INTEGRATED SYSTEMS RESULTS OF THE W78 SURVEY.

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1. INTRODUCTION

At the CIB W78 meeting in Stockholm, august 1983, the working group agreed to conduct a survey on which to base a catalogue of research and development of integrated CAD projects and systems. A questionnaire was to be prepared by an ad-hoc committee consisting of

Ms. Janet Spoonamore, Leader
Dr. Per Christiansson
Mr. Dana Vanier
Mr. Anne Volbeda

A questionnaire, see "3.2 Detailed results" was sent out in november 1984 to 180 addresses forming a wide range of respondents.

The following text is from the introduction to the questionnaire:
"The International Council for Building Research Studies and Documentation (CIB) working commission W78 Integrated Computer-Aided Design is conducting a study to develop a catalog of integrated computer-aided design systems addressing development of integrated computer-aided building design systems. The study will encompass two phases: a) survey of existing systems and on-going development projects, and b) summary of results. The enclosed questionnaire forms the basis for the survey. Fundamental research and development efforts are not to be addressed but will be catalogued in a future study."

"The goal of the study on integrated systems is to identify major available integrated building design CAD systems and those under development. An integrated CAD system for building design is defined as one offering multidicipline (architectural, civil, mechanical, electrical, structural) design analysis, drawing production, specifications development, and estimating support in a shared data environment. Programs or systems which address only a single dicipline or function such as structural analysis are not to be considered here. However, those systems addressing shared data among diciplines and througout the design process should be included. The individual stand-alone tools, e.g., computer-aided drafting, cost estimating, structural analysis, are not being considered in this study except as they relate to the overall integrated system development. If the system you have developed is an extension of another standard product offered by the vendors, then please indicate the unique information on it."

2. PREPARATION OF RESULTS

By April 1985, 45 answers were returned.
The following systems are at present included in the survey: GOAL 4, CANDID, TASKMASTER, DDM, MEDUSA-BUILDER, HOUSECAD, CAEDS, CLM UNIFIER, MULTIDRAW, DDS, PEAC, GINTRAN, 4D SERIES, TIPS, BERIT, MINI-DESIGNER, INTERGRAPH, ENIGMA, KEOPS, RUBENS CONCEPT, CADPLAN, RIBCON, ROBODATA, STELLSTRAC, CADHOUSE, SIGMA III, ARTECH, C.O.D.E., CEDRA, VERSACAD and CADAPPLE, TERAK and DESIGN PRO, DIGIRIT and DIGIKART, BDS, GDS, SVS,

CADRAK, ALVISR, ACDS 7000, ICEM, CDS 4000, AUTOCAD and CEADS-CAD200. The systems supports a total of 52.000 installed work stations.

The questionnaire answers were coded and processed by Ms. Janet Spoonamore at CERL, Illinois. The SPSS, Statistical Package for Social Sciences, was used to process the answers (example on label coding can be found on page 10 of the questionnaire).

Though the questionnaire was quite extensive most forms were carefully filled out.

Possibly additional answers can be requested from those vendors who for different reasons did not answer. (For example concerning the following systems Cadam/Catia, Computervision, Medusa, DOGS, Rucaps etc.).

It takes of course a very big effort to produce an extensive survey like those produced by the FACE, CIAD and CICA organizations on 2D- and 3D-systems. Though some of the big vendors did not reply I think that the result is enough interesting to be presented to give some trends and serve as a base for discussion of further related activities within CIB W78.

3. RESULT OF SURVEY

3.1 General comments.

Most systems include tools to assist both architectural and engineering diciplines.

It is of course very hard to judge how feasible a claimed quality is. For example, external programs can be integrated ("the system is open and analysis program may be attached"), available external formats ("easy to develop"), single-double line generation (what will happen at wall connections) etc. In some cases due to personal experiences it is easier to validate a claimed system feature.

At this stage I think the result should not be tied too hard to specific systems but more serve as an indicator of where integration in some sence exists or will be subjected to further developments. There are some vendors dominating the market who perhaps stronger than other vendors creates de facto standards for CAD-systems in different respects.

In the survey systems which can be installed on minis and micros dominate. At least half of the systems possess some kind of networking capability as well as virtual memory technique.

