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ENGLISH

ADVANCED MANUFACTURING AND ENGINEERING METHODS

DP/BUL/81/009

BULGARIA *

Technical report: Development and Utilization of CAD Systems* *

Prepared for the Government of Bulgaria
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Einar Skjørten

Expert CAD System Analyst

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United Nations Industrial Development Organization
Vienna

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1. TABLE OF CONTENTS

2. INTRODUCTION

This report is prepared by siv.ing. Einar Skjørten, M.S. of NORCONSULT INTERNATIONAL A.S., to UNIDO upon assignment by UNIDO as CAD Systems Analyst on UNIDO project DP/BUL/81/009/11-03/31.9.E, and after visit to CAD/Scientific Laboratory, 55A Chepaev Street, Sofia, in the period Nov. 10 through Nov 21 1985, and after debriefing at UNIDO in Vienna on Nov. 22, 1985.

3. THE ASSIGNMENT

UNIDO has assigned NORCONSULT INTERNATIONAL A.S. represented by siv ing Einar Skjørten, M.S., as CAD System Analyst on project DP/BUL/81/009/11-03/31 9 E according to terms agreed between the two parties. The purpose of the assignment is to assist Bulgaria's State Committee for Scientific and Technological Progress with the development and utilization of computer-aided-design systems (hardware and software), in accordance with UNIDO Job Description of March 20 1985.

The duration of the assignment is two weeks, and the duty station is Sofia.

4. SUMMARY

This report has been prepared after a two week visit to the CAD/Scientific Laboratory in Sofia. The available time has limited the opportunities for obtaining an in-depth understanding of possibilities and restrictions that may apply, and the observations should be considered on this background.

ON ORGANIZATION AND MANAGEMENT

The institution appears to have established a good professional work environment, and a dedicated and well managed operation. It would probably be of advantage to the operation to give priority to further development of project procedures and to project management training.

ON KNOW-HOW

The staff has education and training in various disciplines relating to CAD, but know-how related specifically to CAD application appears in general to be limited to fairly recent training. It would seem desirable in particular to increase the experience from practical implementation and use of CAD systems on various levels in an organization.

Because of the rapid development of hardware and software, up-to-date information is a critical factor in selection of strategies and plans of operation. A well organized library of CAD information in the CAD/Scientific Laboratory will be a valuable resource

Cooperation with international firms is an excellent method for gaining experience within the field of CAD, and such possibilities should be pursued.

ON EQUIPMENT

The lack of up-to-date computer resources may presently be a serious handicap in developing the CAD/Scientific Laboratory effectively towards the objectives. If possible, the Laboratory should as soon as possible be permanently equiped with 1-2 personal computers and at least one modern 32 bit work-station or mini computer.

Standard CAD software for PC's should be available for evaluation and for educational purposes. For more extensive applications, the possibility of obtaining software for work-stations and/or mini computers in cooperation with users and selected developers

could be considered.

ON FINANCES

It seems desirable to secure funding for continuing the development work that has been started with the CAD/Scientific Laboratory.

ON PRODUCTS AND MARKETS

I would assume that the CAD/Scientific Laboratory should operate so as to be considered as an objective institution, economically independent of vendor interests.

5. THE PROGRAMME

Sunday Nov. 10

Transfer from Oslo to Sofia

Monday Nov. 11

Introduction to the project

- General overview of the project
- Introduction to project staff
- Presentation of project offices and equipment

Tuesday Nov. 12

The project object, organization, strategy, operational plans and status (project activities, time-schedules, resources - information, staff, equipment, money).

Introduction to user profiles and user participation in the project.

- Study of project documentation
- Discussion

Demonstration and discussion of project CAD products on PDP 11/34A

- On-line demonstration of existing systems
- Discussion

Wednesday Nov. 13

Introduction to the project educational activities

- Subjects treated in the educational program
- Clients

Demonstration of a "state of the art" Personal Computer brought by Skjærten

- Macintosh user interface
- MacDraft, a 2D drafting program

Demonstration and discussion of project CAD product on IBM PC XT

- On-line demonstration of existing system
- Discussion

Thursday Nov. 14

Friday Nov. 15

In-house workshop/seminars

- The state of the art, current trends and alternatives.

  An overview of CAD trends of development (mainframe, distributed workstations, and PC's, 2D and 3D applications, user interface, transfer formats, user considerations etc.)

- The impact of CAD/CAM systems on the enterprise

  A discussion on the need for know-how, the analysis of the process, planning and

organization of the implementation, training of the staff, management and control of the facilities etc.

