Advanced Interactive Dynamic Facades

Technology or Product? Customised Australian Project Solutions
Future Cities – Shifting Cultural Paradigm

1.5 million people are added to the global urban population every week.

Source: PwC analysis (United Nations Population Division (2014))

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Stakeholder Façade Design Considerations

BODY'S HEAT BALANCE

- Radiation
- Evaporation
- Warm Stratification
- Convection
- Conduction
- Floor Cold/Warm
- Ceiling Warm/Cold Radiation
- Air Draughts
- Façades Light Cold/Hot Radiation
- Cold/Warm Stratification

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Can we say goodbye to glass skyscrapers?

- Can we say goodbye to glass skyscrapers? (Permasteelisa – CEO)
- “I’m not suggesting we need to lower the amount of glass everywhere – [we should] just be more careful with where and how we use [it],” he says. “The problem is [that] we’re using glass in the same way in every climate in Australia. We need to better respond to the unique [characteristics] of our different climates in façade design.” - Prof Oldfield UNSW
- US Glass Magazine Vol 52, Issue 2 Feb 2017
- Steven Selkowitz – Director Building Technology and Urban Systems – Lawrence Berkeley National Laboratories LBNL
- “These require design, construction, commissioning and operations that go beyond the norm for a conventional curtain wall, but they are solvable with the will, interest and investment”

“This new “Closed cavity façade” is in some ways a logical extension of the growing architectural interest in having highly transparent, large-area glazed facades with excellent thermal and visual comfort with low energy and carbon impacts”
Interactive Dynamic Façade Innovations: Are we ready?

or....... “Don’t bother me with new ideas, I’ve got a building to build!”
Are we ready? New ideas & Innovation: Gaps vs Trends

- Gaps – opportunity for *disruptive* technology = Create a market through innovation (200 George St)

- Trends – identify market indicators; pre-empt movements = *anticipate* the market through innovation

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“If I had asked people what they wanted, they would have said faster horses.”

—Henry Ford
Current trends & opportunities

- **Smart Buildings** –
  - Automated BCS control building operations HVAC, comfort, (day)lighting, security
  - Optimization of space, energy reduction and reduced environmental impacts (Celergon)

- **3D/BIM Modelling**
  - Early stage partnering (PCSA)
  - Digital Design, Procurement, Manufacturing, Logistics, QESH & Site Integration (PMF)

- **Energy-efficient buildings:**
  - Saves energy, cut costs, reducing environmental impacts.
  - “Developing these buildings requires a whole-building design approach”.
  - Buildings are up to 70 percent more efficient than the average commercial buildings. (EPBD, Capsol Excellent, MFrees, D3, TEC, Timber Facades)

- **Prefabrication/Modular Design:**
  - Rapid Prototyping
  - Additive Manufacture
Construction Innovation? – Sustainability & IGU’s

- Moisture penetration and gas loss
State-of-the-Art Advanced Facades: Condensation Risks?

- In open systems condensation will occur in Double Skin Facades
  - Active wall: on interior of DGU (incorrectly distributed air flow)
  - Interactive wall: on interior of outer pane (night sky radiation effect)
  - Shadow boxes

mfree-S: No condensation inside the cavity

But how is this achieved and guaranteed?
Advanced Interactive Dynamic Facades, mfree-S: An Australian Perspective

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**Advanced Interactive Dynamic Facades: MFreeS: What & Why?**

**mfree-S Closed Cavity Facade**
- A compact ‘Double Skin Facade’
- Clear Glass Pane
- Shading Device
- High Performance DGU
- Dry Air

**mfree-S Closed Cavity Facade**
- Continually flushed with dry air – low cavity RH%, resulting in low dew point.
- External monolithic glass
- Minimal access to cavity
- Minimal risk of damages to shading device
- Two surfaces to maintain (cleaning)
- Blinds can be considered in the analysis since it is outside of the main insulation – Low SHGC, High thermal performance

**IGU – with jockey sash**
- Naturally ventilated towards the internal of the building.
- External monolithic is not possible due to high condensation risk.
- Jockey sash = door hardware for every panel.
- Four surfaces to maintain – potential damage to shading device.
- Additional clearance space required for sash opening swing
- ESD engineer need to clarify if blinds can be considered if it is inside of the main insulation – Low thermal performance
Mfree-S: Product vs. Technology

- Product: An assembly of components resulting in a standard performance
- Technology: Base system that can engineered for various performance requirements
- MFreeS is a technology encompassing design, quality control and engineering through R&D development, testing and software development in order to provide a degree of confidence and minimize risk
- MFreeS is NOT a pressurized façade system! In fact it must have a certain degree of leakage! Why?
- The system MUST be carefully engineered for each building type and location so as to:
  - Eliminate the risk of failure (i.e. condensation, blinds motors, heat build up)
  - Provide a cost effective solution (efficient sizing and operation of plant)

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Design Requirements: Summary

- Essential design and engineering steps for a MFreeS façade
- Technology is fundamentally simple, but simple oversights and inexperience can lead to problems!