Relational databases are as commonly used as hierarchical for text handling. Hierarchical databases dominate the graphic data management.

Graphic packages mostly use "own" graphic standards.

Surprisingly few systems use wordprocessing and electronic mail. Spreadsheet programs are nearly as common (1/3 of the systems).

More than half of the systems have IGES interface (1/3 offer other formats as well).

The application packages seem to be dominated by architectural and engineering packages especially for the late design stages. Simulations as well as design checking against code/regulations are not very developed (how imbedded are the code packages etc.?). More than half of

the systems can produce quantity take offs of different kinds (the connection to the construction phase of the building process is not treated).

Facility management routines are available in more than 1/2 of the systems.

System utilities as Computer Aided Instruction seem to be quite undeveloped.

Multiple user write/update access to the project building model can be handled in more than half of the systems!

3.2 Detailed results.

The questionnaire contains the following main headings:

1. Name and organisation.
2. Integrated system.
   - 2a. Name of integrated system and/or future integrated system.
   - 2b. Hardware used.
   - 2c. Programming language and Operating system.
   - 2d. Software systems.
3. Existing or future application packages which are interfaced or integrated.
   - 3a. Program/design requirements.
   - 3b. Preliminary design.
   - 3c. Architectural design.
   - 3d. Engineering analysis/design.
   - 3e. Life-cycle building model analysis and simulation.
   - 3f. Cost estimating pricing.
   - 3g. Working drawings.
   - 3h. Quantity take off.
   - 3i. Specifications preparation.
   - 3j. Facilities management.
   - 3k. System utilities.
   - 3l. Creation of personal working environment.
   - 3m. Multiple user access to project building model.
   - 3n. Tools to compare design solutions.
   - 3o. Project documentation handling.
4. History of system.
   - 4a. First installation date of workstations.
   - 4b. Number of workstations delivered in 1983.
   - 4c. Acquisition costs in U.S. dollars for four (4) work station systems.
   - 4d. Maintenance cost in U.S. dollars per month for four (4) work stations systems.
   - 4e. Training available.
   - 4f. Countries marketed in.
5. Target user group marketed or to be marketed to.
6. If under development, status of development.
7. If under development, project development effort remaining.

Comments to answers:
Percent figures are related to the total number of possible answers (45). The figures only give a rough idea of system facilities.

Answers to questions 4-6 are separately accounted after the questionnaire transcript.

On the following four pages the questionnaire is reproduced (including "results"):

Questionnaire

(Fill out for each integrated system)

1. Name and organization. Please fill in name of person responsible for providing the questionnaire information and their organization.

a. Name of Person Filling Out Questionnaire _____

b. Organization/Title _____

c. Address _____

_____

_____

d. Telephone _____

e. Do you wish to have survey results? Yes __ No __

Fill out questions for each individual integrated system both those available and future systems under development, always relating the answers to a specific integrated system.

2.a. Name of Integrated System and/or Future Integrated System _____

(1) Name of Responsible Developer _____

(2) Organization/Title _____

(3) Address _____

_____

_____

(4) Telephone _____

(5) Description of system: _____

_____

_____

_____

_____

_____

_____

b. Hardware Used (check those applicable)

(1) CPU's Supported: 41%

List types: Vax, Apollo and Prime dominate
Personal computer 16% Micro 40% Mini 69% Mainframe 24% Distributed 31%
Other (specify) _____

(2) Graphic Terminals Supported: 93%

List types:
Storage 33% Vector refresh 22% Raster 76% Color 76%
Multi-screen 29%
Other (specify) _____

(3) Digitizing: 98%

Thumbwheels/joystick/mouse 69% Tablet 82% Digitizer 76% (All 56%)
Other (specify) _____

(4) Plotter Supported: 84%

List types: Calcomp, Hewlett Packard dominating followed by Benson Versatec
Electrostatic 40% Pen 80% Inkjet 16% Laser 4%=2
Other (specify) _____

(5) Network, RJE: 62%

Remote Communications 42% Type RS232 27%, X25 9%, HASP 6%, ANY 4%
Local Area Network 42% Type Ethernet 80% Speed 10MB 16%
Remote Job Entry 11% Type [Domain 4% 9.6KB 7%
Additional information _____

