construction.
8. Hard Copy.

The useful and practical features of the Delta 5600 Color Graphic System are highlighted and contrasted against the less practical or seldomly used features. The presentation concludes by describing lessons learned from this project.

COMPUTERS IN ARCHITECTURAL OFFICE PRACTICE

Littleton Daniel, AIA
BruningCAD
Tulsa, Oklahoma

The main effort of this paper was expended on providing advice for setting and achieving realistic expectations. Graphic (CAD) and business computer systems are advertised to Architects as better, faster, bigger, cheaper, productivity-multipliers, etc; but these terms provide nothing more than vague but enthusiastic encouragement to buy, buy, buy. Most design professionals are completely aware that computers are a big part of their future, but they have no yardsticks for predicting the real-world benefits (or lack of them) in their own practices. Therefore, the experiences of researching, planning, evaluating and implementing computers in their offices proves to be confusing, contradicting, and frustrating, and no progress is made.

The presentation then proceeded to provide quantified data in the topical areas of:

- Current computer activity in architectural practices;
- A survey of how time is spent in architectural offices, and the portions of those time investments amenable to computer-assist;
- A description of the "Architectural Practice Database", and what tools, computer and manual, can operate successfully on it;
- A summary of the impacts of computers on billing rates and computations by recounting the experiences of several firms;
- A matrix defining the range of system costs, micros, networked micros, mini-based workstations, etc.;
- A matrix survey of productivity benefits, set in terms of people skills, dollar value, and project scheduling;
- Definitions of acquisition, installation, training and support costs and timelines; and
- A matrix of future system costs, features, and expected availability dates.

The presentation concluded with several sets of "procedures" for use in various tasks:

- System evaluation,
- Feasibility studies,
- Learning curves and training methods,
- Staffing,
- Impact prediction, and
- Applications in Business Development.

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35M

ESTABLISHING AND UNDERSTANDING THE STATUS: THE INFORMATION DATA BASE

Thomas E. Northam
Facility Management Institute
Ann Arbor, Michigan

With the emergence of facility management as a new profession, new tools are needed to support the facility management professional as he manages facilities to ensure proper integration of people, process, and place.

In an environment of increased emphasis on facility management and today's relatively mobile workforce, much vital information leaves an organization before it can be captured and recorded. This session discusses how computer/graphics can, and should be used as tools to support the facility manager which will upgrade and replace the "institutional memory". It will focus on the importance of establishing a facility management information data base, discuss the key elements of such a data base, and the long and short term benefits of this information to the institution.

The primary objectives of this session are to provide the attendees with an understanding of the basic components of a facility management information data base as it relates to physical plant knowledge, attributes of the physical plant, and assignment and use information. It will provide an understanding of the need - the status, the characteristics of most facility management information data bases, and provides a comprehensive overview of the elements which comprise this data base in the five natural groupings of information: space inventory information, property control, general building information, building plans, and map or site plans.

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THE FULL CYCLE OF FACILITY MANAGEMENT IN THE FUTURE

Jim Steinmann
Steinmann, Grayson, Smylie, Inc.
Los Angeles, California

Facility management in the future should be decidedly different than facility management is today. Unfortunately, most practitioners view facility management as the control of space, overseeing the orderly development of more space, and keeping the space user satisfied. It is viewed as "building" or "space" management.

Facility management demands significantly greater skills and an improved process to be truly effective in the management of significant capital resources just as similar management systems have previously been responsive in business and government in managing financial and human resources.

Facility management is a recurring and cyclical process that begins with ideas and concepts, defines goals and objectives, and develops a long range plan of action. Facilities require a long time to develop. They are not very responsive to major changes in the goals of business or government. Facility managers need to plan effectively for the future as much as they plan the efficiency of the space they are responsible for managing.

Facility managers are currently given the responsibility to administer a small portion of the cyclical facility management process -- that of reacting to external stimuli and implementing direction provided by other managers.

Given the need for extending the field of facility management, it is necessary to extend the areas of computer applications available to the facility manager. Current technology exists to provide the facility manager with resources necessary to accomplish goals and objectives, to minimize life-cycle costs, and to maximize space utilization. Current available computer applications tend to concentrate on implementation oriented applications -- data base management, space and furniture inventory, automated space planning, and implemention budgeting and scheduling. Very few applications are

SUMMARY (Continued)
SESSION 36M
Jim Steinmann

available to truly help the facility manager manage facilities. The process of managing facilities is different than the process of implementing a facility action.

It is necessary to establish a facility management system that includes a process, a number of products from workstation standards through computer data bases, and personnel to administer the process.