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<thead>
<tr>
<th>Nr</th>
<th>Item</th>
<th>Measurement</th>
<th>Procurement</th>
<th>Design &amp; Eng.</th>
<th>Testing</th>
<th>Quality Control</th>
<th>Commission</th>
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<td>Preliminary economic assessment</td>
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<td>Cavity Air-tightness CCF</td>
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<td>3.</td>
<td>Cleanliness inside the cavity</td>
<td>No dust nor stains</td>
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<td>4.</td>
<td>Accessibility of the cavity</td>
<td>Maintenance of blinds &amp; dust removal</td>
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<td>5.</td>
<td>Condensation risk assessment CCF for target cavity air-tightness</td>
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<td>Compressed air system sizing to Design air flow</td>
<td>Materials list Cost</td>
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<td>Blind motors &amp; controls blind system selection</td>
<td>Durability test 10 year Warranty</td>
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<td>Thermal assessment</td>
<td>Selection of Glass properties, blind color and frame color</td>
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<td>Compressed air system sizing</td>
<td>Plans finished Materials list complete</td>
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Design Requirements: Cavity Air Tightness

- Cavity pollution and condensation risk influenced by cavity air tightness
- Air flow rate increases as cavity is less air tight
- Higher installation and operation costs of plant
- BUT… cavity must not be completely airtight otherwise dry air exchange will not occur. Cavity must have a certain degree of leakage!
• Since the 90's; architectural trend – transparency & enhanced natural daylight
• Necessity to develop multi-layer facades; use of clear glazing and integrated shading systems
• Permasteelisa Dynamic systems: Closed interstitial blind cavity reducing maintenance costs (Mfree S™©, D3®™). Intelligent management systems (BMS) allow regulated balance between natural daylight, solar transmission control and glare improving occupant comfort and productivity (EPBD)

200 George St (MFreeS™©, ) (Left) & D3™©, Intelligent Façade Scheme (Right)
Interactive Dynamic Façade Innovations – Controlling Comfort Environments

- **BCS extension 1: Enhanced D3 control**
  - System topology and component selection specifically for D3 control system
  - Assessment for maximisation of energy and comfort gains
  - More detailed control strategy/algorithms

- **Green buildings rating systems**
  - Assign & receive valuable credits for our innovation technology (façade systems and prediction tools) for green building rating systems

- **Acoustic flanking**
  - Assessment methodology for detailed assessment for acoustic flanking performance and testing benchmarks (added to our ALABIK software)
BCS extension 2: Web-based interfaces (new)
- Visualisation for blind control without local hardware

BCS extension 3: Enhanced shadow management (new)
- Accurate prediction of shadow
- Reflection from other buildings / water surfaces

BCS extension 4: Daylight management (new)
- Research on (day)light management

Combined room climate controller (new)
- State-of-the-art algorithms
- Optimisation, with BMS sensors to user
- Self-learning
Interactive Dynamic Façade Innovations: FiMTMD & Movable Fire Barrier

**Description / Main reason for research / Request**
There are different ways the façade can help the building to reduce the building vibrations.
More promising solution in short period is the Façade Integrated Multi Tuned Mass Damper

**DAMPING**
Current trend of building design goes in the direction of slender buildings, affected then by comfort issues due to the large values of accelerations.
In order to repair the design shortcomings additional sources of damping must be considered:
- Building strengthening/Outriggers
- Viscous-elastic beam/column connections
- Tuned mass damper

**Movable Fire Barrier:** against vertical spread of fire.
Activation - stand-alone or through BCS integration
Greater Eco-sustainability can be achieved through the use of thermally efficient façade materials with low embodied carbon and energy:

- Glass Fibre Reinforced Polymers (left)
- Timber (right)
Interactive Dynamic Façade Innovations: Additive Manufacturing & Digital Fabrication

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Interactive Dynamic Façade Innovations: Additive Manufacturing & Digital Fabrication
Interactive Dynamic Façade Innovations: Additive Manufacturing & Digital Fabrication
3D Printing, Additive Manufacturing, Digital Fabrication

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