- System evaluation

  On evaluation of vendors, services, hardware, software, performance etc.

- Justifying the investment?

  A discussion on the various elements in evaluating the economics of CAD.

- Industry applications

Dinner with Mr. Bogdanov, First Deputy General Director of Center for Accellerated Implementation - Progress, Mr. Mateev, Director CAD/Scientific Laboratory and Mrs Ivanova, Project Officer of CAD/Scientific Laboratory.

Saturday Nov. 16

Visit to industrial firms BTR ELPROM in Lovetsch and NPK MECHATRONICA in Gabrovo

Monday Nov. 18

User seminar in Sofia.

(See list of keywords in Appendix 1)

Current trends and alternatives in the development of CAD systems and applications

Experiences from implementation of CAD systems, covering subjects as

- Organization and know-how
- Personell
- Hardware and software
- Economy

Tuesday Nov. 19

Review and discussion of observations, possible recommendations

Meeting with Mr. Michni Michnev, Director General of Center for Accellerated Implementation - Progress, Mr. Plamen Mateev, Director CAD/Scientific Laboratory

Transfer to Varna

Wednesday Nov. 20

User seminar in Varna, videotaped for later educational purposes.

(See list of keywords in Appendix 1)

Current trends and alternatives in the development of CAD systems and applications

Experiences from implementation of CAD systems, covering subjects as

- Organization and know-how
- Personell
- Hardware and software
- Economy

Transfer to Sofia

Thursday Nov. 21

Concluding the visit

Transfer to Vienna

Friday Nov. 22

Debriefing in Vienna

Transfer to Oslo

6. THE OBSERVATIONS

It will be obvious that time during this visit has not permitted me to get an in-depth knowledge of the CAD/Scientific Laboratory, or to get a full understanding of possibilities and restrictions that may apply. It must therefore be noted clearly that these observations shall be regarded as preliminary.

6.1 ON ORGANIZATION AND MANAGEMENT

The State Committe for Science and Technical Progress has established the Center for Accellerated Implementation - Progress, with mr. Michni Michnev as Director General. The CAD/Scientific Laboratory is established under this Center for Accellerated Implementation, with mr. Plamen Mateev as Director

The CAD/Scientific Laboratory is situated on 55A Chapaev Street, Sofia, with mailing adress P.O. Box 112, Sofia 1113, Bulgaria. Telephone (359 2) 705257/705356

There is presently a total staff of about 30 people in the CAD/Scientific Laboratory, to be increased according to current plans to about 50 people by medio 1986. With few exceptions the staff consists of personell with technical education.

The laboratory is currently organized with four departments reporting to the Director These are the Modelling Department (Mr. Popov), the Methodological Department (Mr Bedrossyan), the Technological Department (Mr. Mindow) and the Implementation Department (Mr. Raynov). Reporting to the director is also a Decision-making Group with department managers and some other persons as members, and an Operations Group headed by the Project Officer (Miss Ivanova). Projects are performed in a project organization under the Director, with staff from the various departments.

It is my impression that the organization has established a good professional work environment. The operation appears informal and dedicated, and well managed in a typical Dicipline/Project organization. Time did not permit me to get a closer impression of planning, organization, control and operation of projects. I would

however generally assume it to be feasible to give priority to further development of project procedures, in particular in view of the planned expansion of the activities I would also consider it of advantage to the organization to get some training in project management on various levels. This can be achieved e.g. by offering external training courses to one or two key persons, as a basis for further internal training. Alternatively it can be achieved by in-house seminars given by an external specialist during 2-3 weeks.

As part of the development of project procedures, I would consider it of advantage to develop a "quality assurance/quality control" manual for the performance of projects for external clients. I would assume that this will be of benefit for internal organization and management of the work, and also for marketing of the "products"

6.2 ON KNOW-HOW

The technical staff has education and experience from various universities and companies, within fields of Electronics, Automatics, Telematics, Radiotechnics Automation of production processes, Mathematics, Technical cybernetics, Statistics etc. Some know-how is available within education and within use of media for teaching, and some education and experience is available within the field of civil engineering Know-how which is related specifically to CAD seems in general to be limited to fairly recent additional training of the staff. The staff appears to have a good basic know-how, and is working dilligently on extending the CAD know-how in several fields by use of available equipment. The equipment is however a limitation, as mentioned below

It would seem highly desirable for the laboratory to have experience from practical implementation and use of CAD in industrial production, but such know-how is of course not easily available in Bulgaria for the time beeing. I will consider it as an important advantage that the organization also continues to develop its understanding of the wievpoints, at management level as well as at operator level, of an industrial end-user.