_____

_____

(6) Distribution format for data and source/object code: 96%

Tape 78% Disk 40% Floppy 58% Other (specify) 17%

(7) Additional Information: _____

_____

_____

c. Programming language and Operating Systems 100%

(1) Language:

FORTRAN 78% PASCAL 31% C 18% COBOL 7%=3
Other (specify) _____

(2) Operating System:

98% Operating system type(s) List Unix 4.2 20%, VMS 27%, MSDOS 9%
87% { User defined real time programming 31%
Virtual memory 67% Overlays 42%
Other (specify) _____

d. Software Systems

(1) Data base management:

87% List types
Graphic: Hierarchical 55% Network 18% Relational 29%
Other (specify) _____

67% List types
Text: Hierarchical 38% Network 18% Relational 29%
Other (specify) _____

16%=7 List types
Expert Systems 9%=4 Knowledge Bases 11%=5

(2) Graphics package: 80%

GKS 11% Siggraph CORE 13% PLOT10 24% Other (specify) 44%

(3) Geometric modelling:

98% Real World Measurement: Metric 96% English 50% Other (specify) _____

69% 2-d __ 2-d & z coordinate __ 3D: Wire-frame 60% Surface 44% Solid 27%
Other (specify) _____ 73%

interference/clash checking 31%

(4) Surface geometries handled: 84%

Rectangular 62% polygonal 73%
Curved surfaces 35% rotational/ruled surfaces 38%
Other (specify) _____

(5) Physical attribute model/parts model? 84%
How do you attach attributes to geometric model?

parameterized library 60%
graphic/non-graphic data link 60% } Both 40%
Other (specify) 18%

(6) Information handling: 78%

Word Processing 38% Type _____
Electronic Mail 31% Type _____
Mixed Text Grahpic Output 53%
Other (specify) 16% Data transfer from db to micro-based spread sheet, etc.

(7) Additional Information: 38%

Spread Sheet 29% Special I/O Features 13% (specify)
Other:
Free sketch digitizing, scanner interface etc.

(8) External formats available: 69%

IGES 58% SIF 20% SET __ Other (specify) 33% (as well)

3. Existing or future application packages which are interfaced or integrated. Please check those applicable. Please detail function and amount of interface. Specify if not existing.

a. Program/design requirements 44%

(1) Functional space requirements 31%
(2) Proximity requirements 29%
(3) Technical design data development 24% } All 24%
(4) Other (specify) _____

b. Preliminary design 67%

(1) Automatic floor plan layout 35% (2) Automatic site layout 29%
(3) Single-double line generation 56%
(4) Other (specify) 13% area reports, adjacency analysis etc.

c. Architectural design 91%

(1) Detail development support 78% (2) 3D Visualization 75%
(3) Other (specify) 16% site planning/design, cost calculation etc.

d. Engineering analysis/design 76%

(1) Structure:

Foundation layout 47% Finite Element Models 36% Detailing 42% } All 15%
Framing 53% Calculation of loads/moments/shears 53%
Member select/sizing 38% Dynamic analysis 25%
Other (specify) 9% reinforced concrete etc.

(2) Mechanical: 71%

(44% future)
Schematic layout 60% Calculation of loads/volumes 38% } All 18%
Equipment select/sizing 30% Duct and pipe sizing 18%
Other (specify) _____

(3) Electrical: 67%

Schematic layout 56% Calculation of loads 22% (47% future)
Equipment select/sizing 22% Conduit sizing 16%
Other (specify) _____

(4) Civil: 58%

Water/sanitary/storm drainage analysis 22%
Earthwork calculations 38%
Water runoff calculations 20%
Pavement design 20% Bridge Design 25%
Other (specify) 11% Building layout, Land use etc.

