

BIM & BUILDING SIMULATION

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ABSTRACT

Over the last three years the understanding, adoption and use of BIM has gained international momentum. Industry and Governments are starting to develop policy and resources needed to make this technology & process change be more effective.

This year buildingSMART Australasia held conferences in Brisbane, Sydney and Melbourne responding to a Industry Innovation Council managed BIM Economic Study which shows that the adoption of this innovative digital technology can bring substantial benefits to the construction sector.

MESH 2011 focussed on this challenge: if digital technology is so good as predicted how are we as the Built Environment sector going to make sure we ensure a national, whole of industry benefit?

What are the blockages that we need to solve and other necessary actions to realise the improvements in sustainability, productivity, quality etc?

In parallel, research groups - such as CIB, leading practitioners and Governments are envisaging new ways of simulating and measuring building performance based on multi-disciplinary building models, integrated with GIS based land and infrastructure data.

buildingSMART Australasia is negotiating with the Commonwealth Government agency DIISR to develop a formal plan for the implementation of a National Initiative and support for the resources required to deliver this paradigm change successfully.

A key priority area for the National Initiative is the development of BIM compatible Building Product Libraries that are needed to move from models that have good geometry to models that also have consistent properties about material, performance and configuration supporting the whole facility lifecycle.

A further complexity is the need to put in place global solutions, since business is already global, products are manufactured globally and we consequently need common standards.

Some of these initiatives are in progress already while others will need to be established or encouraged. There has been overwhelming support from Australian Industry with over 70 persons across

the country offering personal and organisational resources.

Most projects today using BIM are exploiting the advantages of clash detection, which underpins lower risks to contractors and clients. But what about design optimisation, enhanced energy and sustainability performance and product quality?

This paper will elaborate the challenges to the industry in its increasing adoption of BIM and references the general simulation of building performance as examples.

Keywords: building information modelling, buildingSMART, IFC, IFD, BEIIC, BIM Guidelines, Simulation, Sustainability, Energy performance

CONTEXT

In March/April this year buildingSMART held conferences MESH 2011 - in Brisbane, Sydney and Melbourne responding to the Built Environment Industry Innovation Council (BEIIC) BIM Economic Study which shows that the adoption of this innovative digital technology can bring substantial benefits to the construction sector (Allan Consulting Group 2010).

MESH 2011 focussed on this challenge: if digital technology is so good as predicted how are we as the Built Environment sector going to make sure we ensure a national, whole of industry benefit?

Chuck Eastman (2006) in a paper New Opportunities for IT Research in Construction identified the opportunity that BIM and related activities would bring:

“3D parametric modelling and rich attribute handling are making increasing inroads into standard construction practice, worldwide. This fundamental change of building representation from one that relies on human readability to a machine readable building representation, opens broad new opportunities for enhancing design and construction in ways that have been dreamed about over the last two decades. The new technology and its facilitated processes are called Building Information Modelling, or BIM. BIM design tools provide a few direct and obvious benefits. these are based on a single integrated representation from which all drawings and reports are guaranteed to be consistent, and the easy catching of spatial conflicts and other forms of geometrical errors.

Even the first step of realising these basic BIM capabilities requires new practices regarding design development and coordination between design teams". (this writer's italics)

What are the blockages that we need to solve and other necessary actions to realise the improvements in sustainability, productivity, quality etc?

buildingSMART believes that the widespread adoption of BIM will lead to a genuine process of substantive innovation for the construction sector. It will make Australia internationally competitive, keep us at the forefront of nations now adopting BIM and support Australia's challenge to be sustainable and energy efficient.

The BEIC report highlights a range of issues that constrain adoption or prevent the maximum potentials being realised. As an industry, we must turn those impediments into key priorities for concerted action. Everyone has a role to play in this, and it is only as each one plays their part that we will realise those national benefits.

THE NATIONAL BIM INITIATIVE

buildingSMART Australasia is negotiating with DIISR to develop a formal plan for the implementation of a National Initiative and the resources required to deliver it successfully and expects to complete this for the beginning of 2012.

