A UK SURVEY OF INTEGRATED PROJECT DATABASES

Robert Amor, Building Research Establishment Ltd, UK

ABSTRACT

The UK network of experts in objects and integration for construction has now been in existence for a year. In this time it has built up to over a hundred members drawn in almost equal parts from industry and research. The initial meetings of this network have strived to identify areas of concern in the domain as well as to provide feedback to the supporting government agency in terms of policy issues, and to inform its members of the range of issues in the domain.

The first published output of this network is to be a survey of integrated project databases (IPDB). The initial survey work, analysed and described in this paper, looks at IPDB development and use in the UK. Preliminary work of the network determined a set of criteria to be used to measure the development and impact of various IPDB. These criteria were then used to survey a range of EC supported, UK developed, and commercial implementations of IPDB. Though not comprehensive in terms of the total number of IPDB developments in the world, it gives an initial benchmarking of the state of this domain.

The results of this survey, and the ongoing surveys of IPDB developments, are being used to inform the network and government of the state of play in this area. It provides a point to determine: what work has previously been done; which data models might be re-used; where tools reside that could be re-used; where commercial developments have taken place which implement portions of the surveyed projects; what the problems of commercialisation have been; where there are gaps in research; and what life-cycle stages are poorly addressed by IPDB development.

Keywords, integrated project database, survey, national network

1. UK NETWORK OF EXPERTS IN OBJECTS AND INTEGRATION

The creation of a network of experts in ‘Objects and Integration’ was mooted in the ‘Construct IT Implementation Plan’, published by the UK Department of the Environment, Transport, and Regions (DETR, but back then just the DOE - see DOE 1996). This implementation plan proposed three networks, one in objects and integration, one in knowledge based systems, and one in process. The first two have been created and are now running, see http://www.bre.co.uk/oonet/ and http://helios.bre.co.uk/kbs/ respectively.

Why the Network?

What was the reason behind setting up a network facilitator in the object and integration field? It is known that a key aspect of much that happens in construction is the result of interactions between informal networks of individuals. People always seem to meet the same faces at the same events, and people often find out what is happening in our field through talking to others they know who are working in the same area.

DETR's reasons for setting up the network domain specialist is to attempt to leverage the activities of these networks, all of which are intended to focus on the key technologies most likely to drive change in the construction industry. In this way, DETR hopes to use its influence to help individuals and organisations get more out of their efforts in this specific technology area. Further, through facilitating communications within and outside the network, it is hoped to raise the level of awareness and understanding of current and future developments, not only between individuals in the network but also within DETR and other key industry communities. This, it is hoped, will help the DETR improve the effectiveness and focus of its own programme, and also provide opportunities for those in the network to influence other members of the construction community.

What is the network

The network is intended to comprise an informal grouping of experts and committees working in the area of objects and integration. The network brings together both academic and commercial interests and is facilitated by the BRE. The facilitator's role is to act as a focal point of the network and to work to promote and support the network through the collation and sharing of information and opportunities. The facilitator also undertakes work, steered by the network members, so as to develop viewpoints on how the technologies are developing within the domain in order to influence DETR strategy and input to the wider DETR research programme. Membership of the network is open to anyone with an interest in the area.

Scope

The network title of 'Objects and Integration' is very general, and a fuller definition of the areas to be covered by this network has been detailed. The network covers the areas specified below:

- Object Oriented Models
- Object Oriented Databases
- Object Libraries and Intelligent Object Libraries
- Object Oriented Systems
- Integrated Project Databases
- Integrated Building Design Systems

Expected structure

As previously stated, the network is not a formal organisation and so tries to limit stand-alone meetings of the network as a whole. Instead, meetings piggy-backed on those of other organisations and projects are used to access subsets of the network. The majority of the communications of the network are undertaken through electronic (or paper) means in terms of a WWW site (http://www.bre.co.uk/oonet/) containing all communications and reports as well as discussion space. The network facilitator attends various organisation meetings to explain the network, as well as to obtain feedback and expert advice on issues and strategy for the DETR. The network facilitator also visits relevant DETR funded project meetings, major commercial institutes working in the area, institutes with relevant programmes, and individuals with relevant expertise.