Some of the more important products are computer applications to help the facility manager. A number of existing computer applications are available and can assist implementation activities. Other applications are developable in that technology and interest is there while others are mere possible thoughts on the horizon. The more important applications -- those aimed at the management side of facility management need further efforts to become available.

The most important of these applications are those that provide decision aids to management to help project needs, analyze data and develop planning models.

An organization should identify the types of information needed to computerize the facility management system and assess the development potential of each. Once the components are identified, the organization should analyze existing systems and, when current applications are not adequote, develop a performance specification for the system so that new software will be within the overall context of the total space system that will eventually evolve.

The facilities management system will benefit by establishing a high level of authority within the organization to make necessary decisions. The availability of an adequate staff is mandatory. In the future, with a facilities management system including personnel, products, and procedures in place, the importance given to facilities will increase and the problems that are always blamed on facilities will be reduced.

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INTERACTIVE THREE-DIMENSIONAL TOPOLOGICAL MODELING

James P. Corbett
Independent Consultant
Florence, Massachusetts

In designing a system for CAD it is important to adopt a complete and correct geometric model. The most appropriate model for this purpose is the three dimensional cellular complex. In particular, the most suitable form is the CW-complex introduced by J.H.C. Whitehead (1948). The presentation begins with a description of such a model.

The CW-complex is the most suitable form for the construction of the carrier topology. In this topology the closed sets are the sub-complexes. Exploitation of this topology results in many simplifications of the detection of interferences and the enforcement of continuity conditions at structural boundaries.

The theory is also exploited in producing homeomorphic cellular maps. Such maps permit one to incorporate independently coded details as integral parts of a structure.

One of the most important consequences of the exploitation of this model is the facility with which preliminary designs may be created. One may rough in an approximation to a structure with only approximate dimensions. One may compare different preliminary solutions to a design problem without entering into elaborate dimensioning and detailing. A rough design is easily turned into a finished structure once the major design alternatives have been compared.

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COMPUTER-INTEGRATED DESIGN: PROBLEMS AND PROSPECTS

Daniel R. Rehak
Carnegie-Mellon University
Department of Civil Engineering
Pittsburgh, Pennsylvania

The building design and construction process is a labor intensive information processing task (the information being the building design). It has long been recognized that the computer has a great potential for improving the process, and a variety of successful software tools for building applications currently exist. Integrated design systems, dealing with the entire life-cycle of the design-construction process and providing capabilities for all of the various disciplines involved in the process, have an even greater potential for improving productivity and the quality of the final structure. However, a variety of issues are currently limiting the full potential of such systems.

When one looks at the total building design and construction process, some issues and problems become apparent. First, due to the separation of the process into stages (plan, design, review, construct) and the separation by discipline (structural, electrical, mechanical, etc.), there is a fragmentation of the overall process. This results in a situation where design data is fragmented, yielding problems of how to best handle all of the design information. Second, design and construction are influenced by the regulatory process (codes and standards). Dealing with these in the computer is a difficult task with many technical problems. Third, current computer applications are in the form of algorithmic programs, with every contigency, option, and possibility considered a priori. Because of the complexity and indeterminate nature of the process, development of complete, comprehensive algorithmic programs is impossible. These issues combine to limit the effectiveness of computer-integrated design systems.

Within recent years, several computer science technologies which are quite beneficial in the development of computer applications for the building process have emerged. Two aspects look most promising. Relational database management systems (with their ability to deal with data on an organizational basis rather than on a representational basis) treat some of the data handling problems caused by industry fragmentation. Expert systems (an application area of artificial intelligence) provide mechanisms for dealing with ill-structured problems and provide an alternative to algorithmic programs. In addition, constraint enforcement in databases and knowledge representation in expert systems are both related to handling codes and standards. Thus, these technologies provide promise for developing improved computer-integrated design systems, but some open issues and research remains before complete systems enter production.

CURRENT RESEARCH AND DEVELOPMENT ON THE USE OF COMPUTERS FOR COST CONTROL AND ESTIMATING

or

"Computers and the Search for An Accurate Estimate"

Brian Bowen
Hanscomb Associates, Inc.
Atlanta, Georgia

The introduction of computers for cost control and estimating has been encouraged by their ability to improve productivity by eliminating clerical tasks, improving delivery schedules and offering flexibility in presentation. The most promising benefit however is the potential to improve estimating accuracy. This presentation will:

- define the "accurate estimate".
- relate accuracy to data sources and time of estimate development.
- examine the estimating process, identify problem areas and where computers can help.
- define federal government needs for computerized estimating and cost control assistance.
- review existing activities in both the Federal and Private sectors.
- speculate on the influence of CAD and cheap computing costs on future developments.