The six priority areas established for the National Initiative are

- Product Information and BIM Libraries
- Adoption of Common BIM Guidelines & Information Exchange
- Compliance and Certification
- Procurement, Legal Issues & Insurance
- Business Process Change
- Multi-disciplinary BIM education

We recommend the establishment of a National Technology Implementation Program with the objective to implement building information model technology and information networks in the construction processes and to make it possible to manage information flows during the entire life cycle of buildings. This program, if adopted, would set Australia as a leading player in the global construction sector.

The priorities are:

Priority 1: Product Information & BIM Libraries

This ensures that all the components that make up a building are properly specified, fit for purpose and correctly integrated in to the fabric of the building.

The responsibility for action here lies with product manufacturers, suppliers, Natspec, industry bodies and software vendors. The challenge is to establish agreed object library formats and appropriate methods for integrating those in to the array of BIM software tools employed by all sectors of the industry across the full building life cycle.

Priority 2: Adoption of Common BIM Guidelines

While some excellent model building guidelines have been developed (see CRC-CI 2009 <http://buildingsmart.org.au/home-page/digital-modelling-guidelines-review>), there is a need for further work to document best industry practice in each client portfolio as a basis for effective collaborative working.

This requires concerted action by government client agencies, as well as primary industry and professional standards organisations, private owners and property developers. This could involve a review of our approach to briefing, development of BIM-based design standards, a rethink of asset management protocols and the adoption of comprehensive naming and classification conventions.

The Australian [National BIM Guide](#), developed by NATSPEC is a reference document to be read in conjunction with a Project BIM Brief which outlines the particular requirements for each project.

Adapted by permission from the US Veteran Affairs BIM Guide, the National BIM Guide is to assist clients and consultants to clarify their BIM requirements in a nationally consistent manner. This will reduce confusion and duplication of effort.

Priority 3: Compliance and Certification

BIM provides superior ways to measure, simulate and analyse performance, with its integrated data of building & service system elements, GIS context and definition of human and related activities.

To underpin sophisticated analysis and performance measurement, we need to understand the urban context of building development, in this example for urban planning of new precincts etc. In Figure 1 above the prototype urban model incorporates precise cadastral data with its coordinate reference systems etc and other land data - e.g. the NSW LPMA cadastral data sets. The addition of zoning, planning, earthquake zone etc adds to the integrated data.

As a demonstration of these new capabilities, the NSW BASIX assessment system was implemented in part in an IFC compliant building model server. The example shows determination of Construction wall types. The code checking script has accessed each wall element in the building, and then tabulated the wall type name, the layerset name, length, etc from the model data. Such systems provide 24x7 availability, promote greater efficiency and rely on the calculation of performance data rather than manual interpretation.