(5) Additional Information: 16%

Acoustics 7% =3
Other: 11% Shadows, Thermal analysis etc.

e. Life-cycle building model analysis and simulation

13% (1) Simulation of flows of People 4% =2 Material 4% =2 (+7% future)
Other (specify) _____

(2) Energy HVAC: 33%
Loads 27% Simulation 9% Other (specify): ~~Specify loads:~~ 7% (+7% =3 future)

(3) Energy lighting:
20% Loads 11% Simulation 9% Other (specify): ~~Specify loads:~~ 9% (+4% =2 future)
24% Natural Lighting 11% Artificial Lighting 18% (+7% future)

(4) Maintenance: 13%
Loads 7% Simulation 2% Other (specify): ~~Specify loads:~~ ____ (+7% future)

(5) Interference or clash checking 29% (+4% future)

(6) Design result checking against regulations and codes: 24%
Space 11% Proximity 13%
Life safety 2% =1 Security (+4% =2 future)
Structural 11% Electrical 4% Mechanical 7%
Civil 7%
Other (specify) 4% Thermal quality, town planning

f. Cost estimating/pricing 77%

(1) Preliminary 69%
(2) Detailed 56%
(3) Life cycle operations/maintenance costs 18%
(4) Other (specify) 7%

g. Working drawings 89%

(1) Scaling 87% (2) Annotation 82% (3) Automatic Dimensioning 84%
(4) Automatic Schedules 56% (5) Boring Log Schedules 20%
(6) Automatic Details 31%
(7) Other (specify) 4%

h. Quantity take-off 84%

(1) Architectural interior/exterior construction/finishes 58%
(2) Structural members 69%
(3) Mechanical equipment/distribution 51%
(4) Electrical equipment/distribution 51%
(5) Civil earthwork/pavements/utilities 42%
(6) Equipment/furniture 67%
(7) Other (specify) 4%
} All 31%

i. Specifications preparation

38% (1) Word processing library 22% Automatic production of specification from a master specialist 20% (+9% future)
22% (2) Format of sections: CSI 13% SfB 7% Other (specific) 13% {NS3420 user defined
20% (3) Text assembly: Phrase (fragment) based 13% clause based 13%
16% (4) Systematic/indexed references to Standards/Codes of Practice 16%
especially regarding options (grades, methods, etc.) and revisions 7% =3
(5) Other (specify) _____

j. Facilities Management and Space Management 62%

(1) Organizational relationships 38%
(2) Equipment requirements 31%
(3) Actual versus required space areas reporting 33% (+2% =1 future)
(4) Stacking and blocking diagrams of building 36%
(5) Tie to Architectural design 40%
(6) Detail development support 40% 3D Visualization 49%
(7) Other (specify) 7%

k. System utilities 73%

(1) Report of current configuration 53%
(2) Report of changes of system 36%
(3) Aids to integrate user modules:
callable subroutines 44%
file interface 49%
(4) Macro language 51%
(5) CA instruction 16%
(6) Other (specify) _____

l. Creation of personal working environment 87%

(1) Command menus (user definable) 71%
(2) Recording of design work history 60%
(3) Local office data base:
doors/windows 67%
walls/floors/ceilings 60%
structural/members 58%
mechanical/electrical equipment 58%
Other (specify) _____
} All 36%

(4) Project specific library files 67%
(5) Temporary files for saving design calculation results 49%
(6) Other (specify) 9%

m. Multiple user access to project building model 69%

(1) read access 62%
(2) write/update access 64%

n. Tools to compare design solutions

(1) Graphical comparisons 56%
(2) Parameters compared:
construction costs __ vs. energy costs __ 27%
Other (specify) area vs. construction cost
area vs. energy cost
(3) Other (specify) land use vs. standards
construction time cost

o. Project documentation handling

~~78%~~ (1) During design: disk 76% tape 40% Other (specify) 4% All 40%
~~76%~~ (2) Long-term storage: disk ~~58%~~ Tape 64% Microfiche 4%
Paper 30% Other: ___
(3) Other (specify) ___

4. History of System

a. First installation date of workstations: ___

Total number of workstations installed: ___

b. Number of workstations delivered in 1983: ___

c. Acquisition costs in U.S. dollars for four (4) work station systems

(1) Hardware: ___
(2) Software license: ___

d. Maintenance costs in U.S. dollars per month for four (4) work stations systems

(1) Hardware: ___
(2) Software: ___

e. Training Available

Instructor costs/hour in U.S. dollars: ___

f. Countries marketed in

List: _____ _____ _____ _____ _____

5. Target user group marketed or to be marketed to

Q5
a. Small size firms (1-10) 1
b. Medium size firms (10-100) 2 16-17
c. Large firms (100+) 3
d. Governmental/Public agencies 4
e. Other 5