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IGES, A Key Interface Specification for CAD/CAM Systems Integration

Bradford M. Smith
(Joan Wellington)
National Bureau of Standards

The Initial Graphics Exchange Specification (IGES) program has focused the efforts of 52 companies on the development and documentation of a means of graphics database exchange among present day CAD/CAM systems. The project's brief history has seen the evolution of the Specification into preliminary industrial usage marked by public demonstrations of vendor capability, mandatory requests in procurement actions, and a formalization into an American National Standard in September 1981. Recent events have demonstrated intersystem data exchange among seven vendor systems with a total of 30 vendors committing to offer IGES capability. A full range of documentation supports the IGES project and the recently approved IGES Version 2.0 of the Specification.

APPENDIX II

TECHNICAL SESSION SPEAKERS

David L. Armstrong Director Facility Management Institute 3971 South Research Park Drive Ann Arbor, MI 48104	Session 6M
George A. Bartsiotas Program Manager for Engineering Systems Naval Facilities Engineering Command 200 Stovall Street Alexandria, VA 22332	Session 18D
Daniel J. Borda Arthur D. Little, Inc. Acorn Park Cambridge, MA 02140	Session 14C
Harold Borkin College of Architecture and Urban Planning University of Michigan 2000 Bonisteel Boulevard Ann Arbor, MI 48109	Session 41D
Brian Bowen Executive Vice President Hanscomb Associates, Inc. 8 Piedmont Center, Suite 500 Atlanta, GA 30305	Session 42D
Ronald Brown EDCS U.S. Army Corps of Engineers P. O. Box 1600 Huntsville, AL 35807	Session 20M
C. R. Carroll, Jr. Manager Bowne Information Systems, Inc. 5804 Roland Avenue Baltimore, MD 21210	Session 12D

Edward G. Collins
John S. Bonnington Partnership
Tyttenhanger House
St. Albans, Herts AL4 0PG
ENGLAND

Session 22D

Graham Copeland
Haines Lundberg Waehler
2 Park Avenue
New York, NY 10016

Session 21D

James Corbett
24 Sheffield Lane
Florence, MA 01060

Session 37D

Kenneth Crawford
U.S. Army Construction Engineering
Research Laboratory
P. O. Box 4005
Champaign, IL 61820

Session 30D

Bruce Dains
Medica Facilities Office
HQDA DAEN-ECE-M
U.S. Army Corps of Engineers
Washington, DC 20314

Session 30D

Littleton Daniel
President
Grafcon Corp.
7906 East 55th Street
Tulsa, OK 74145

Session 34D

Neal G. Davis
HNDAM, P. O. 1600
U. S. Army Corps of Engineers
Huntsville, AL 35807

Session 4D

Michael Dembo
EDCS, P. O. Box 1600
U.S. Army Corps of Engineers
Huntsville, AL 35807

Session 20M

Daniel K. Drake
Systems Coordinator
Turner Construction Company
633 3rd Avenue
New York, NY 10017

Session 27C

Charles M. Eastman
Director
Institute of Physical Planning
Carnegie-Mellon University
Pittsburgh, PA 15213
Session 28D

Lee Emberley
Interactive Graphic Services Co.
200 South Meridian Street
Indianapolis, IN 46225
Session 15D

Steven J. Fenves
Department of Civil Engineering
Carnegie-Mellon University
Pittsburgh, PA 15213
Session 26D

Lee S. Garrett
3313 N. Kensington Street
Arlington, VA 22207
Session 13C

R.C. Griffin
2000 West Loop South
Houston, TX 77027
Session 13C

Jeff Hamer
The Computer-Aided Design Group
2407 Main Street
Santa Monica, CA 90405
Session 19M

Carlos Higashide
Advanced Engineering
Honeywell, Inc.
1500 West Dundee Road
Arlington Heights, IL 60004
Session 32M

Frank Hutchinson
Senior Vice President
Planning and Development
Gibbs and Hill, Inc.
11 Penn Plaza
New York, NY 10001
Session 14C

James M. Ingram
Vice President
Leo A. Daly Company
8600 Indiana Hills Drive
Omaha, NB 68114
Session 21D

Thomas Kenney — Session 30D
Supervising Architect
Building Technology Section DAEN-ECE-B
U.S. Department of Army
Washington, DC 20314

