IAI AND IFC - STATE-OF-THE-ART
IAI and IFC

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Abstract

This paper presents the current situation in IAI, the International Alliance for Interoperability, and the different versions of IFC, the Industry Foundation Classes. The issues presented in this paper include IFC versions from R1.0 to R3.0, the current IFC implementations and tools, IAI relations to ISO STEP, the current organisational structure of IAI and the possible future activities in IAI.
IAI is an open, worldwide organisation preparing an industry standard for architecture/engineering/construction/facilities management (AEC/FM) software based on product models. The modelling language is EXPRESS and data exchange format is the STEP physical file. .

Keywords: IAI, IFC, product data modelling, data standards, data sharing, AEC/FM, software implementation

1   IFC development chain R1.0 - R1.5 - R1.5.1 - R2.0 - R3.0

1.1   IFC release 1.0

The scope for IFC R1.0 was very limited; it included only five processes for architectural design, two for HVAC design, two for construction management and one for facilities management. Final Release 1.0 was published in January 1997.

The total schedule for IFC R1.0 was 16 months, from September 1995 to January 1997. IAI international "hard" cost was $60K and the estimated member contribution was $1.6M (See 1998).

The main results of IFC 1.0 were experiences for further IFC development as well as a pilot implementation for demonstration (demo software), which presented IFC functionalities. In total 17 companies made IFC R1.0 pilot implementations.

1.2   IFC Release 1.5

The scope of IFC R1.5 incorporated feedback from the implementers, model architecture improvement, plug-in extensions and improved development tools. Final Release 1.5 was published in November 1997.

Twenty-seven software vendors participated in the IAI implementation program in R1.5 development. The total schedule was 10 months, from February 1997 to November 1997. IAI international "hard" cost was $225K and estimated member contribution was $250K. (See 1998)
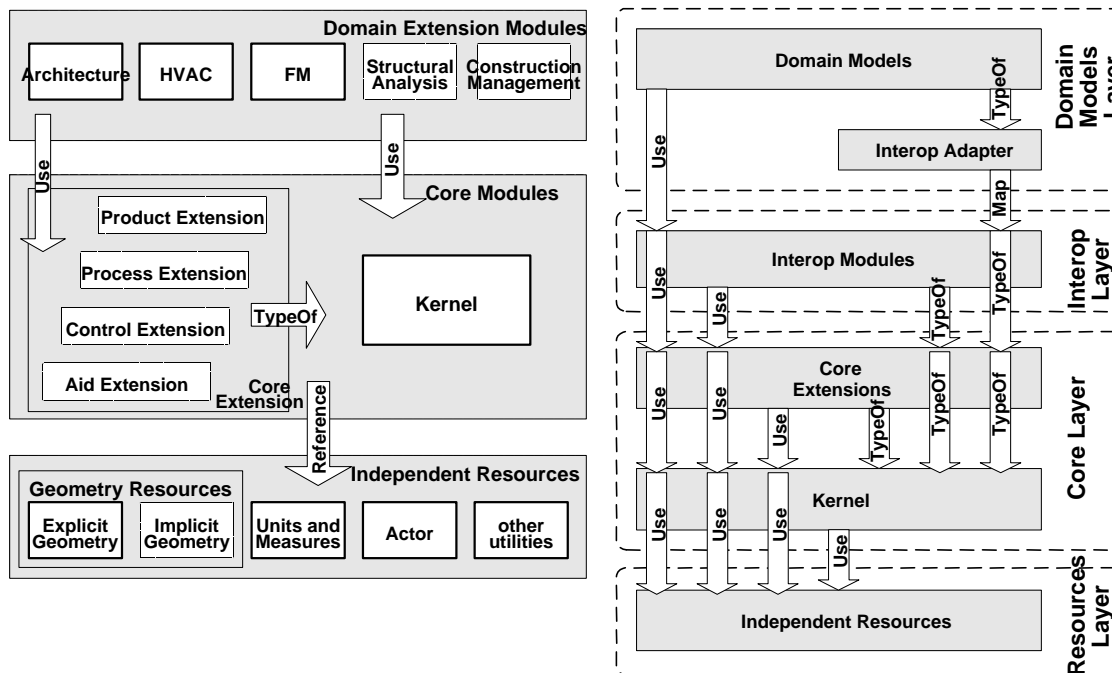