The implementation of CAD in an engineering or production enterprise is not only a technical question of hardware and software. It is indeed also a difficult and important organizational and economical question. How to aquire the know-how

necessary for making the right decisions? How to define the objectives and the strategy, and how to plan and organize the selection and implementation of CAD Many experienced CAD users in the world today will agree with the following careful management statement: "Even if we can say today that the results of our expenditure are good, it is correct to acknowledge that we did not fully see the problems and possibilities in implementing and using CAD."

Important questions rise in relation to how to aquire a system. By third party procurement, by third party development, by in-house development, or by any combination of these. In-house information is often regrettably overlooked. Education of operators as well as, not to forget, of management is important. Tender procedures and tender evaluation must be carefully planned and contract conditions negotiated. Delivery, installation and takeover must be considered along with training of operators. Adaption of the system to the actual applications is costly and time consuming and involves definition of standards and procedures, development of libraries and macro commands, etc. Quality assurance must not be forgotten. And finally the question of economic evaluation is maybe the most difficult of all. Most of the experienced users referred to above will in addition agree to the following statement: "Do not expect immediate cost reduction."

The frontiers of development within the field of CAD are moving very fast. It is of great importance for correct evaluation of the various possibilities for development of CAD in Bulgaria that the CAD/Scientific Laboratory is keeping well up to date in information about the general development of CAD. This relates to trends in hardware, software, cost, vendor profiles, practical applications etc. Examples of comparison matrixes for software and for vendors for use in a an information library are shown in Appendix 2. Information may be obtained in many ways, but may not be so readily available in Bulgaria as I would be used to from e.g. Norway. A well organized library of CAD information in the CAD/Scientific Laboratory will be a valuable resource for a number of institutions and companies in Bulgaria. This will however require specialized personell and use of modern methods for information management. It would seem of advantage to give relatively high priority to the development of the information library in the CAD/Scientific Laboratory.

The educational programme of the CAD/Scientific Laboratory appears to be well balanced, and the teaching equipment seems good. I did however not have sufficient time to study the programme closely. It might possibly benefit from expanding on some of the trends and user viewpoints I had the opportunity to express during my visit. I would recommend this to be given further consideration.

The Director of the Center for Accellerated Implementation, as well as the Director of

the CAD/Scientific Laboratory expressed special interest in finding fields and methods of cooperation with international firms in order to extend the know-how of the CAD/Scientific Laboratory. This is an exellent method for gaining experience, which I recommend should be pursued. UNIDO might possibly be of assistance also for this purpose. Knowing the field of realtively advanced research and application of CAD in Norway, I can see certain possibilities for expanding the contact between the CAD/Scientific Laboratory and Norwegian institutions and companies.

6.3 ON EQUIPMENT

The CAD/Scientific Laboratory is equipped with a PDP 11/34A computer with hard-disk, tape-unit, plotter, hard-copy unit, Tektronix 4013 storage tube graphics terminal, standard ASCII terminal etc. The Laboratory has access to IBM PC XT personal computer. CAD software is partly based on commercial products (DOGS) and partly on in-house development.

It is my impression that the lack of up-to-date computers may be a serious handicap in the future development of the CAD/Scientific Laboratory towards the specified goals.

The development of CAD is to a large extent tied to the development of hardware equipment. Only a few years ago mainframe computers dominated in CAD applications. Now we se at least three distinct development trends 1) The mainframes are being used only for the very large applications, and minicomputers have been gaining territory. 2) The so called **work-stations**, powerful small machines working together in **networks**, are developing very fast and may be taking over the majority of the CAD computer market. 3) The Personal Computers, small desktop machines, are gaining popularity for less extensive applications and pilot projects. The application of work-stations and networks allows the development of powerful CAD systems with capacity tailored to variable demands and with a reasonable entry-level cost. The cost of a 32 bit modern work station with 1-2 Mb memory and say 50-100 Mb disk storage is presently $ 20,000 - 50,000.

At the same time we find a trend in software and hardware development with increasing attention paid to the **user interface**. This involves the use of fast bit-mapped displays, also capable of handling pop-up or pull down **menus** which often may be user defined. The use of menus may allow a high degree of adaption of the system to the process and procedures which may be relevant for each different user. Development also involves the use of **window** technique allowing separate application to be active in different windows on the same screen, with a facility to transfer information between the windows. In this way a designer may run a CAD system in one window, while at the same time running e.g. an application for analysis in another window and e.g. a word processor in a

third window, and then transferring information between the windows as needed This opens the possibility of using one medium in a practical and flexible integration of different application, possibly running on different computers.

