a history of product models for facilities

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before models

• In the early days of CAD, there were lots of programs.
• Exchanging data between all of these programs was a problem!
• HPGL gave some relief using ‘pen up’, ‘pen down’ commands.
• In 1979, the need for data exchange in defense work initiated efforts on IGES (Initial Graphics Exchange Specification).
• This rapidly became a standard as ANSI Y14.26M.
• The last version (5.3) was published in 1996 but is still widely used in many industries.
• It was recommended in ‘Data Exchange Between Computer Systems for the Construction Industry’ (Jeffrey Wix and Colin McLelland, 1986).
• … but, with the advent of DXF, it never took off in construction.
STEP

- In 1984, work started on STEP which is the STandard for the Exchange of Product model data.
  - In the US, it was originally called PDES or Product Data Exchange Specification.
- STEP used the newly emerging ideas of information modelling and data definition developing from the relational database world.
  - EXPRESS as the data definition language.
  - IDEF1X, then NIAM and now EXPRESS-G for notation.
- In November 1986, at a STEP meeting in London, the AEC working group was formed.
Designations of model type reflect the authors opinion rather than a specific technical development. This diagram is not a timeline.

Jeffrey Wix: July 2008
reference models

- Developed by Wim Gielingh at TNO (Netherlands).
- Key ideas were:
  - separation of functional units (requirements) and their technical solutions,
    - now being implemented through constraint based models such as SMARTcodes;
  - generic, specific and occurrence level requirements and solutions,
    - implemented through library, type and occurrence objects.
- GARM was the originator of many ideas in the IFC and ISO 15926.

- Building Systems Model emerged in 1986.
- Developed by Prof. James Turner at University of Michigan (USA).
- It provided a system oriented description of the world.
- Key ideas were:
  - system taxonomy (separated into active and passive systems);
  - assignment of elements to multiple systems (multifunctionality);
  - arbitrary grouping on elements to systems;
  - port based connectivity.
Aspect models

- Aspect models deal with the totality of one particular subject.
- They emerged around 1989/1990 to add topical requirements to reference models.
- The best known models are COMBINE and CIMsteel.
- COMBINE dealt with energy and HVAC and was led by Fried Augenbroe (TU Delft, now Georgia Tech).
- CIMsteel focussed on structural steel frameworks through design, modelling and fabrication.
- Originally led by Alastair Watson at University of Leeds, CIMsteel is now at version 2 and is widely supported and used in the US through AISC and work at Georgia Tech led by Chuck Eastman.
view models

• View models focussed on supporting the software implementation.
• The most significant developments were the EU funded projects ATLAS and COMBI.
• Development of these models was in the period 1992-1994
• Historically, these are significant.

• More recently, the aecXML activity attempted to accelerate product model development.
• Two activities have become established from this initiative:
  – gbXML dealing with energy,
  – landXML dealing with road construction geometry.
• Both of these conform to the view model idea.
application protocols

• In 1993, at an ISO STEP meeting in Berlin, plans were made for several application protocols for construction.
• The aim was to have an HVAC protocol based on an extension of the COMBINE work (ISO 10303:228) and a structural steel protocol based on CIMsteel (ISO 10303:230).
• Lack of funding killed these efforts.
• However, a German initiative led by Wolfgang Haas on ‘building elements using explicit shape representation’ did proceed. This became ISO 10303:225.
• Later work through the FunSTEP project on furniture led in Portugal/Spain by Ricardo Goncalves is driving ISO 10303:236.
core models

- In 1993, model development focus moved back to ISO where the idea of Core Models was emerging.
- This drew on ideas by Gielingh and Tolman reinforced by the development of ‘high quality data modelling’ at Shell by Matthew West.
- The Epistle Core Model and the Building Construction Core Model (BCCM) built on this.
- BCCM was also able to build on the implementation success of the ATLAS project and merged ideas from COMBI.
- BCCM was developed as a resource part in STEP which became a problem as it could only be instantiated through application protocols (for which funding was an issue)
In 1994, Autodesk brought together 8 developers from around the world to test their new ARX development for an intensive 2 weeks (with some success).

12 companies then came together to further test interoperability ideas around AutoCAD Release 13.

In 1995 they demonstrated success and opened out to industry as a whole. This was the International Alliance for Interoperability (IAI), now called buildingSMART.

At the heart of IAI was the IFC product data model.
The vision of an integrated framework emerged at a meeting in Vancouver in 1999.

It looked at areas of ICT development and how they connected.

A conclusion was that terms and their meanings must be standardized through a dictionary.

Provided the ‘kick-off’ for what is now the IFD initiative.
In June 1999, the need for a dictionary of user defined properties in multiple languages was defined.

Translation would be via a globally unique identified concept rather than just a word translation.

This became ISO 12006:3 in 2007.

It is better known as IFD, International Framework for Dictionaries.

IFD is being further developed by a consortium comprising Norway, Netherlands, USA, Canada.

Provision for its use is in the IFC 2x4 model release.

IFD is now being tested as a means to map between classification systems; something not previously achieved.
object name services

ISO 12006-3 Dictionary
/Ontology

Heating
- Low Pressure Hot Water
- High Pressure Hot Water
- Radiant panel

Electrical
- DC
- Extra low voltage AC
- Low voltage AC

Residential
- Commercial
- Industrial

Design
- Space layout
- Structural frame
- Ducted systems

Simulate
- Thermal performance
- Structural response
- Evacuation procedures
No-one implements the whole of the IFC model, except model server and viewer providers.

Views provide a focus for software implementation.

Principally, this is the coordination view at present.

Now expanding to QTO, FM, HVAC and Structural.

In 2003, Jiri Hietanen from Finland developed a more diagrammatic approach to model view development (MVD).

Approved by buildingSMART as the ‘official’ method.

Views provide the basis for certification which tests support by software for required entities, attributes, property sets.

It does not test that the data shared is valid.
In 2005, the ‘Information Delivery Manual (IDM) was developed by Jeffrey Wix, Bjorn Stangeland and Lars Christensen.

- It’s aim is to support users in the construction process.
- It specifies exchange requirements and business rules.
- This allows for model use to be extended:
  - allows acceptable data values to be specified;
  - information shared can be configured to local or project needs without having to vary the model;
  - supports the use of models in the construction process;
  - enables shared building information to be validated.

- IDM is currently being developed as ISO 29481:1 and is harmonized with buildingSMART view development.
‘other’ key ideas

• The technology used for the ICC SMARTcodes project is also being adapted to provide validation of data exchange.
• It can also be extended to become a SMARTdocuments knowledge capture capability.
• IFC will need to work in conjunction with other data exchange specifications including:
  – GML/CityGML/KML (geographic information and city maps);
  – landXML (roads);
  – TransML (transportation systems generally);
  – gbXML (energy);
  – ISO 15926 (process plant).
• IDM will extend to define workflow provisions using a process execution standard such as BPEL.
what next?

• IFC is a result of continuous development that started 20+ years ago.
• What can we expect in the next few years?
  – Model stability;
    • the policy of maintaining the 2x model series will continue for several years since buildingSMART is committed to a full ISO release of IFC in 2010.
  – Extension of the ‘ontology’ support from IFD;
    • this will include much more terminology and more language support
  – Growth in view and exchange requirement provision.
  – Introduction of data validation methods to quality assure exchanges.
  – Development of object libraries that will allow information delivery via the web.
  – Executable process workflows.
  – Enhanced implementations through services oriented provisions.
  – ….. and more