Fig. 1: IFC R1.0 and R1.5 model architecture © Thomas Liebich

The demo implementations of IFC R1.5 showed the need for some corrections in the model and documentation. The improved version IFC R1.5.1 was developed parallel to IFC R2.0 work; the final version of the model was published in September 1998, and the last changes to the implementation guidelines were agreed in November 1998. All early commercial products supporting IFC will be based on version IFC R1.5.1. At the end of 1998 the total number of expected implementations with IFC 1.5.1 support was reported to be 41. (Steinmann 1998).

1.3   IFC Release 2.0

IFC R2.0 is the first truly international IFC version, and its development has been the main activity in IAI since the beginning of 1998 until the end of March 1999. IFC R2.0 will be published in the IAI Summit in Washington April 1999.

The scope of R 2.0 includes architecture extensions, HVAC systems, code checking, cost estimating, occupancy management for facilities management (FM), property management, general-purpose networks and external document references. The schedule was 28 months, from December 1996 to March 1999. IAI international "hard" cost was $385K and the estimated member contribution was $2.5M. (See 1998)

1.4 R3.0 development

Parallel to the IFC R2.0 work, the IAI domain projects have been developing IFC R3.0. The scope has included more architectural elements, power and lighting systems, plumbing, structural systems, construction management, scheduling, temporary construction, more code checking, more facilities management, maintenance, area measuring, system management and referencing libraries on the web.

The current schedule is 30 months, from January 1998 to July 2000. The planned IAI international "hard" cost is $500K and the estimated member contribution is $5.0M (See 1998).*]* The plans are currently under discussion and will most probably change at the Washington Summit in April 1999.

	1997												1998												1999											
	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12
R1.5			Specification																																	
												Implementation																								
		Requirements																																		
R2.0															Specification																					
																								Implementation											
					Proposals									Requirements																					
R3.0																											Specification									

Fig. 2: IFC release schedule

2 IFC implementation and toolboxes

2.1 Implementation presentations of IFC R1.5

In 1998, several software vendors presented their implementations of IFC R1.5 in a series of A/E/C and CAD events around the world. The main events were:

- A/E/C Systems in Chicago, June 1998
- IAI Industry Day in Berlin, June 1998
- Australia Road Show in the InterBuild Trade Show, July 1998
- A/E/C Systems Show in Tokyo, September 1998
- SOLUBAT in Paris, October 1998
- ACS in Frankfurt, November 1998
- Nordic IAI Workshop in Helsinki, November 1998
- UK IAI Workshop in London, December 1998

The following summary of the demonstrations and the participating companies is provided to give an image of the possibilities in IFC 1.5 implementation.

A/E/C Systems in Chicago in June, 1998 demonstrated two processes. The first one was presenting architectural design and energy simulation possibilities in the early design phase by acadGraph, Nemetschek, Autodesk, Olof Granlund and PNNL. The second process presented architectural and HVAC design and cost estimation by Keops, Timberline, Muigg, RoCAD and Graphisoft

The A/E/C Systems Show in Tokyo in September, 1998 included two sequences of presentations from 11 Japanese companies. The first demonstrated architectural design, structural calculations, cost estimation and visualisation by

Graphisoft Japan, NEC Corporation, Japan Research Institute, KANEMATSU Electronics, Sumitomo Cement Computers Systems and Dynaware Corporation. The second presentation included architectural and HVAC design, fire alarm system and visualisation by Kozo Keikaku Engineering, FUJITSU, Informatix, Kyushu Institute of Technology, Chuden Computer.