Ronald L. King — Sessions 2D, 40D
Senior GAO Evaluator
Procurement, Logistics and
Readiness Division
U.S. General Accounting Office
Washington, DC 20548

Duane P. Koenig, General Manager — Sessions 15D, 40D
Computer Drafting Division
Continental Graphics
2016 Riverside Drive
Los Angeles, CA 90039

Peter R. Lage — Sessions 10C, 25D
Associate
Leo A. Daly Company
8600 Indiana Hills Drive
Omaha, NB 68114

Leonard Lopez — Session 26D
Department of Civil Engineering
University of Illinois
Champaign, IL 61820

John D. Madsen — Session 13C
Vice President
Kellogg Corporation
5601 South Broadway
Littleton, CO 80121

Martin S. Markowicz — Session 24C
System Development Corporation
800 Oak Ridge Turnpike
Oak Ridge, TN 37830

Neal Mitchell — Session 9C
President
Mitchell Systems Inc.
83 Boston Post Road
Sudbury, MA 01776

William Mitchell — Session 16M
The Computer-Aided Design Group
2407 Main Street
Santa Monica, CA 90024

Reg Monteyene — Session 2D
Vinto Engineering
10950 119 Street
Edmundton, Alberta T5H3PS
CANADA

Thomas Northam — Session 35M
7409 Forest Hunt Court
Springfield, VA 22153

MAJ Thomas Nowak — Session 23C
U.S. Army Corps of Engineers
Area Office of Engineering
Wright-Patterson Air Force Base
P. O. Box 3268
Dayton, OH 45431

Daniel S. Raker — Sessions 2D, 14C
President
Design and Systems Research, Inc.
55 Upland Road
Cambridge, MA 02140

Daniel Rehak — Session 41D
Department of Civil Engineering
Carnegie-Mellon University
Pittsburgh, PA 15213

Charles M. Richardson — Session 29D
C.M. Richardson, Architects
South 3175 Orchard Park Rd.
Orchard Park, NY 14127

Mel Schlitt — Session 11M
International Facility
Management Association
3970 Varsity Drive
Ann Arbor, MI 48904

C. David Sides, Manager — Session 2D
Construction Market Programs
Cybernet Services
Control Data Corporation
8100 34th Avenue, NW
Minneapolis, MN 55440

Gary Silver — Session 28D
Hellmuth, Obata & Kassabaum
1270 Avenue of the Americas
New York, NY 10020

David J. Skar, P.E., Director — Session 1D
Engineering Systems and Management Division
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Bradford M. Smith — Session 43D
Center for Manufacturing Engineering
National Bureau of Standards
Washington, DC 20234

Dana K. Smith — Session 12D
Engineering Systems & Cost Branch
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Jim Steinmann — Sessions 11M, 36M
Steinmann, Grayson, Smylie
8831 Sunset Boulevard
Penthouse West
Los Angeles, CA 90069

Fred A. Stitt — Session 3D
Editor/Publisher
GUIDELINES
P. O. Box 456
Orinda, CA 94563

Douglas Stoker — Session 25D
Skidmore, Owings and Merrill
33 W. Monroe Street
Chicago, IL 60603

Eric Teicholz — Session 7D
Graphic Systems, Inc.
180 Franklin Street
Cambridge, MA 02139

David Wolfberg — Session 1D
Wolfberg, Alvarez, Taracido and Assoc.
1300 N. 17th Street, Suite 1030
Rosslyn, VA 22209

Wallace B. Wright — Session 10C
DIS/ADLPIPE, Inc.
55 Wheeler Street
Cambridge, MA 02138

APPENDIX III

FEDERAL USER GROUP SESSION ATTENDEES

Federal User Group: The Need for and Nature of Federal User Groups

First Session: Thursday, April 7, 1983

Ado Adami
Chicago Operation
U.S. Department of Energy
9800 S. Cass Avenue
Argonne, IL 60436

James Lee Aiken
ATTEN: ATEN-FN
HQTRADOC
Ft. Monroe, VA 23651

Cecil Ashford
Chief, Engineering Division
USAFESA
Fort Belvoir, VA 22060

Ronald Bailey
Facilities Engineering Division
CDR ARRADCOM
Dover, NJ 07801

Richard A. Baxter (Code 401)
CHESDIV BLDG 212
Naval Facilities Engineering Command
Washington Navy Yard
Washington, DC 20374

Melroy I. Brandt, Chief
Engineering and Construction Division
San Antonio Real Property
Maintenance Agency
P. O. Box 8295 Wainwright Station
San Antonio, TX 78208