Benefits of the network

The benefits that can be gained from the network fall into four main areas. These are described below:

Publicity

Participants in the network are provided with extra publicity for the projects they are working on and developing. DETR is currently preparing to raise the level of communications on its programme through a variety of means. Network members will be able to take advantage of this, thereby raising the profile of their project's aims, its participants, and the tools and models being developed. The network will also help to publicise intended projects, where requested, to enable contacts to be made with potential collaborators (e.g., industry partners) and thereby widen the network further. Publicity also comes through inclusion in DETR sponsored publications and newsletters, the network web site, and presentations at seminars and other meetings.

Knowledge sharing and access

Participants in the network have access to a large range of information about this domain and its trajectory. Part of this knowledge will encompass DETR policy and the reasoning and imperatives behind policy. This should be of use in the development of UK based funding proposals. The network will aim to make all participants aware of what exists in the domain already and how to get to it. To help achieve this aim the network will provide a permanent repository of valuable information from completed projects.

Service help-desk

As the network grows and draws in more members the breadth of information it will contain will be very comprehensive for this domain. It is envisaged that the co-ordinator of the domain network will provide information services to those accessing the network. This will include help in locating information about projects, including models developed in projects and their scope; whether models have ever been developed for specific areas; the tools used or developed in the course of a project; and organisations interested in projects in particular areas. The co-ordinator will be able to provide information on current DETR strategy in the domain, how that interacts with other domains (e.g., KBS) and further contacts for more information.

Communications

The network will enhance communications in this domain. It will open up a line of communication between DETR and members of the network. This will allow an independent promotion of the network's ideas to DETR and into their strategy, as well as providing an industry voice to comment on existing strategy. The network will seek to develop consensus views, where appropriate, and ensure that major issues are fully understood by DETR and the industry. To help promote the regard DETR holds for their networks they publicise the domain networks and their workings.

Objectives

To summarise, the objectives of the domain specialist and network are as follows:

- To tap into, leverage and further focus the current networks that exist to help facilitate change

- Through the domain specialist and his interaction with the network, provide an expert, independent view of technology developments in the area to DETR and commentary on DETR projects.
- To provide a two way communication channel for DETR strategy in the technology area
- To provide expertise that DETR can draw on for strategic planning and other activities
- To provide a group that can communicate and work with other groups and bodies as part of the DETR programme
- To provide guidance to ensure that the right projects are undertaken in the domain within the DETR programme

First Steps

The network was initiated in 1997 and has held four meetings of its members. The membership has grown to about one hundred over the year, with a fairly even split between industry and research. A WWW site has been established and a range of projects, tools, and papers have been input into its database. A clear message from DETR and the members was the benefit of having a comprehensive understanding of IPDB projects that have been undertaken. This survey and its analysis will become the first major output of the network.

2. THE SURVEY FOR INTEGRATED PROJECT DATABASES

The survey form is split into four sections to gain differing perspectives upon IPDB projects. Following a general name and description request there are sections for IPDB scope, the IPDB's availability and usability, the IPDB's development background, and its technical details. The information obtained in each of these four sections is further described below.

Scope

The scope section gathers information about the area of impact of the IPDB. It looks at which life-cycles are covered, the domains that are tackled, and what type of organisation the IPDB would be usable in. It asks about the amount of BPR required to implement in an organisation, what business processes the IPDB links to, and the types of concurrency that are engendered by the IPDB. The scope asks about process management supported by the IPDB, and its links with best practice and standards. The scope also tries to find out about business benefits which are claimed for the IPDB.