Q5f f. Countries marketed in or to be marketed in: List

Q5f1	Q5f2	Q5f3	Q5f4	Q5f5
18-19	20-21	22-23	24-25	26-27

SK 28

6. If under development, status of development

Q6
a. New Project 1
b. Midway 2 29
c. Near completion 3

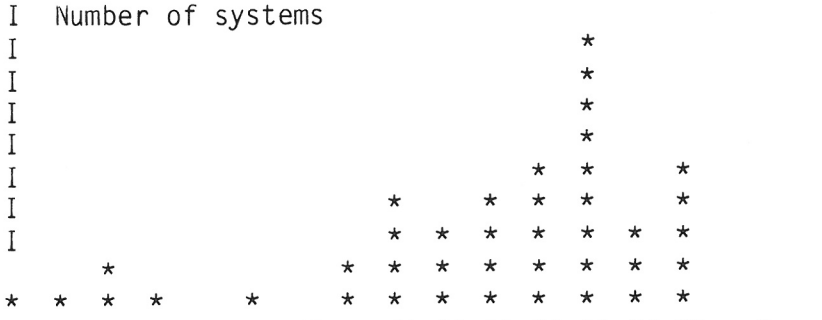
7. If under development, projected development effort remaining

Q7a a. Computer programmers staff years 30-31
Q7b b. Designer staff years 32-33
Q7c c. Expected market availability date 34-35

SK 36-79
80-CD3

4. History of system (from questionnaire)

a. First installation date of workstations: 91%



Total number of workstations installed: 73%

1-2 (WS)	4	(number of systems)
5-10	7	
12-35	6	35 = median
40-80	7	
285-450	2	1568 = mean
2.000-4.000	5	
15.000	1	
20.000	1	51774 = total number of WS

b. Number of workstations delivered in 1983: 58%

1-2 (WS)	8	(number of systems)
3-8	5	8 = median
15-25	4	
50-100	4	130 = mean
250	1	
500	2	
700	1	
1000	1	3378 = total number of WS

c. Acquisition costs in U.S. dollars per month for four (4) work stations.
(1) Hardware: 58%

20.000- 40.000 US$	5	(number of systems)
45.000- 72.000	4	100.000 = median (25.000 US$/WS)
90.000-125.000	8	122.000 = mean (30.000 US$/WS)
170.000-200.000	6	
263.000	1	

(2) Software license: 58%

3.000 US$	1	(number of systems)
8.000 -13.150	5	
18.000-25.000	8	25.200 = median (6.300 US$/WS)
37.500-40.000	2	35.750 = mean (9.000 US$/WS)
48.000-52.600	5	
55.000-65.750	2	
80.000-90.000	2	

d. Maintenance costs in U.S. dollars per month for four (4) work stations.

(1) Hardware: 47%

60 US$	1	(number of systems)
150-170	2	
400-500	4	
630-720	3	
1.000-1.280	5	1.000 = median (250 US$/WS/Month)
1.500-1.975	3	
31.560?	1	

(2) Software: 44%

30 US$	1	(number of systems)
63-100	5	
150-200	4	200 = median (50 US$/WS/month)
250	1	
430-550	4	352 = mean (88 US$/WS/month)
625-750	4	
1.000	1	

e. Training available

Instructor costs/hour in U.S. dollars: 42%

15-20 US$	3	(number of systems)
38-45	4	50 US$/hour = median
50	5	52 US$/hour = mean
60	3	
65	1	
75	2	
125	1	

f. Countries marketed in: 78%

A complete list is not given here (only sample figures)

Worldwide	14	systems
EEC, Europe	6	
Scandinavia	4	
UK	5	
Europe continent (west)	10	
USA	11	
Canada	6	
Australia	2	
South Africa	1	
China	1	
Japan	2	
Singapore	1	
Indonesia	1	
South Korea	1	
Hong Kong	1	