At the **Frankfurt ACS** in November, 1998, the companies participating in the software demonstrations were acadGraph, Nemetschek, Graphisoft, Autodesk, Sofistik, Olof Granlund, RoCAD and Muigg. The show was also a turning point in IAI because several software vendors - Autodesk, Nemetschek, Graphisoft, Muigg and Olof Granlund - announced their IFC product releases. Alberti and NEC had announced their IFO products earlier. At that time, all available products were based on IFC R1.5 and were meant for test use by end users. The final products will be based on IFC R1.5.1, and the first ones were available in early 1999.

The Nordic IAI-Workshop in Helsinki in November, 1998 presented almost the same international demonstration as the ACS in Frankfurt, as well as, a Finnish project, which is a part of the national Vera programme. The project is called SPADEX (Spatial Data Exchange) and it is lead by Dr. Jarmo Laitinen from YIT. It demonstrated an information chain including architectural design (AIO Group: ARXi), precasted concrete elements (Cadex Software: ConcreteCAD), thermal simulation (Olof Granlund: SMOG), HVAC design (Progman: MagiCAD), production planning including cost estimation (YIT and Design Power Europe: COVE) and IFC model browser and VRML interface (VTT: ProMoTe).

2.2 Toolboxes, SDAI and other interoperability platforms

Several software vendors have already implemented tools to help IFC-compliant software development.

Most of the IFC 1.5 demonstration software has used the toolbox from **Concad (See Appendices 1 and 2)**, which includes library for read and write IFC files.

CSTB has developed a SDAI platform which can be used in two different ways: either as a generic STEP platform which can be loaded with any EXPRESS schema (late binding) or as a dedicated IFC toolbox where the platform is build with the IFC 1.5 schema and supports the associated algorithmic. This software implements the ISO 10303 SDAI (Standard Data Access Interface) and is delivered as an InProc (DLL) ActiveX Automation server; its interface is based on the C++ late binding of ISO 10303-23. It can be used within various programming environments including Visual Basic, Visual J++, and Visual C++, on both the Windows 95 and Windows NT 4.0 platform.

Muigg Computer Applications (See Appendices 1 and 2) has published a tool called Active-IFC, which has Active-X control to retrieve IFC-files. This tool enables easy Visual Basic interface programming to Active-X supported software, like MS Excel.

Nemetschek has developed a late binding data sharing platform (middleware) called o/p/e/n® - *Object-oriented Product model Engineering Network.* It is an open IT platform providing integrated support for the modeling and maintenance of complex products and entire business processes. It is an IT infrastructure for deploying product data in a distributed environment. The data

model can be changed at run-time. The system can easily be adapted or extended to fulfill new requirements. O/p/e/n$^{®}$ provides the technology for integrating different applications that use the same data source. **(See Appendices 1 and 2)**.

VTT has developed a a generic schema and data browser called Promote.. The schema browser generates Java classes and can create reproduced schema as a plain text and also as a HTML file, as well as browsing the content of EXPRESS schema in many views. Data browser enables viewing of STEP product data as an entity hierarchy and as a data content hierarchy-based tree, if it is supported in the schema. The software supports access to distributed models in client/server mode over the Internet. The browser can also create virtual reality models, which can be used as a 3D user interface to product models and related documents over the Internet. **(See Appendices 1 and 2)**.

2.3 Commercial Software with IFC R1.5.1 interface

One of the problem areas in IFC-compliant software development has been the compliance testing. IAI has been working on the issue for some time; but the final requirements and procedures are still unresolved. At the moment it seems that the first tools for compliance testing will be developed for IFC R2 and there will be no testing for the IFC R1.5.1 implementations.