Khim Chudasama, Electrical Engineer
Office of Construction
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Harold D. Clements
General Manager, Estimating Division
Real Estate & Buildings Department
U.S. Postal Service
Washington, DC 20260

Lawrence F. Cole
DARCOM I7SA ATTN: DRCIS-RI-IM
Rock Island Arsenal
Rock Island, IL 61201

Michael M. Dembo
U.S. Army Engineer Division
P. O. Box 1600
Huntsville, AL 35807

William Eddy
Naval Facilities Engineering Command
Hoffman Building II
200 Stovall Street
Alexandria, VA 22332

James G. Farish
Cartographer Code 2041K
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Robert G. Ford, Chief
Planning and Operations
(DAEN-ECC-C)
U.S. Army Corps of Engineers
20 Massachusetts Avenue NW
Washington, DC 20314

John L. Gilbert
M.S. 5A014
Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

Neil R. Greene, Architect
HQ Air Force Systems Command/DEE
Andrews AFB, DC 20334

Louis G. Grimble
CADNET Computing Systems Inc.
8107 43rd Street
Edmonton T6B 2M3
CANADA

Joel M. Haden
Tennessee Valley Authority
400 E. Summit Hill Drive WPB18
Knoxville, TN 37917

Dorris J. Hill
U.S. Postal Service
475 L'Enfant Plaza WSW, #4300
Washington, DC 20260

Tony D. Hinson
ATTN: Code 2021
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Thomas A. Kenney
DAEN-ECE-A
USACE
20 Massachusetts Avenue NW
Washington, DC 20314

Peter Kimmel (PRMS)
General Services Administration
Washington, DC 20405

W. Thomas Louie
084C
Veterans Administration
Washington, DC 20420

Dwight K. Matthews
Chief, Facilities Branch
DOD Dependents School--Germany Region
APO, NY 09633

William R. McCombs
ATTN: AFEN-RMP
HQ FORSCOM
Fort McPherson, GA 30330

Robert McMurren
DAEN-RMI-S
USACE
20 Massachusetts Avenue NW
Washington, DC 20314

Richard L. Monnett
General Manager of Construction
U.S. Postal Service
475 L'Enfant Plaza WSW #4334
Washington, DC 20260

MAJ T. Nowak
U.S. Army Corps of Engineers
P. O. Box 31039, Airway Road
Dayton, OH 45431

Fong L. Ou
Civil Engineer, 1202 RPE
USDA Forest Service
P. O. Box 2417
Arlington, VA 23020

Kenneth C. Parsons
U.S. Postal Service
475 L'Enfant Plaza WSW, #4300
Washington, DC 20260

Daniel Pinero-Mulero
084C
Veterans Administration
810 Vermont Avenue NW
Washington, DC 20420

Donald B. Pledger
ATTN: Code 202A
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

F. Mario Saba
Mechanical Engineer
U.S. Postal Service
475 L'Enfant Plaza
Washington, DC 20260

Richard L. Schneider
U.S. Army Construction Engineering
Research Lab
P. O. Box 4005
Champaign, IL 61820

Benny G. Scott
HNDPD-C (CE Huntsville)
Huntsville, AL 35807

Donald E. Selby
South Pacific Division
Corps of Engineers
630 Sansome Street, Room 1216
San Francisco, CA 94111

Paul K. Senter
USAE Waterways Experiment Station
P. O. Box 631
Vicksburg, MS 39180

F. L. Simmons
DAEN-ECE-I
HQUSACE
Washington, DC 20314

Vincent M. Spaulding
Code 04M1A
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Ray Spunzo
ATTEN: ATEN-C
HQTRADOC
Ft. Monroe, VA 23651

Gilbert Stockman
DAEN-ECC-C
HQUSACE
20 Massachusetts Avenue NW
Washington, DC 20314

George Turner
B168-BR
National Bureau of Standards
Washington, DC 20234

Robert A. Walker
Chief, West HAC Division (084D)
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Second Session: Friday, April 8, 1983

John N. Agnos
CHESDIV BLDG 212
Naval Facilities Engineering Command
Washington Navy Yard
Washington, DC 20374

Alton S. Bradford
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Ronald E. Brown
Corps of Engineers
Huntsville Division
Huntsville, AL 35807

John A. Cook
O/C (08H)
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Robert M. DiAngelo
CHESDIV BLDG 212
Naval Facilities Engineering Command
Washington Navy Yard
Washington, DC 20374

Gary Duncan
Design and Construction
U.S. Postal Service
475 L'Enfant Plaza WSW
Washington, DC 20260