5. Target user group marketed to or to be merketed to:
(a)-(d) 78%

a. Small size firms (1-10) 64%
b. Medium size firms (10-100) 71% (a)-(d) 43%
c. Large firms (100+) 71%
d. Governmental/Public agencies 69%

f. Countries marketed in or to be marketed in: 60%

A complete list is not given here (only sample figures)

Worldwide	10	systems
EEC, Europe	7	
Scandinavia	3	
UK	6	
Europe continent (west)	8	
USA	12	
Canada	6	
Australia	2	
China	2	
Japan	3	
Indonesia	1	
South Korea	1	
Hong Kong	1	
Far East	1	
Malaysia	1	
Asia	1	

6. If under development, status of development

a. New project 0
b. Midway 2 systems
c. Near completion 7 systems

7. If under development, projected development efforts remaining

a. Computer programmers staff years

1 year	3	systems
4	1	
5	1	
6	1	
10	1	
20	2	(9 systems)

b. Design staff years

1 year	2 systems
5	1
6	1
10	2
12	2 (8 systems)

c. Expected market availability date: 10 systems

1985	8 systems
1987	2 systems

4. FUTURE ACTIVITIES.

The final shape and content of a state of the art report on integrated CAD systems should be further discussed within CIB W78.

A first step has been taken to a survey of on-going development projects, a second survey of fundamental research and development efforts is still to be done.

A survey could consist of two main parts

(1) a broad survey pointing out interesting areas, development activity levels and "completeness" of systems. Close contacts with "CICAs" in different countries are most valuable.

(2) deeper studies on areas, see also figure 1, within the sphere of CIB W78 interest. Contacts with organizations like IFIP WG5.2 are most valuable.
Example on such areas:
  (a) experience with integrated design, survey
  (b) design/project model - descriptions, "standards"
  (c) knowledge engineering tools in CAD, demands
  (d) database structures, survey
  (e) data exchange formats, standards
  (f) system structures and learning strategies, long term

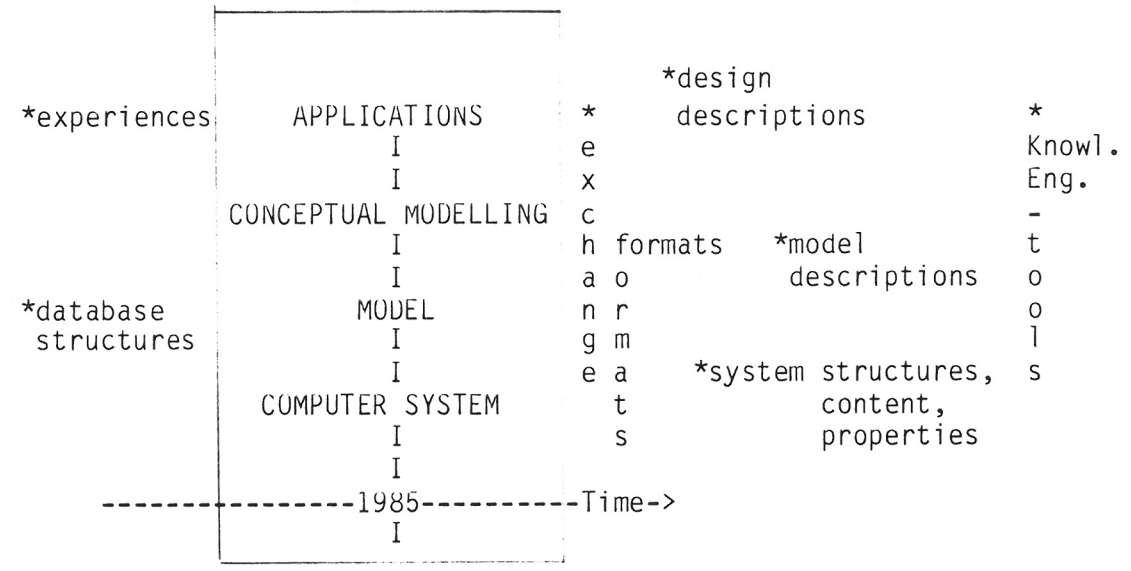


Fig. 1 Conceptual scheme supporting discussions on future activities within CIB W78.
From CIB W78 Terms of Reference: "emphasis is .. on .. computer-based technologies that support all design diciplines and their integration".