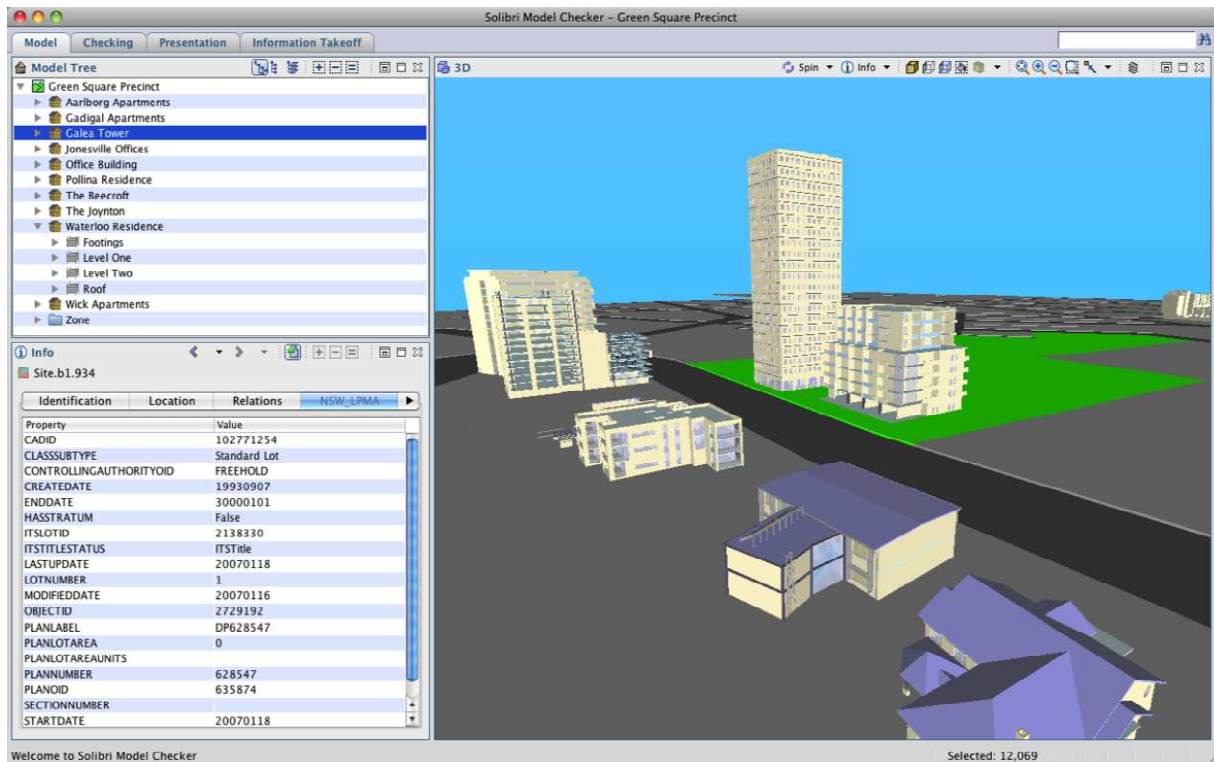


Figure 1: Green Square Precinct prototype model, urbanIT research project¹, FBE, UNSW, 2010

