What is Integrated Design?

Means different things to different people:

• When a designer produces a concept, everyone else tries to make things work around it?

• Where an architect produces a design and engineers use tools to make it a reality?

• Where design team members work together to produce a design by iteration?

• When the building form follows function - resulting in a building that is successful for the users?

• When buildings perform their function successfully and meet all aspects of sustainable design in the built environment Societal, Economical and Environmental?
It should be when buildings:

• Perform their function successfully, and are sustainable in all senses of the word:
• Have a positive impact on society on an individual and group level.
• Are economically sustainable in design, procurement, construction and operation.
• Do not negatively impact the natural environment.

How do we achieve this?

• Who or what drives the process (or *should* drive the process)?
• What are the technologies – now, new and next?
Now – 2d drafting is still industry standard

- 2D documentation
- dispersed documentation
- 2D thinking
- coordination by imagination
- fee curtailed documentation
- Result: problems on site $$

- Poor documentation is costing the Australian Construction Industry $12bn every year

Industry-wide Task Force Study June 2005
3D Modeling

input = 3D model

output = 2D drawings

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2D drawings produced automatically

Changes to the model can be quickly reflected in the drawings:
Change column positions, beam sizes, etc…
Plan drawings are updated.
Sections & elevations drawings are updated.

ARUP
Structural Models - Revit

Clear information, produced in 3d, can produce 2d drawings

But buildings are not getting any simpler. What tools next?
Lack of coordination in design = waste in construction. Therefore we must integrate + coordinate before construction.
Virtual Construction

Diverse Software packages need integration – Triforma/Revit/ABS

Facade
Structure
Services

Software integration – By Pre-agreement - Triforma
Why have common models?

- Coordination of information
- Facilitates and eases communication
- Consistency of information
- Integrated documentation
- Use for design, construction and operation
- Speeds up the design and coordination process

And with a few small steps…
Building Information Modeling - BIM

- Inclusion of data other than geometry into the model
- Construction Scheduling
- Cost Estimating

4D – Construction Staging, Timing

Gantt charts / programs linked to the 3D model to plan staging options
Quantity, cost, quality estimating (5D)

Extract quantities into spreadsheets and estimate costs

Direct Manufacture from 3d - No Drawings
Asset Management

Costs 5 x more than capital construction costs

Model is a *window* to a database of the asset
**Asset Management**

Model is a *window* to a database of the asset

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**Supply Chain Management**

Manage and coordinate the supply chain - improve communication between trades - addition of specific supply chain components - supplier coordination
Benefits realized for clients:
- Cost and quantity assurance
- Time saving
- Better product
- Lifecycle assessments
- Asset management

It considers how the user interfaces with the building, not just the building design itself.

Will soon be the industry standard – driven by the clients long terms needs for the building (US GSA requires this for all new projects).

NEW

ARUP
"A sustainable city is a city in which achievements in social, economic and physical developments are made to last."

United Nations Sustainable Cities programme
Centralized Management of Environmental Impacts

- visual assessment
- overshadowing
- noise mapping
- light emission/light exposure
- wind environment
- traffic / transport movement
- pedestrian movements
- temperature
- flood mapping
- water resources
- public information

- Public Access
- Longer Term Planning
- Long term impact assessment

All accessible via the web
Environment Modeling, Performance based design

Energy Modelling  Comfort Prediction  Daylighting, Lighting & shading  Acoustics

Fire Safety Design  Immersive Environments  Façade Performance  Climate Change Impacts Assessments

Tools and techniques for modeling environments in and around buildings
To deliver designs that *perform better* and are...

sustainable & energy efficient

subject to reduced risk

offer greater amenity

more comfortable

This requires specialists analysis, special software, but models can be derived from the common model, connected to it, or referenced by it.

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**Analyze Design Options – Architecture, Structure and Building Services**
Analyze Sightlines

Smoke modelling

Acoustic modelling
So what is **Next**?

- Real-time
- Instantaneous/Interactive
- Optimized
- Immersive – experience the model with all the senses
- Experiential
- Self-Improving
- Self Learning

**Immersive Environment – Arup SoundLab**
Listen to Sound and Immersed in Visual

Listen to buildings before they are built
Listen to the sounds of the environment

What About Digitally Populating the Model?
Mass Motion- what is it?

- Behaviour modelling utilizing autonomous agents in virtual 3D environments – they
- Initial application in pedestrian modelling – a next generation solution beyond STEPS, ARENA, Exodus, Pedroute etc.

Mass Motion – Autonomous Agents in the model behave like people
JetBlue Terminal 5, New York

- Model central terminal node
- Passenger Arrivals and Departures
- Food Services
- Retail
- Flight Information Displays

- Level of Service metrics
- Qualitative assessment of the space’s performance
- Extract data including individual delays due to congestion
JetBlue simulation

Toronto Union Station Regional Rail
Concourse - 2021
Couple Agent Based Model with Visualization

Mass Motion – What If?

• What if we could predict the financial performance of retail layouts and merchandizing plans?
• What if we could predict the impact of school layouts and teacher monitoring on bullying behaviour?
• What if we could simultaneously optimize the layout of a hospital surgery and the staffing plan that goes with it?
• What if we could test blast impact, fire development, egress, acoustic environment and emergency response procedures in a single model?
• What if we could test operational decisions in crowd management in real time as a training tool?
• What if we had a way to interactively model pedestrian behaviour on a bridge and its structural performance?
Mass Motion – What If?

• What if we could predict the spread of an infectious disease in a hospital, hotel or prison?
• What if we had a digital Petri-dish or beaker to test biological and chemical processes?
• What if we could model an eco-system to examine the impact of global warming, pollution or diminished habitat?
• What if ....?
• The next generation for models interactive, immersive and optimized.

We shape a better world