The software vendors are usually not openly advertising their release dates in advance and, because the final implementable version of IFC R1.5.1 was published in late 1998, the final schedule for commercial software releases is difficult to forecast. The following list is therefore only a guess by the author. In 1998, Alberti by acadGraph, NcadArk by NEC and SMOG by Olof Granlund have already published commercial products based on IFC R1.5. Architectural Desktop by Autodesk and Allplan FT by Nemetschek also has IFC R1.5 interfaces available for end users, but they are meant for test use only. Graphisoft has promised that an IFC interface for ArchiCad will be available in summer 1999. At least these six commercial products, maybe more, will most probably be on the market at the A/E/C Systems Show in Los Angeles May 1999; but as indicated earlier, this expectation is based on a personal view of the author, and not facts.

3   Relation to ISO TC184/SC4 STEP

3.1   Liaison status and memorandum of understanding

IAI made a liaison agreement with ISO TC184/SC4 STEP in 1997. The proposal for a Memorandum of Understanding was formed at the IAI International Technical Management (ITM) meeting in Nice January, 1998 and was approved by the STEP Building Construction group in Orlando in February, 1998. IAI International Council approved the documents officially in Copenhagen in April, 1998; whereas ISO TC184/SC4 did the same in the Bad Aibling in June, 1998.

The objectives of the MoU are to strengthen development efforts for building construction within ISO TC184/SC4 through technical input and participation by IAI member companies and to strengthen development of the IFC within the IAI through technical input and use of appropriate within the purview of ISO TC184/SC4.

3.2 Joint meeting in Munich August 1998

At the joint IAI ITM/STEP Building Construction meeting in Munich August, 1998, the following agreements were approved:

- Develop links between IFC and STEP Part 225
- Develop links between IFC and STEP Part 230
- Joint trial interpretation of elements of IFC Core (as STEP Part 106)
- Hold more joint meetings
- Collaborate on the CDS and DXF2 drawing exchange developments
- Review EXPRESS 2 specification
- Investigate the most appropriate approach to standardisation of IFC
- IAI participation in meetings on Technical Architecture in Bad Hennef
- All IAI documents are publicly available except the formal model
- IAI wants to encourage STEP members to review the IFC model. The IAI International Technical Director (See Appendix 1) can be contacted to obtain access to the model

4 Organisational structure of IAI

In 1996 the IAI changed its name from the Industry Alliance for Interoperability to the International Alliance for Interoperability. Currently, IAI has nine regional Chapters with more than 600 member companies from 20 countries. The Chapters are Australasia, French speaking, German speaking, Japan, Korea, Nordic, North America, Singapore and the United Kingdom.

Until the Copenhagen Summit in April, 1998, IAI was on the international level only as a voluntary co-operation of these regional Chapters. In Copenhagen, IAI started a process, which is aiming to form an international legal entity at the April 1999 IAI Washington Summit. In Copenhagen, the organisational Charter was formed in the model shown in **Fig. 3**. In Copenhagen, the Executive Committee included three members and one deputy, at the Paris Summit in October, 1998; it was expanded to the current five members and two deputies.
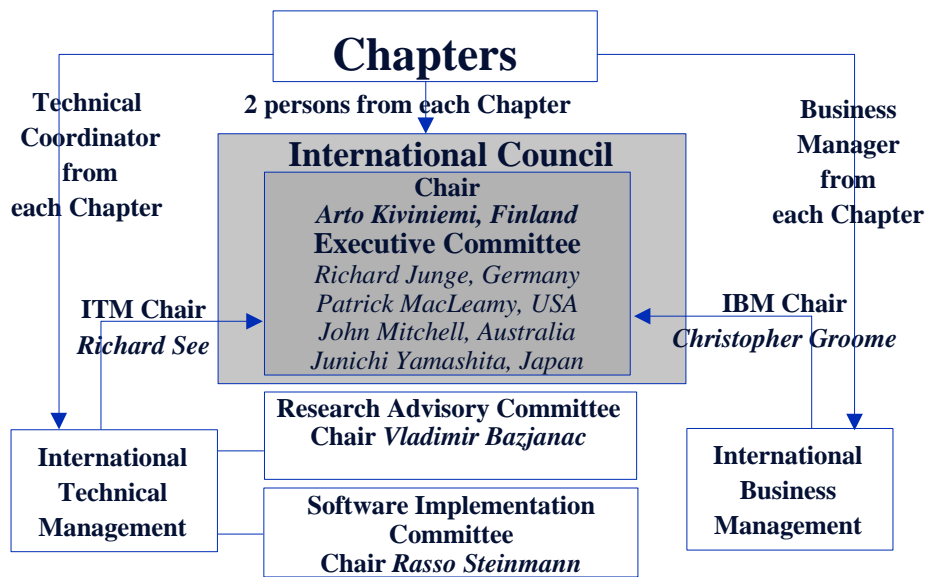
Fig. 3: IAI organisational structure