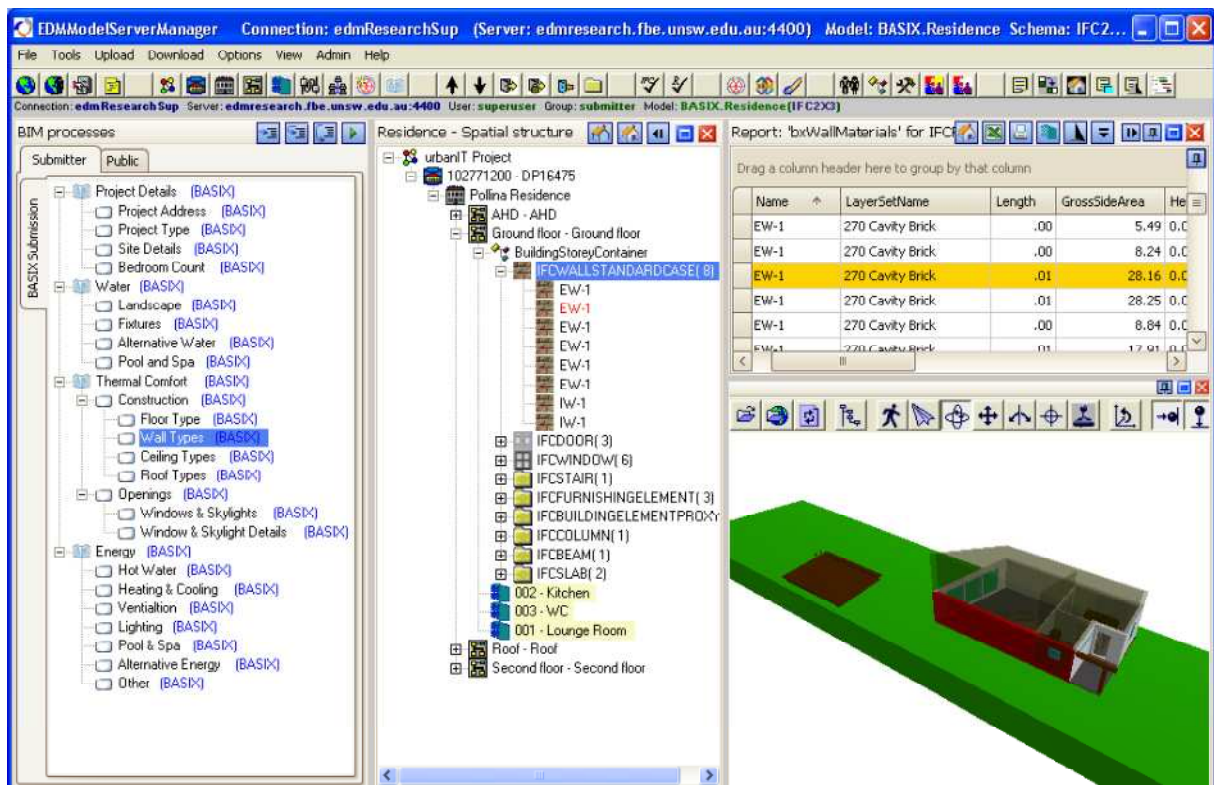


Figure 2: BIM based compliance checking, NSW BASIX sustainability assessment, urbanIT research project, FBE, UNSW, 2010. The tree view in the centre pane above, shows the hierarchy of the building elements by storey. The report pane (RH) lists each wall element with its key attributes and quantities. The LH pane stores the individual compliance scripts for each step in BASIX.

¹ see here <http://www.fbe.unsw.edu.au/cityfutures/UrbanIT/>

Priority 4: Procurement, Legal Issues & Insurance

A logical consequence of integrated project delivery is its impact on current consulting services, management of risk, fee structures, responsibilities, intellectual property, legal liability and indemnity insurance. All these are seen as significant impediments to the adoption of BIM.

These matters can be resolved, but only through informed and rigorous debate of probity issues among groups such as the APCC, state agencies, legal practices, professional indemnity insurers and Standards Australia Contract Committees. There is a need to develop new forms of contract that facilitate alliancing and take advantage of the opportunities afforded by model-based collaboration, performance assessment and information sharing.

Priority 5: Multi-disciplinary BIM education

Widespread use of BIM requires a high level of knowledge and expertise in the use of specific software and the capability or 'know how' to exchange appropriate model data at critical times during the building design, construction and management processes.

Educational institutions at all levels, from Universities and TAFE through to Secondary Schools, need to take the lead here, but they must be strongly supported by professional accreditation bodies and groups such as the Construction Industry Training Board.

Priority 6: Business Process Change

There is little history of good process management in the construction industry, giving rise to an urgent need for cultural as well as process change. Many factors contribute to this, including reluctance to adopt new technologies and methods, cost of implementation, fragmentation of the industry and the need for all parties to move at once, and a general reluctance to share information.

A key enabler for the effective adoption of BIM is the smooth exchange of information between all project participants at every stage of the building procurement process.

buildingSMART International has undertaken an exhaustive program over more than a decade to develop a robust and comprehensive data model able to represent any building project, incorporating local nomenclature where appropriate, as well as defined methods for identifying the precise information needed to support industry processes.

The adoption of these technologies requires concerted effort by industry players to define effective collaborative processes that capitalise on the opportunities, plus a commitment from clients, industry professionals, software vendors,

manufacturers and suppliers to implement those protocols.

Process change must be encouraged and facilitated by peak industry bodies, supported by process specialists, education providers, supply chain alliances and the development of guidelines.

Pilot Projects by Early Adopters

The outputs of the National Technology Implementation Program would be used and tested through a series of National Pilot Projects with in-kind commitment of project teams that test and confirm these issues.

We need to test new protocols, procurement methods and collaboration scenarios.

This initiative must come from clients, both private and government, since ultimately they are the beneficiaries of quality and increased productivity in the industry. Pilot projects would form a series of case studies that would disseminate results and feedback to the program.