William W. Houser
CHESDIV BLDG 212
Naval Facilities Engineering Command
Washington Navy Yard
Washington, DC 20374

Murray Huffman
Corps of Engineers
Fort Worth District
Fort Worth, TX 76102

Donald Lencioni
Design and Construction
U.S. Postal Service
475 L'Enfant Plaza WSW
Washington, DC 20260

William R. McCombs
AFEN-RMP
HQ FORSCOM
Ft. McPherson, GA 30330

David S. Picone
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Dennis Scheessele
CHESDIV BLDG 212
Naval Facilities Engineering Command
Washington Navy Yard
Washington, DC 20374

David Skar
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Tom Toy
Design and Construction
U.S. Postal Service
475 L'Enfant Plaza WSW
Washington, DC 20260

Carole E. Williams
National Technical Institute
for the Deaf
Rochester, NY 14623

Federal User Group: Computer Graphics Library--Details and Drafting Symbols

Charles Auerbach
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

L. M. Baldt
U.S. Postal Service
1845 Walnut Street
Philadelphia, PA 19897

George Bartsiotas
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Frank A. DiMatteo
U.S. Army Corps of Engineers
20 Massachusetts Avenue NW
Washington, DC 20314

Michael Fenton
Building 230, Room 113A
U.S. Army Corps of Engineers
Ft. Shafter, HI 96858

Neil R. Greene
Architect
Air Force System Command/DEE
Andrews AFB, DC 20334

Stephen R. Hagan
Architect
17th Coast Guard (ecu)
P. O. Box 462
Juneau, AK 96856

Anthony Joyce
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Lawrence Kaetzel
National Bureau of Standards
Department of Commerce
Washington, DC 20234

Yehuda Kalay
Division of Civil and
Environmental Engineering
National Science Foundation
Washington, DC 20550

LTC B. F. Miller
U.S. Army Corps of Engineers
Baton Rouge, LA 70821

Wayne D. Reynolds (CPT)
USAF Academy
Golden, CO 80840

Tom Toy
Design and Construction
U.S. Postal Service
475 L'Enfant Plaza WSW
Washington, DC 20260

John Weber, Architect
Design and Program Branch
General Services Administration
Washington, DC 20405

Charles R. Williams
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Federal User Group:
Expansion of Computers/Graphics Use Among Contract A/E's

Richard F. Astrack
U.S. Corps of Engineers
USAEDE EUDED-SE
APO, NY 09757

Scott K. Borges
USAF
7625 CES/DEEE
Golden, CO 80840

Jerry Enverso
U.S. Postal Service
1845 Walnut Street
Philadelphia, PA 19897

W. D. Fote
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Dennis Grooms
KC FREB
U.S. Postal Service
5700 Broadmoor
Mission, KS 66101

Clair H. Kenaston
Code WE310
U.S. Postal Service
850 Cherry Avenue
San Bruno, CA 94066

Ronald L. King
Senior GAO Evaluator
U.S. General Accounting Office
441 G Street NW
Washington, DC 20548

David J. Skar
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Deke Smith
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Janet Spoonamore
U.S. Army Construction Engineering
Research Laboratory
P. O. Box 4005
Champaign, IL 61820

Federal User Group: Managing a CAD Installation in the Government

H. C. Bohannon, Jr.
1606 ABW/DEE
Kirtland AFB, NM 87117

Sherman Bollinger
U.S. Army Corps of Engineers
215 N. 17th Street
Omaha, NE 68102

Ronald E. Brown
EDCS
U.S. Army Corps of Engineers
P. O. Box 1600
Huntsville, AL 35807

John A. Cook (08H)
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Richard H. Dennis, Manager
Design and Construction
U.S. Postal Service
P. O. Box 701
Columbia, MD 21045

CAPT W. M. Duncan
AFIT/LS
Wright Patterson AFB, OH 45433

Philip T. Frank
Manager, Design and Construction
Real Estate and Buildings Department
U.S. Postal Service
Inglewood, CA 90311

Vincent Gallo
Architect Designer/Transit Planner
New York and New Jersey Port Authority
1 Path Plaza, 6th Floor
Jersey City, NJ 07306

Jasper L. Garner
CHESDIV NAVFAC
Building 226 Washington Navy Yard
Washington, DC 20374

Roger P. Henry
Public Works Canada
Riverside Drive
Ottawa, Ontario K0A 0M2
CANADA