At the Paris Summit in October, 1998, the structure of technical committees was changed so that all project leaders were included as members in the International Technical Management group, as shown in **Fig. 4**.
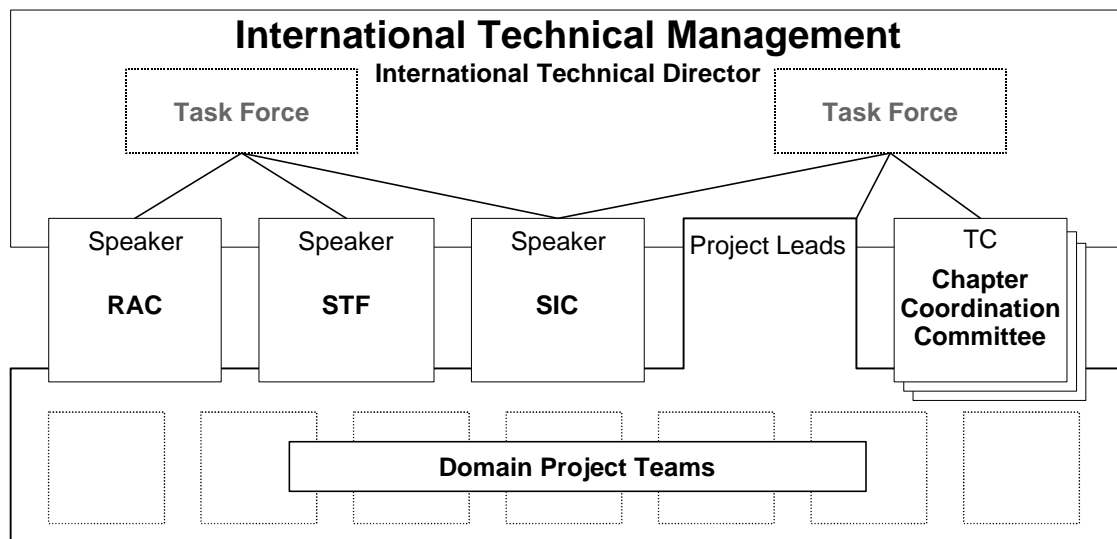

Fig. 4: ITM and other technical committee's © Richard See

5 Future plans after Washington Summit April 1999

The year 1998 has been a period of strong changes in IAI. At the moment (March 1999), the situation is very open and therefore the view presented here is the personal view of the author, and not an official statement by IAI. At the time of presentation of this paper in Vancouver in May, 1999,we all will know which of these alternatives will come true or if the April, 1999 Washington Summit found some new solutions.

The funding problems for the IAI have been increasing because of several reasons. The budget of IAI has always been very limited in relation to the scope of

the venture. The number of members in all Chapters has not increased as the Chapters have hoped. On the contrary, the expectations of new members were maybe set too high in the beginning and now the effect can be seen in some Chapters as frustration, because the software products are not yet on the market. The decision made at the Copenhagen Summit in April, 1998 fixed the delivery of IFC R2.0 to April 1999 and although the Specification Task Force has been able to work on schedule and under budget, a major part of the funding for 1999 will be already used before April 1999. This means that the funding for the rest of 1999 is much too low compared to the scope of IFC R3.0; and IAI must find new ways to fund the future work.