These actions would provide leadership in the built environment, give industry confidence to adopt the new technologies, and make more efficient use of resources within a known time frame.

CIB INTEGRATED DESIGN & DELIVERY SOLUTIONS

Several key bodies internationally have been examining where the adoption of BIM is leading, and CIB² in response to this challenge have developed a white paper.

"Integrated Design & Delivery Solutions (IDDS)³ is aimed at transforming the construction sector through the rapid adoption of new processes, such as Integrated Project Delivery (IPD), together with Building Information Modelling (BIM), and automation technologies, using people with enhanced skills in more productive environments. The development of IDDS is about radical and continuous improvement"

Skills and software tools at this present stage can only achieve modest demonstrations of these potentials, but many are starting to understand that the industry's focus on geometrical clash detection - which reduces risk for both designer, builder and client - is just the beginning of a much larger construction sector transformation, *much more* significant than the adoption of 2D CAD in the 90s.

CIB observes that "Successful use of IDDS involves changes in each of the project phases: conceptual planning and making the business case; all parts of

² International Council for Research and Innovation In Building and Construction, see http://www.cibworld.nl/site/about_cib/index.html

³ CIB White Paper on IDDS Integrated Design and Delivery Solutions, CIB Publication 328 ISBN: 978-90-6363-060-7

design, supply chain, construction, commissioning; operation; retrofit; and decommissioning. For each of these phases, key changes in the structure and culture of the project team, including the firms that contribute its members, create a favourable context for IDDS.

Examples of these changes include: a team approach; support for innovation and tolerance of failure; strong lateral linkages and decentralised decision making; networks of commitment; and new forms of contracting, transparency and risk management (including insurance models).”

Analysis of Building Performance

Green House Gas reduction in response to global warming and an appreciation of the finite nature of physical resources on the planet has driven new initiatives in the design of the built environment.

Thermal performance of buildings has along history of application and has become a central focus today as a means to improving building environments yet using less resources. This has put a new demand for *multiple performance optimisation* that embraces the basics of structural stability, health, egress, fire protection etc with environmental qualities of noise control, daylighting, and indoor comfort. The application of advanced manufacturing and enhanced product assembly and quality add further dimensions to the modelling and analysis task.

Eastman (2006) believes the use of BIM ensures “...many other benefits are available, such as integrated feedback from analysis/simulation and production planning tools. BIM allows tools for

structural, energy, costing, lighting, acoustic, airflow, pedestrian movement and other analyses to be more tightly integrated with design activities, moving these tools from a long loop iteration to one that can be used repetitively to fine tune architectural design to better achieve complex mixes of intentions. Many of these capabilities have been outlined in the research literature for decades and they now have the potential to be realised”.

Where does the Data Come from?

A key priority area for the National Initiative - shared by buildingSMART chapters worldwide - is the development of **BIM compatible Building Product Libraries** that are needed to move from models that have good geometry to models that have consistent properties about material, performance and configuration.

A further complexity is the need to put in place global solutions, since business is already global, products are manufactured globally and to operate effectively we consequently need common standards. Building product makers have for some years hesitated to make “BIM” data available seeing it as a repeat of the futile drive for common formats with the advent of CAD in the 90s. The the effort outweighed the benefits, but the new digital modelling environment makes this a highly valuable outcome.

buildingSMART’s *International Data Dictionary* project⁴ has already developed some key infrastructure for the definition of terminology in a global, multi-lingual context.