Availability and Usability

The availability and usability section gathers information on the status of the IPDB and the effort required to take it forward for different circumstances. To this extent it captures the development status and its availability, or time to availability. It tries to find out how long it would take to install the system in a practice, and the expertise that would be required to do this. Where the system would have to be extended for use at a particular institution it gathers information on the time required to add a new CAD system, design tool, or to extend to a new domain, or to extend to a new life-cycle. It also asks for the level of expertise required to make these extensions. Some IPDB systems include configuration management software which eases this task, and this is recorded. The survey also asks if it is possible to have a gradual introduction into a business's practice. Where the system is being used on other projects, information is gathered on contacts for these projects. Many research based IPDB projects are used for teaching purposes and details of these courses are gathered to understand what level of graduate is going to have an understanding of IPDB systems.

Development background

The development background section gathers information on who was involved with the IPDB project, and details about how it was run. To this extent, information on the lead partner and other project participants, and their interests, is captured. The survey gathers information on how long the project ran for and the effort spent on it. The funding body and project number are identified to tie back to the databases of those funding bodies. The survey asks whether the IPDB was developed for a specific project, gathers details of that project, and benefits claimed or measured for the use of the system on the project. Details of the demonstration of the IPDB are collected, along with any testing sites following the end of the project. Where a system was not taken forward after development the survey allows a description of the reasons for this. The location of information on the project is recorded (web site), and the list of reports and papers produced as part of the project is collated. The network plans to operate a library, collecting together all public outputs of IPDB projects so that this information is not lost when projects terminate and their teams disperse.

Technical details

The technical details section gathers information on the actual structure of the IPDB and the various components which exist in the IPDB framework. To this extent it asks about all the tools which are tied into the IPDB, and the method in which they are integrated. It gathers information on the hardware and software requirements of the IPDB and sources for specialist components. It surveys the underlying data model, and provides summary data (an inheritance tree) of the model where available. The survey asks whether product libraries of any form are connected, and if standards are incorporated into the framework in any form. It asks about the framework of the IPDB, its distribution strategy, and any data mapping strategy incorporated. Where project management tools are incorporated it gathers information on their use, and also looks for details of any adaptation software developed to help integrate tools into the system.

3. SURVEYED IPDBS

Surveys of IPDBs have been initiated, six major research projects have been studied, and several industrial projects have been identified and about to be reviewed. These surveys of projects will continue for at least the next two years, endeavouring to cover all major projects that have taken place with UK participants, both research and industry based. The full details of the project surveys are on the network web site (and papers on these projects have been published at previous CIB W78 workshops). For brevity, only the general description of each project is included below (a full survey runs from five to ten pages in length).

COMBINE - COmputer Models for the Building Industry in Europe

COMBINE (http://erg.ucd.ie/combine.html and Augenbroe 1994) was a major EC funded research project within the JOULE programme of the European Commission's Directorate General XII for Science, Research and Development. COMBINE ran from 1990 until June 1995 and encompassed 70 person years effort, with 11 partners from seven countries. Its objective was the development of future intelligent integrated building design systems (IIBDS) through which the energy, services and other performance characteristics of a planned building can be analysed. This was accomplished through the use of standardised IT solutions for data integration emerging from the ISO-STEP standardisation effort. The research concentrated on establishing a data infrastructure and tools for managing the information exchange in a building design team, with emphasis on the energy and HVAC consultant. This enables better and more efficient building designs, especially from the viewpoints of energy conservation, building quality and heating and ventilation.

COMMIT - COnstruction Modelling and Methodologies for Intelligent information inTegration

COMMIT (http://www.salford.ac.uk/iti/projects/commit/ and Brown et al. 1996) was a three year UK-EPSRC funded project running from April 1995 until March 1998. Projects in the construction industry are increasingly characterised by large numbers of actors working concurrently at different locations and using heterogeneous technologies. In order to support this kind of collaboration, project information needs to be conceptually modelled throughout its life-cycle, along with the events that impact upon it by causing state changes. The COMMIT project aimed to address these issues by building on the work of previous projects, such as ICON, which proposed model-based solutions to the problems of computer integrated construction. The COMMIT Information Management Model (CIMM) was proposed which addresses many of the problems surrounding this kind of collaborative work, such as versioning, notification, object rights and ownership. The model also facilitates the recording of the intent behind construction project decisions, thereby providing a complete project history. The project is ongoing; the CIMM is being currently being developed and refined and software prototypes demonstrating its use have been produced. The CIMM and CIMM prototype are intended to be generic in that they can, in principle, work with a range of object-oriented computer integrated construction environments.