The Paris Summit in October, 1998 introduced a project-based funding model where the international costs based on membership fees would be cut to the obligatory administration and model integration work, or project funding would even cover that part. The main problem in this funding model is that the domain projects for IFC R3.0 have already worked based on the old funding principles. It seems very difficult to find project funding for the existing projects, and it is also impossible to ignore the work, which the domain projects have already done for over a year. In principle, all Chapters agree that in the long run the project funding must be adopted, but the transition period will be a problem.

The project based funding will enable an approach where companies or other organisations can fund the projects, which produce the functionalities they need in their own activities. This kind of funding is always much easier to find than overall funding for general purposes. The danger of course is that there will be no general view of development needs in the model and all projects will concentrate on short-term goals and immediate needs in the funding companies.

At the January, 1999 San Francisco Executive Committee (ExCom) meeting, a so-called "Quick R3.0" plan was introduced. It basically meant that immediately after IFC R2.0 announcement, IAI would start the IFC R3.0 development with a new scope. The schedule aimed to a frozen model by October, 1999, with full documentation by the end of 1999. The goal of this plan is that the first IFC R3.0 products could be published by the time of A/E/C Systems Show 2000. The scope would include core stabilisation, up- and downward compatibility and very few new functionalities. Most R3.0 projects would be sifted to IFC R4.0, where the schedule is still open. The main problems in this model are the implementation support for IFC R2.0 and the possible frustration in the R3.0 domain projects.

To avoid these problems, the author proposed that after the January, 1999 San Francisco meeting that IAI should work with IFC R2.01 after April 1999 and continue with IFC R3.0 for the agreed schedule (July 2000) or, if necessary, lengthen the schedule until October 2000. The scope for IFC R2.01 would include model improvements based on the early implementation of R2.0, up- and downward compatibility and core stabilisation. Some new functionalities with minor impact to the model could be added only if the projects have full funding including the integration work. In this development model, IFC R2.01 products could be on the market by the time of A/E/C Systems Show 2000 and IFC R3.0 products at A/E/C Systems Show 2001.

In any case, all members in the IAI technical teams agree on the need for early commitment and comments from software vendors for model development. Currently the problem has been that the final review and comments come too late.

Usually that happens when the model is already finalised, which means an improved or corrected version of each release.

Other open issues are the organisation, especially for the technical team, procedures for the new project proposals, funding for international work, release schedules and the final form of the constitution. The Washington IAI Summit in April, 1999 will be crucial for the future activities in IAI.

6   Concluding remarks

Despite of the current problems, IAI has been a success in many ways:

- Three major releases and one minor one in 3.5 years
- IFC Release 2.0 will be published on schedule and under budget
- Integrated AEC information model - nearly 300 object classes and over 400 object types
- 16 IFC R3.0 domain project requirements nearly complete with much better requirement specification than in previous releases
- 33 vendors have demonstrated software and evidence that more applications are coming, four software vendors shipping, five more have extension modules available, and three more will ship later this year
- Increasing visibility on many levels: research conferences and papers, press and the most important issue: AEC/FM industry customer awareness

7   References

See, Richard (1998) IAI International Technical Director, Personal Communication.

Steinmann, Rasso (1998-99) IAI Software Implementation Committee Chair, Personal Communication.

Appendix 1: IAI International contacts and IAI related web links

International contact persons:

Council and ExCom Chairman	Arto Kiviniemi	arto.kiviniemi@vtt.fi
Technical Director	Richard See	richard.see@ibm.net
Assistant Technical Director	Jiri Hietanen	
	jiri.hietanen@qpartner.com	
Business Manager	Christopher Groome	brt-
groome@dial.pipex.com		
Research/Advisory Committee	Vladimir Bazjanac	V_Bazjanac@lbl.gov
Software Implement.Committee	Rasso Steinmann	
	rasso.steinmann@ibm.net	

Web links to IAI Chapters:

International IAI site	http://www.interoperability.com/
or	http://iaiweb.lbl.gov/
IAI Australasia Chapter	http://www.interoperability.org.au/
IAI French Chapter	http://mediaconstruct.cstb.fr/actb.html
IAI German Speaking Chapter	http://mtr.opb.de/iai/
IAI Japan Chapter	http://www.interoperability.gr.jp/
IAI Korea Chapter	http://italab.kyunghee.ac.kr/iai_korea/
IAI Nordic Chapter	http://www.vtt.fi/cic/niai/
IAI North American Chapter	http://iaiweb.lbl.gov/Chapters/North_America
IAI Singapore Chapter	http://www.ncb.gov.sg/ncb/construction/iai/
IAI UK Chapter	http://helios.bre.co.uk/iai/

Web links or contacts to software or toolbox vendors:

Autodesk - IFC	http://www.autodesk.com/products/ifc/index.htm
Bentley - IFC	http://www.bentley.com/news/99q1/iai.htm
Concad - toolbox	Bernd Ingenbleek <bernd@concad.de>
CSTB	http://www.cstb.fr/
Graphisoft - IFC	http://www.graphisoft.com/corporate/press/dxf.html
Muigg	http://www.muigg.com/
Nemetschek	http://www.nemetschek.com/
Olof Granlund	http://www.granlund.fi/
RoCAD	http://www.mum.de/produkt/haustec/rocadhaus.htm
Sofistik	http://www.sofistik.de/
Timberline	http://www.timberline.com/
Visio	http://www.visio.com/
VTT - Promote	Tero Hemiö <tero.hemio@vtt.fi>

Appendix 2: Software commitments *[Steinmann 1999]*

It is expected that 41 software vendors will implement IFC Release 1.5.1:

French Speaking Chapter (5):
Batisoft	CAD for architects, announced IFC support
BBS SLAMA	HVAC
CSTB	SDAI toolbox, middleware, IFC 1.5, 1.5.1&2.0 support
KEOPS	CAD
XD2 Allsystem	Cost estimation

German Speaking Chapter (8):
acadGraph	Conceptual design, CAD for architects, IFC 1.5 support
Concad	Toolbox, IFC 1.5 & 1.5.1 support
Graphisoft	CAD for architects, announced IFC support in 1999
MB	CAD for architects
Muigg	CAD for architects, Active X-control, IFC 1.5 support
Nemetschek	CAD for architects, CAD and FEM for structural engineers, structural analysis, FM, IFC 1.5 support, Middleware, IFC 1.5, 1.5.1&2.0 support
RoCAD	HVAC design, IFC support in 1999
SOFiSTiK	CAD and FEM for structural engineers, IFC support in 1999

Japan Chapter (11):
Chuden Computer	HVAC
Fujitsu	CAD for architects
Hitachi	Elevator Setting Design
Informatix	CAD for architects
Japan Res. Inst.	Structural Design
KANEMATSU	CAD for architects
Kozo Keikaku	CAD for architects
Kyushu	Equipment
NEC	CAD for architects, IFC 1.5 support
Sumitomo	Equipment
Yondenko	HVAC

Nordic Chapter (9):
AIO Group Oy	CAD for architects and electrical engineers
Cadex Oy	CAD for concrete design
Jidea Oy	CAD for architects and FM software
Olof Granlund Oy	CAD and building services, IFC 1.5&1.5.1 support
Progman Oy	CAD for HVAC engineering
Tietovalli Oy	Software for HVAC contractors
ToCoMan Oy	Software for the main contractors
Viatek Oy	FM software
VTT	PM browser, JAVA and VRML, IFC 1.5&1.5.1 support

North American Chapter (8):

Autodesk	CAD for architects, CAD platform, IFC 1.5 support
Bentley	CAD for architects, CAD platform, announced IFC 2.0
CIFE	Construction management, scheduling
Marinesoft	Thermal calculation
NAOKI	FM software
PNNL	Energy code compliance checking, IFC 1.5 support
Timberline	Cost estimation
Visio	Drawing and 2D CAD