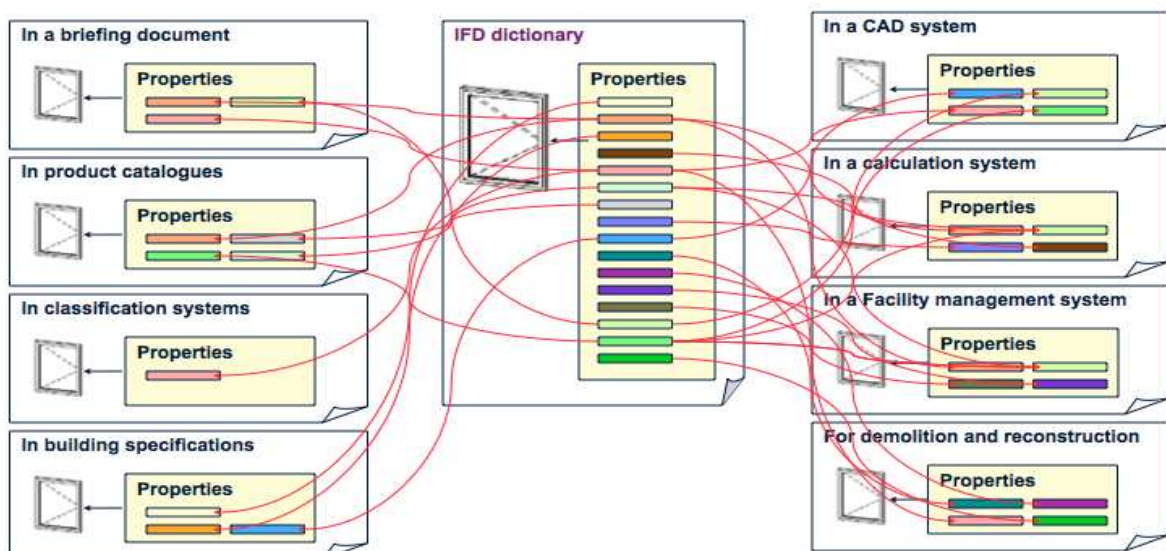


Figure 3: A humble window typifies the overlapping different requirements for product specific information needed by various actors over the lifecycle of a project. This work involves large international resources and the cooperation of multiple building product manufacturers, learned societies and research groups to be successful (From a presentation by Lars Bjørkhaug & Håvard Bell, SINTEF, Norway 2009.)

⁴ see <http://buildingSMART.com/standards/buildingSMART-standards/ifd>

Today we demand the information. It requires a whole-of-supply chain change - a formidable political and cultural task. That is why governments must be involved.

AN INDUSTRY VISION

Where is all this technology and global flurry on BIM heading?

Ultimately we need to remember that the traditional paper based 2D systems and the work practices developed from them have been so inadequate in face of the new environmental challenges.

Cities need to be planned better; social services need to be delivered more equitably and of increased quality. The construction sector needs to transform its business goals.

The roadmap projects reviewed by Froese and Amor (2007) identify a change in the way the construction sector can work (underpinned by these new technologies) moving to value driven processes in contrast to the current least cost procurement market.

There is much work to be done. buildingSMART is committed to forming a national initiative to expedite this movement. Your industry needs to be fully engaged in this activity.

The objective today is to work together with all parts of the industry so that the the built environment is both environmentally responsible, provides a first class habitat for its citizens and is sustainable in a local and global context.