ICON - Information/Integration for Construction

ICON (Aouad et al. 1994) was a two year research project (February 1992 until June 1994) sponsored by the UK-EPSRC and undertaken at the University of Salford in the UK. Its primary aim was to assess the feasibility of establishing integrated databases for the construction industry. The project was developed by a group of researchers from IT and construction backgrounds (nine researchers), assisted and guided by a steering group of industrialists and representatives of the major professional institutions in the UK (RIBA, RICS, CIOB) and representatives of building standards (NBS). This wide spectrum of expertise gave ICON a strong credibility by involving academia and industry in establishing a framework together. However the scope of this project was limited to the functions of design, procurement and management of construction. These areas fitted properly within a context model defined by ICON which established the framework for an integrated database.

OSCON - Open Systems for CONstruction

OSCON (http://www.surveying.salford.ac.uk/aic/oscon.htm and Aouad et al. 1997) was a two year research project running from May 1995 until May 1997. It was sponsored by the Department of the Environment (DOE) Partner in Technology (PiT) programme and undertaken at the University of Salford in the United Kingdom. Its primary aim was to use case studies from real-life construction projects to demonstrate the usefulness of integrating project information in a central project database. The OSCON project built upon the recent experience of the Salford team in developing a framework for integration of information in their ICON project.

SPACE - Simultaneous Prototyping for An integrated Construction Environment

SPACE (http://www.surveying.salford.ac.uk/aic/space.htm and Alshawi 1996) was a 30 person year project developed under the UK-EPSRC funding regime. The AIC group has taken theoretical work into the implementation phase where a significant contribution was made to the management of information and their flow within the integrated environments. This includes a modularised approach to the concept of the integrated databases and the a structured approach to objects' life cycle. The work led to the development of a leading edge prototype environment for an Integrated Construction Environment (ICE). It is expected that this prototype will be a test bed for future development in this field. The ICE transfers project information dynamically, at run time, to and from individual construction application packages. This facilitates an automatic generation of VR models, specifications, construction plans, cost estimates, site layout planning directly from CAD drawings.

ToCEE - Towards a Concurrent Engineering Environment in the Building and Engineering Structures Industry

ToCEE (http://wwwcib.bau.tu-dresden.de/tocee/ and Turk et al. 1997) is an EC-ESPRIT (Ep 20587) funded project, running from 1996 until December 1998. The goal of ToCEE is the development of systems of information exchange in support of a concurrent engineering environment. The output will be of benefit to the whole of the European construction industry, its largest industrial sector, improving quality and reducing lead time and hence costs by an estimated 20%. Immediate exploitation of the results is ensured as the industrial partners are leaders within their own countries' construction industry.

For Concurrent Engineering innovative techniques to co-ordinate and manage information, resources and documents need to be developed to integrate successfully and reduce lead times, increase quality and keep within budget constraints. The ToCEE project addresses the following key issues that are essential for a successful concurrent engineering approach: distributed product and document modelling including intra- and inter-model operability; conflict management; information logistics; version management; legal issues related to electronic documentation; monitoring and forecasting; and cost control. Its application fields are: design process; construction process; and facility management.

An overall framework for a concurrent engineering environment will be developed along with the initial development of supporting and enabling tools, compatible with existing software already marketed by members of the consortium. Prototype tools addressing longer term developments will also be developed. The twin approach of short term application and longer term development is fundamental to the project. Emphasis will be placed on the application of Artificial Intelligence (AI), such as decision support, knowledge based and machine learning methods and multi-agent and distributed database systems.