I would for several reasons recommend that the CAD/Scientific Laboratory, if at all possible, as soon as possible should be permanently equipped with 1-2 personal computers (e.g. IBM PC AT, Olivetti M24 or equivalent) and at least one work station (e.g. Apollo or Sun or equivalent) or a powerful minicomputer (e.g VAX II, PRIME or equivalent). I would also consider it of advantage for the laboratory to gain experience with the use of a Local Area Network for reasons mentioned above. I am not familiar with present restrictions regarding procurement of such equipment in Bulgaria, and it would be necessary to consider various aspects of this recommendation more closely This also applies to the important question of vendor support. An upgrading of the computer equipment in the lab would stimulate the professional environment, increase the capacity for assistance to users and open the possibility of offering hands-on demonstrations to various clients. In this connection I might mention the positive experiences with "CAD Walk-in Centers" in other countries, where CAD hardware and software is available to potential users for the purposes of education, evaluation and training.

There is presently a large number of CAD software systems of different types (2D, 3D, Modelling) available for as well main frame computers, as for minicomputers, work stations and for PC's. The development of an in-house CAD system from scratch has proven to be very time and cost consuming, and should possibly be avoided. For this reason I would recommend that the CAD/Scientific Laboratory does an evaluation of several commercial systems of various types, in order to gain know-how and to be able to give realistic and independent advice to potential local buyers. This may primarily apply to CAD systems for PC-type computers, and may in my experience not involve prohibitive costs.

For work-station or mini-computer the CAD software is more costly and complex, and it might be necessary/feasible to aquire (preferably general and open) CAD software system(s) in some sort of cooperation with users or user groups on one hand and with selected developers on the other hand. The purpose of the cooperation would be to assist in, and accellerate, the development of more extensive CAD application, and of course to develop the in-house know how of user requirements and system restrictions and

possibilities. The first step in this direction could possibly be to develop a list of system specifications based on general local users requirements, and then to approach developers/vendors on this basis for the purpose of discussing possible cooperation. The use of locally produced central and/or peripheral equipment could be considered in this connection.

6.4 ON FINANCES

The development of the CAD/Scientific Laboratory for the objectives stated in the Project Document would according to all experience be demanding on financial resources, a demand which may be very difficult to estimate in advance. Time has not permitted me to get an in depth impression of the financial situation, and I am consequently not presently in position to comment on this. It would however seem desirable to secure the funding for continuing the development work that has been started with the the CAD/Scientific Laboratory. It is my impression that there is presently a solid foundation and potential for development towards the specified objectives.

6.5 ON PRODUCTS AND MARKETS

The CAD/Scientific Laboratory will in many respects operate as a consulting company. The products may be outlined as:

- Feasibility studies concerning CAD implementations.
- Project Management for CAD implementations.
- CAD hardware and software system modification, adaption and implementation.
- CAD systems procurement on behalf of client.
- Training and education in CAD applications.
- Information concerning CAD systems and applications.

I will consider it desirable for the CAD/Scientific Laboratory to be considered as objective and economically independent of vendor interests. This, together with high

professional quality and service minded approach, will secure the necessary confidence from clients.

The markets for the services of the CAD/Scientific Laboratory are in broad terms:

- Industry
- Engineering, Architecture
- Education

CAD/Scientific Laboratory, Sofia

Some keywords from seminars on selection and implementation of CAD in an organization

Sofia/Varna November 1985

Know How

- Litterature
- Journals and newsletters
  - Journals
    - Computer Aided Design
    - The Anderson Report
    - CAD/CAM Digest
    - Computers in Mechanical Engineering
    - Kleins Newsletter of Computer Graphics
  - Reviews
    - Periodic Review of CAD/CAM Industry
      - Merrill Lynch, New York
  - Books
    - The Guide for Evaluation and Implementation of CAD/CAM Systems
      - C. Chasen
    - Computer Aided Design
      - Edited by J. Encarnacao, Springer Verlag
- Lectures and seminars
- Exhibitions
- Consultants
- Pilot projects
- CAD/CAM "Walk in Centers"
- R&D activities

Definition of objective

- Productivity
- Turn around time
- Quality
- Work environment
- Competition
- Office space

The formal objective is to produce documentation in shorter time, at a lower cost and with better quality. But the practical objective is to keep up competivity.