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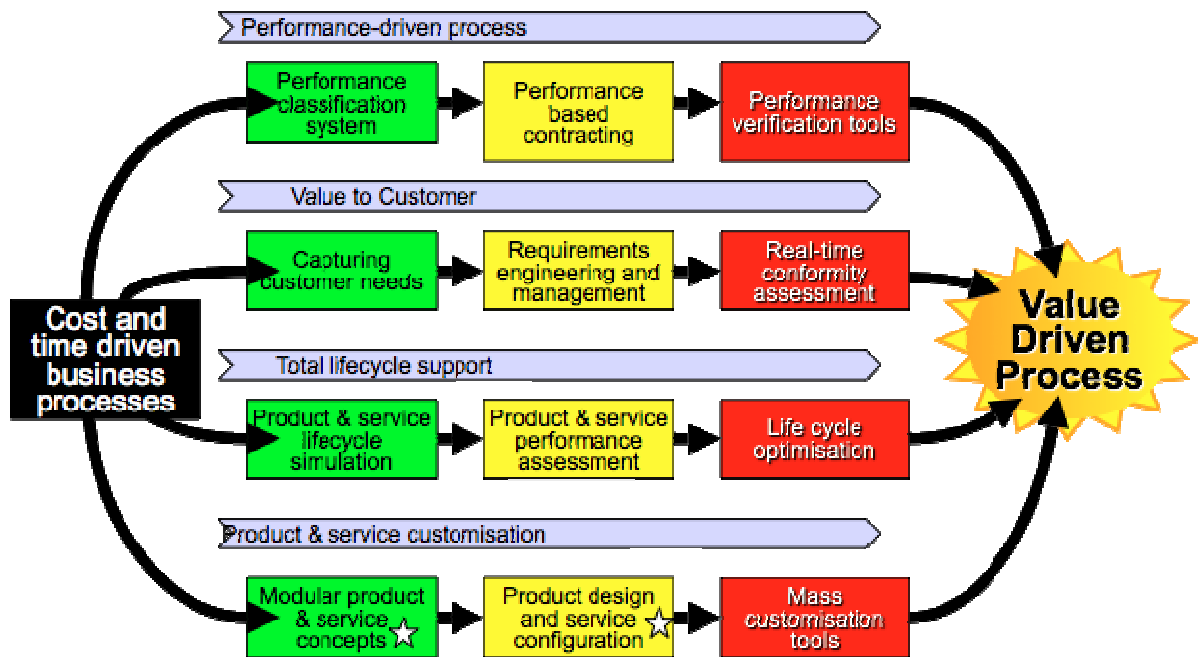


Figure 4: Value-driven process, Global Construction ICT Roadmap Development (from CIB)

APPENDIX

buildingSMART International

buildingSMART is an international body, with members formed in 11 National chapters drawn from both public and private organisations in the Construction Sector devoted to the improvement of the built environment through better digital communications and the use of building information Modelling (BIM) technologies.

buildingSMART is the author of the only global openBIM standard IFC. It is a neutral and open specification that is not controlled by a single vendor or group of vendors, facilitates interoperability in the building industry, and is a commonly used format for Building Information Modelling (BIM). The IFC model specification is open and available to all. It is registered by ISO as ISO/PAS 16739.

Vision

A Sustainable built environment

Mission

Contribute to sustainable built environment through SMARTER information sharing and communication amongst all stakeholders in the building and construction sector, private and public.

Goals

1. Develop and maintain open international standards for Building Information Modelling (OpenBIM)
2. Accelerate market assimilation of interoperability through successful sustainable projects
3. Provide networking opportunities, specifications and written guidance.
4. Resolve high value problems that hinder sustainability.

Benefits

- Realisation of public and private sustainability agendas
- Better buildings faster and cheaper (value for money).
- More predictable outcomes (reduced risk).
- High performing, energy efficient buildings.
- New business opportunities

See international <http://buildingsmart.com/> or Australasia site <http://www.buildingsmart.org.au>

International Council For Research And Innovation In Building & Construction

CIB was established in 1953 with the support of the United Nations, as an association whose objectives were to stimulate and facilitate international collaboration and information exchange between governmental research institutes in the building and construction sector.

Amongst the CIB member organisations are almost all the major national building research institutes in the world, as well as many other types of organisations in the building and construction sector who have joined us since. And although within the CIB programme considerable attention is still given to technical topics, there are now also activities focused on topics like organisation and management, economics of building, legal and procurement practices, architecture, urban planning and human aspects.

At present CIB is the world's foremost platform for international cooperation and information exchange in the area of building and construction research and innovation.

The design, construction, and commissioning sectors have been repeatedly analysed as inefficient and may or may not be quite as bad as portrayed; however, there is unquestionably significant scope for **Integrated Design and Delivery Solutions** (IDDS) to improve the delivery of value to clients, stakeholders (including occupants), and society in general, simultaneously driving down cost and time to deliver operational constructed facilities. CIB's white paper on IDDS is a definitive roadmap for the global construction sector.

See here <http://www.cibworld.nl/>