4. PRELIMINARY FINDINGS

The initial analysis of these IPDB projects, and knowledge of the commercial systems which are to be surveyed, gives rise to several initial conclusions about the development of IPDB systems in the UK. The major ones are as follows.

The IPDB frameworks developed in a range of projects have almost identical conceptual components, though the implementation of these components varies between projects. This is a good sign for IPDB development as it shows that the ideas on IPDB systems are moving to a common understanding throughout the industry. However, having said this, the systems being developed, especially in industrial projects, are driven very strongly by the tools and domains involved. This creates a very tightly coupled system which works well for the designated problem, but is not as easily extensible as a more open framework.

Though many domains and life-cycles are claimed to be covered, or where the IPDB is not tied to a particular data model, the range of models developed are not sufficient for a cradle-to-grave goal of an IPDB. This is, in some extent, due to the pragmatic development approach of many projects, where the data modelled needs only be sufficient for the design tools utilised. It is also due to the enormous scale of the problem of defining data models for the whole construction industry. It is clear that a versatile cradle-to-grave IPDB will not appear in the near future.

The ability to reuse whole or partial data models is often assumed following a project, but appears unobtainable in reality. A data model developed for one IPDB will not cover all the areas required by another IPDB. In some cases this only imposes a requirement for further domains and life-cycles to be added. In general it requires a reworking of the previously developed model to provide the attributes and relationships required in the new model. It appears that most groups would rather develop models from scratch than take on a previously developed model and understand all its assumptions and requirements.

This is also an issue where small parts of a model may be required, for example if a new IPDB development wants a door model. Because of the hierarchical (inheritance based) development of models, and the defined relationships between entities, it is not easy (or sometimes even possible) to extract a single component of a model and reuse it in a new model. To a large extent an old model provides only a checklist of factors to be considered in a new model. A partial solution to this problem can be seen in the development of industry wide core models. In particular, the IAI's IFC version 1.5 (IAI 1997), which is being utilised in many projects, would provide some commonality to the range of developed models. However, even this won't solve the whole problem of reuse of partial models.

The interface between design tools and the IPDB provides a further source of problems. As there are no standard models for the industry, there are no standard interfaces for these design tools. This leads to a situation where to utilise a design tool in an IPDB requires either a wrapper around the design tool, or, as is often seen in CAD tools, a layered interface imposed in the design tool. This approach ties the design tool very closely to the particular IPDB it is being integrated with. The reasons for this are as follows. The interface to the design tool incorporates a range of assumptions about how the design tool will be operated and the type of model that will be passed through to it. This usually means that only a limited subset of a design tools capabilities, including building types it can work with, are accessible to the IPDB. The mapping between the design tool's data structure and the IPDB data structure is usually hand coded into the design tool interface. This will make it more difficult to adapt a design tool interface to a new IPDB model than if a formal mapping language is used to define the differences between the two data models. Again, the development of standard models in this domain will alleviate many of these problems. However, it is unlikely that any one data model will cover all aspects of a design tool's use and hence an interface will be needed to map between the full IPDB data model and the subset data models that will be seen in each design tool.

5. CONCLUSIONS

A network of experts in the area of objects and integration has been established in the UK and has been operating for over a year. In this time it has built up a membership of around one hundred participants, drawn equally from industry and academia. The first major task tackled by this network has been to survey the IPDB systems that UK members have been involved with. This ongoing survey will attempt to establish what work has been done in the UK, and provide a basis for the more effective development of new IPDB systems by making available a greater amount of information on what has been done before. The initial survey of IPDB projects has, as well as highlighting the varied and enormous amount of work performed in the UK, shown a set of problems that affect the further development of IPDB systems. The main resolution of these problems appears to be the development of more standard data models for the various domains in the construction industry, as well as the use of more structured and standardised approaches to the development of IPDB interfaces (e.g., formal mapping languages).

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