Planning and organization

- Task force
- Schedule
- Budget
- Analysis of applications
- Selection of strategy
  - Myrphy's Law of CAD
    - The system that you can afford, can't do what you want it to do.
    - The system that can do what you want it to do ... you can't afford.

- Type of visualization
  - 2D/2D with 3D visualization
  - 3D
  - Modelling
- Specialization
  - General drafting
  - Problem oriented
  - Product oriented
- System philosophy
  - Mainframe
  - Distributed work stations
  - PC
- User interface
  - Menu (Pop-up)
  - Windows
  - Pointing device (Puck/Mouse)
- Aquisition of system
  - Third party procurement
  - Third party development
  - In-House development

Information in-house

Evaluation of potential systems

- Hardware
  - System configuration
    - Mass storage
      - Floppy disk
      - Hard disk
      - Streamer tape
      - Video disk
    - RAM minimum
      - recommended
    - ROM routines
    - CPU capacity
      - floating point
    - Serial ports
    - Options for upgrading
  - Display
    - Integrated or separate VDT
    - Colours or B/W
    - Size
    - Refresh rate
    - Resolution low (500x500)
      high (800x800) or better
    - Dual screen configuration
  - Input devices
    - Keyboard
    - Mouse
    - Joystick

- Digitizer
- Tablet
- Scanner

- Hardcopy output devices
  - Plotter
  - Hardcopy unit
  - ASCII printer
  - Graphics printers
- Integration with other hardware systems
  - Network
    - Protocol
    - Speed
    - Transfer cable
    - Multiuser applications
  - Modem line transfer (RS232)

- System software
  - Operating system, alternatives
    - Windowing technique
    - Pop-up menues
    - Terminal emulation
  - Editors
  - Language compilers
  - Symbolic debugger
  - Number of work stations to connect
  - Drivers for connected hardware equipment
  - Access control
- Application software
  - Portability
  - Macro command language
  - Interface to standard Fortran IV
  - Database import and export capabilities
  - Documentation and vendor support
  - Updates - Costs
  - Facilities for drafting, editing, document control, etc.
- Physical requirements
  - Temperature
  - Noise
  - Vibrations
  - Area
  - Heights
  - Power
  - Light
  - Fire

Tender procedure, tender evaluation, contract negotiations

Delivery, installation and takeover

Training of operators

Adaption of system to application
- 3-12 months?
  - Standards
  - Procedures
  - Libraries
  - Macro's
  - Menue's

Pilot production
- 3-6 months?

Quality assurance

Maintenance

Economic evaluation of application system
- Productivity ratio
  - Manhour consumption (2:1 ?)
- Turnaround time ratio
  - Time gained (5:1 ?)
- Error reduction ratio
  - Potential error reduction (4:1 ?)
    - inaccuracies
    - transitions
    - communication
- Office space cost impact (.5 ?)
    - Drafting table
    - Desk
    - Reference documents
    - Storage space
- Operational cost impact (.8 ?)
    - Labour cost
    - Equipment cost
    - Maintenance cost
    - Training/support charges
- Pay-out period (12 months ?)
    - Total system cost
    - Labour cost savings/month
    - Office space savings/month
    - CAD system cost/month
    - CAD system maintenance cost/month

APPENDIX 2

CAD INFORMATION LIBRARY, SKETCHES

A User Questionnaire

A Comparison Matrix for evaluation of software and software vendors with particular relevance for PC-based software

A Vendor Comparison Matrix

A Vendor comparison Matrix example

CAD INFORMATION LIBRARY
SKETCH OF A USER QUESTIONNAIRE
With particular relevance for PC-based software
Reference: Graphic Systems Inc.

GENERAL INFORMATION

Organization name:

Adress:

Name of respondent:

Type of firm:

Software package name:

SYSTEM UTILIZATION

System configuration and cost:

Use of CAD:

Percent of drewings normally completed entirely by CAD:

CAD integrated with other software?

Effect of CAD on office:

Strengths and weaknesses of system:

CAD INFORMATION LIBRARY
SKETCH OF A COMPARISON MATRIX FOR EVALUATION OF SOFTWARE AND SOFTWARE VENDORS

With particular relevance for PC-based software

Reference: Graphic Systems Inc.