B. J. Hoppenjans
DRSMI KLE
U.S. Army Missile Command
Redstone Arsenal, AL 35888

Murry Huffman
ATTN: ADP Center
P. O. Box 17300
Ft. Worth, TX 76102

Barry W. Kollme
HQMAC/DEEE
Scott AFB, IL 62225

Larry Lawrence
HQESC/DEE
San Antonio, TX 78243

Dave Picone (086C)
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Marie D. Roberts
EUDDP-S
USAEDE
APO, NY 09757

John W. Roberts
ATTN: SASEN-MP-4
U.S. Army Engineer District
P. O. Box 889
Savannah, GA 31410

Carl S. Stephens
Design Branch
U.S. Corps of Engineers
P. O. Box 61
Tulsa, OK 74121

Lee Stigall
ADP Center
U.S. Corps of Engineers
P. O. Box 61
Tulsa, OK 74121

Federal User Group:
Engineering Analysis Programs

Khimchand H. Chudasama
Office of Construction (087C)
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Louis G. Grimble
CADNET Computing Systems Inc.
8107 43rd Street
Edmonton, Alberta T6B 2M3
CANADA

Robert Johnston
Code 04M4D
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Paul K. Senter
USAE Waterways Experiment Station
P. O. Box 631
Vicksburg, MS 39180

Fred I. Stahl
BR B-168
National Bureau of Standards
Washington, DC 20234

Federal User Group: Integrating CAD Systems into the Design Process

John A. Barnes
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Richard A. Baxter
CHESDIV NAVFAC
Building 212 Washington Navy Yard
Washington, DC 20374

Sherman J. Bollinger
U.S. Army Corps of Engineers
215 17th Street
Omaha, NE 68102

Scott K. Borges
7625 CES/DEEE
USAF Academy
Golden, CO 80840

Melroy I. Brandt
San Antonio Real Property
Management Agency (USAF)
San Antonio, TX 70243

William H. Cable
Office of Construction
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Robin M. Ellerthorpe
ARCH SPVC BR
Tennessee Valley Authority
Knoxville, TN 37917

Jasper L. Garner
CHESDIV NAVFAC
Building 226 Washington Navy Yard
Washington, DC 20374

Joel M. Haden
WP818
400 East Summit Hill Drive
Tennessee Valley Authority
Knoxville, TN 37917

Mark G. Hall
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Franz W. Krebs
Department of Health and Human Services
330 Independence Avenue SW
Washington, DC 20201

Larry L. Lawrence
HQESC/DEE
San Antonio, TX 78243

Daniel Pinero-Mulero (084C)
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Daniel W. Reynolds
U.S. Army Corps of Engineers
Sacramento, CA 95801

Richard V. Roche
HQ ESC/DEE
San Antonio, TX 78243

Donald E. Selby
SPDED
U.S. Army Corps of Engineers
San Francisco, CA 94111

Federal User Group:
Data Exchange Standard

Neal Davis
HNDAM
U.S. Army Corps of Engineers
P. O. Box 1600
Huntsville, AL 35807

Roger Henry
Public Works Canada
Riverside Drive
Ottawa, Ontario K0A 0M2
CANADA

Anthony Joyce
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

Marie D. Roberts
Computer Specialist EUDDP-S
U.S. Army Corps of Engineers
APO, NY 09757

George Turner
B168-BR
National Bureau of Standards
Washington, DC 20234

Federal User Group:
Justification and Acquisition of Computers/Graphics Systems

Satish Abrol
HQ USAF/LEEES, Building 516
Bolling AFB
Washington, DC 20332

Richard F. Astrack
USAEDE EUDED-SE
APO, NY 09757

William A. Brown, Sr.
HQ USAF/LEEES, Building 516
Bolling AFB
Washington, DC 20332

Jean Cenac
ATTN: CCC-CED-SAT
U.S. Army Communications Electronics
Engineering and Installation Agency
Ft. Huachuca, AZ 85613

Bob Clontz
Office of Construction
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Pablo Cruz
U.S. Forest Service
Department of Agriculture
Washington, DC 20250

Rick Dennis
U.S. Postal Service
P. O. Box 701q
Columbia, MD 21045

James G. Farish
Code 2041K
Naval Facilities Engineering Command
200 Stovall Street
Alexandria, VA 22332

W. D. Fote
Veterans Administration
811 Vermont Avenue NW
Washington, DC 20420

Dennis Grooms
WSPS
KCFREBOD&C
Mission, KS 66101

Dorris J. Hill
U.S. Postal Service
475 L'Enfant Plaza WSW RE&B
Washington, DC 20260