Vendor Name

System name

Application type

System configuration

- Floppy disk system support
- Hard disk support
- RAM minimum
  recommended
- Mathematical coprocessor
- Serial ports required
  recommended

Display adapters

- Resolution low (320x200)
  high (640x400) or better
- Dual screen configuration

Input devices

- Keyboard
- Mouse
- Digitizer

Hardcopy output devices

- Plotter
- Graphic printer

Macro and database Extraction Capabilities

- Macro command language
- Graphic data extraction
- Symbol attribute extraction
- Bill of Materials

Documentation and vendor support

- Tutorial
- Demo disk
- Software "Help" facility
- Assistance by phone
- Training course
- User group/Newsletter
- Updates - Costs

CAD INFORMATION LIBRARY
SKETCH OF VENDOR COMPARISON MATRIX

Reference: Graphic Systems Inc.

Vendor
- Name
- Adress
- Telephone
- Contact
- Date of first design firm installation
- Number of installations
  - Domestic
  - Foreign
  - Total

Basic drafting software
- Package name
- Programming languages supported
- Number of layers
- Data base geometry
- Macro commands
- Application libraries supplied
- Features
- Application software description

Hardware
- Digitizer
  - Manufacturer
  - Positioning device
- Graphic display
  - Manufacturer
  - Type
  - Maximum resolution
  - Features
  - Type of menuing
- Central processing unit
  - Manufacturer
  - Maximum number of graphic displays/processors
  - Networking
- Plotter
  - Manufacturer

Support
- Training
- Maintenance
- User group

Price
- Hardware & Software
- Software only
- Hardware only
- Maintenance cost
- Training cost

Users

Vendor company organization type

Year company founded
- Type of ownership
- Number/Location of offices
  - Domestic
  - Foreign
- Finacial profile/Gross sales
  - Corporate
  - CAD

CAD INFORMATION LIBRARY
SKETCH OF VENDOR COMPARISON MATRIX
EXAMPLE
Reference: Graphic Systems Inc.

Vendor
- Name
  - *Computervision Corporation*
- Adress
  - *14 Crosby Dr. Bedford, MA 01730*
- Telephone
  - *(617) 275-1800*
- Contact
  - *Elizabeth McKinley, Manager Public Relation, 201 Burlington Rd., Bedford, MA 01730*
- Date of first design firm installation
  - *3rd quarter 1984*
- Number of installations
  - Domestic *N/A*
  - Foreign *N/A*
  - Total *N/A*

Basic drafting software
- Package name
  - *CADDA 4X / DRAFTING 3000*
- Programming languages supported
  - *FORTRAN/C, PASCAL, FORTRAN 77*
- Number of layers
  - *256/1024*
- Data base geometry
  - *3-D / 2.5-D*
- Macro commands
  - *Supported*
- Application libraries supplied
  - *A/E/C and user created*
- Features
  - *Extensive, complete descriptions available*
- Application software description
  - *Integrated CAD/CAM/CIM/CAE systems with more than 300 specialized applications software packages. A/E/C applications include architecture, facilities management, mapping, process and power plant design I and II, building engineering, civil/site engineering; plant modelling, detailing and reporting; isometrics, piping and instrumentation, general building design, general mapping, survey data input, information management and tech. publications. Specialized packages are also available for marine design and electric, gas and telephone applications.*

Hardware

Digitizer

Manufacturer

Computervision, Insteview

Positioning device

Puck

Graphic display

Manufacturer

Computervision

Type

Monochromatic raster., color raster optional

Maximum resolution

900x1152 pix

Features

Varies with system

Type of menuing

Screen, keyboard, function keys, tablet/stylus, push button cursor

Central processing unit

Manufacturer

Computervision, IBM, Digital, Sun

Maximum number of graphic displays/processors

Varies

Networking

Varies

Plotter

Manufacturer

Computervision, Versatech

Support

Training

Offsite op. training; appl./productivity support

Maintenance

Hardware and software

User group

East, Midwest, International

Price

Hardware & Software

Low end systems $ 49,000 + in 3000 series

Software only

Start under $ 5000 for IBM PC XT and AT

Hardware only

Prices vary by system configuration

Maintenance cost

Varies with type of contract

Training cost

Varies; avg. offsite op. training $800/wk

Users

Architecture (10%), Elect.Engineering (40%), Mech. Engineering (50%)

Vendor company organization type
Systems (hardware and software) integrator

Year company founded
1969

Type of ownership
Public (NYSE)

Number/Location of offices

Domestic
6 in US + Canada

Foreign
25

Finacial profile/Gross sales

Corporate

CAD
1984 $ 566M
1983 $ 400M