B. J. Hoppenjans
DRSMI KLE
U.S. Army Missile Command
Redstone Arsenal, AL 35888

Clair H. Kenaston
Code We310
U.S. Postal Service
850 Cherry Avenue
San Bruno, CA 94066

Anne Massey
U.S. Customs Service
Washington, DC 20229

Bobby R. Mullinix
DRSMI-KLE
U.S. Army Missile Command
Redstone Arsenal, AL 35898

Carlyle Neely
ATTN: DAEN-RMI-S
U.S. Army Corps of Engineers
20 Massachusetts Avenue
Washington, DC 20314

Mario Saba
U.S. Postal Service
475 L'Enfant Plaza WSW
Washington, DC 20260

Richard Schneider
U.S. Army Construction Engineering
Research Laboratory--FS
P. O. Box 4005
Champaign, IL 61820

Benny G. Scott
U.S. Army Corps of Engineers
P. O. Box 1600-HNDPD-C
Huntsville, AL 35807

Carl S. Stephens
Design Branch
U.S. Corps of Engineers
P. O. Box 61
Tulsa, OK 74121

Lee Stigall
ADP Center
U.S. Corps of Engineers
P. O. Box 61
Tulsa, OK 74121

APPENDIX IV

STUDENT ASSISTANTS

Students at schools of architecture and engineering were invited to apply as student assistants for the congress. Twenty-seven students from 17 universities were selected from more than 50 applications received. Student assistants were admitted without charge to the entire congress and were free to attend regular technical sessions and special sessions organized specifically for them. In return, each student assistant served as an auditor or recorder at one or more of the congress sessions. Names and addresses of the student assistants follow.

Mark Aseltine
Center for Environmental
Design and Planning
Graduate School of Fine Arts CJ
University of Pennsylvania
Philadelphia, PA 19104

Walt Bransford
School of Architecture
209 Vol Walker Hall
University of Kansas
Fayetteville, AR 72701

Phil Brock
c/o Jon H. Pittman
College of Architecture
143 East Sibley Hall
Cornell University
Ithaca, NY 14853

Gordon E. Cameron
University of Waterloo
61 Hillview Street
Kitchener, Ontario N2H 5P9
CANADA

Brian Chavis (Student Supervisor)
U.S. Army Construction
Engineering Research Laboratory
P. O. Box 4005
Champaign, IL 61820

Yi-Wu Chi
Atherton Hall, Box 168 A
Penn State University
University Park, PA 16802

Scott Diehl
Building Engineering Group
University of Waterloo
Research Organization
415 Phillip Street
Waterloo, Ontario N2L 3X2
CANADA

Robin M. Ellerthorpe
University of Tennessee
4117 Foley Drive
Knoxville, TN 37918

Karen Flynn
University of Maryland
5708 Seminole Street
College Park, MD 10740

Lola E. Graeme
University of Arizona
3000 Camino de Bravo
Tucson, AZ 85718

Trent Green
Department of Architecture
Hampton Institute
Hampton, VA 23668

John Heile
University of California
1502 Cotner Avenue #8
West Los Angeles, CA 90025

William Holt
University of Oregon
1340 East 19th Street #1
Eugene, OR 97403

Gwen C. Huegel
Penn State University
722 N. Holmes Street
State College, PA 16801

Nate Kaiser
Department of Architecture
University of Illinois
Champaign, IL 61801

Howard Kimura
c/o J. Jeffrey Burnett
Department of Architecture
Washington State University
Pullman, WA 99163

Walter Kuntner
c/o John Tector
School of Design
North Carolina State University
Raleigh, NC 27650

Robert Lascelles
California Polytechnic State University
1960 Partridge Drive
San Luis Obispo, CA 93401

Glenn Miller
c/o J. Jeffrey Burnett
Department of Architecture
Washington State University
Pullman, WA 99163

Dale Peterson
Columbia University
431 Riverside Drive #4J
New York, NY 10025

Alan R. Popovich
Penn State University
R.D. #1, Box 415
Bellefonte, PA 16823

Larry W. Rose
University of Arizona
685 S. Pantano Parkway
Tucson, AZ 85710

Luis Salomon
204 East White Apt. 37
Champaign, IL 61820

Joanne Scott
California Polytechnic State University
1415 Stafford Street, Apt. D-1
San Luis Obispo, CA 93401

Mark Smith
College of Environmental Design
University of California
Berkeley, CA 94720

Stephen B. Smith
University of Maryland
5916 Harrison Avenue
Riverdale, MD 20737

Graham Wyatt
Columbia University
235 West 102nd Street, #101
New York, NY 10025