NFPA Research Foundation Symposium: Fire Protection for a Changing World

April 18, 2016
Munich, Germany
Intelligent Building Design for the 21st Century

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What is an Intelligent Building?
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The Current Definition:

Intelligent buildings integrate various types of building systems to manage operations, optimize performance, improve functionality and increase occupant comfort and productivity.
What is an Intelligent Building?

The Architect’s Definition:

Intelligent buildings integrate various types of building systems to manage operations, optimize performance, improve functionality and increase occupant comfort and productivity and look like they are doing it too!
Start with Intelligent Design

- Site Selection and Planning
- Building Orientation
- Reduction of Loads
- Utilization of Existing Resources
Start with Intelligent Design

- Site Selection and Planning
- Building Orientation
- Reduction of Loads
- Utilization of Existing Resources
THE STUDY AREA

Proximity to:
- Transit
- Schools
- Employment
- Entertainment
- Etc.
DATA MODEL

BUILDING USE

BUILDING SIZE

TOTAL CARBON

ENERGY USAGE/INTENSITY
Start with Intelligent Design

- Site Selection and Planning
- Building Orientation
- Reduction of Loads
- Utilization of Existing Resources
Environmental Contextualism:
Vernacular Building Style Study
Start with Intelligent Design

- Site Selection and Planning
- Building Orientation
- Reduction of Loads
- Utilization of Existing Resources
Load Reduction: Orientation of Glazing
Load Reduction:
Shading and Micro Climate
Start with Intelligent Design

- Site Selection and Planning
- Building Orientation
- Reduction of Loads
- Utilization of Existing Resources
Existing Resources - The Advantage of Height Temperature Lapse and MEP Plant Room Placement
Existing Resources - The Advantage of Height
Wind Turbines
Existing Resources - The Advantage of Height
Solar Energy
Existing Resources- The Advantage of Depth
Geothermal Piles
Existing Resources - The Advantage of Depth
Geothermal Piles
Existing Resources- The Advantage of Depth
Geothermal Piles
Existing Resources- The Advantage of Depth Exchange Slabs / Labyrinths
Next is the Intelligent Application of Technology with the Architecture

- Engineer Serendipity
- Capitalize on the “Space Between Screens”
- Design for Energy Efficiency
- Optimize Underutilized Attributes
(1) Engineer serendipity

People are more productive when they are alone

People are more innovative and collaborative when they are together

A middle ground can be designed: mobility + special variety creates serendipity
Assigned Seating

Flexible Seating

Private Offices

Open Plan

Rapid Prototyping
Iterative creativity, brainstorming, and small-group idea refinement

Cross-Pollination
Silo-busting, increased creativity, and more innovation

Individual Productivity
Personal productivity, focused individual work, and deadline work

Group Efficiency
Team productivity, focused group work, and project development
Enabling Technologies

Ubiquitous, wireless, high-speed, modular connectivity

Hardware device agnosticism

Cloud-based productivity tools (messaging, file collaboration, sharing, etc)
Measuring Technologies: The Internet of (Office) Things

Cost-per-foot² ≠ performance of people

Sensors, activity trackers, smartphones and social networks can be used to measure professional interaction, chance encounter, and “collisionable hours”

1. Security Cameras
2. Sensitive Planters
3. Full Spectrum Lighting
4. Doorbells
5. Networked Lighting
6. Locks
7. Climate Control
8. Water Gauges
9. Motion Sensors
10. Conference Rooms
11. Elevators
Measuring Technologies: The Internet of (Office) Things

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BIG DATA or BIG BROTHER ?
Capital on “space between screens”

Average smartphone screen time per day: 3 hours, 16 minutes

21 device changes per hour

90% of office workers accomplish tasks across multiple screens

“Managing transitions between computing devices could very well be the primary software problem of the next 5 to 10 years.” - Farhad Manjoo, New York Times
IT implications for “space between screens”

Plan for gadget-hopping

Share activities, not just data

Make peer-to-peer sharing seamless

Design for sensors

Put objects on equal footing (avatars)
(3) Design for energy efficiency

Plug Loads & Lighting

HVAC Infrastructure

Retrofit Chicago Case Studies
Plug Loads & Lighting

Sensors
- Barometric pressure
- Temperature sensor
- Humidity
- Temperature sensor
- Light sensor

Technology
- Raspberry Pi
- Breadboard
- WIFI dongle
Granular Measurement, Feedback and Control

- Workstation level
- Control
- Measurement
- Logging
- Feedback
"My Space"

- Empowered staff
- Informed actions
- Consensus building with Data
- Privacy and Transparency Challenges
Building a platform for the future

- HVAC
- Lighting
- Wireless
FAN COILS Retrofit to ACTIVE CHILLED BEAMS / Radiant Cooling
Active Chilled Beams

- New Style Induction
- Heating/Cooling
- Flexible
- Low Noise
- Energy Savings potential
- DOAS system based
Radiant Ceiling System

- Decoupled Ventilation & Cooling
- Heating/Cooling
- Flexible
- Low Noise
- Once through air – high IEQ
- High Energy savings potential
- DOAS system based

CEILING RETROFIT OPTION – RADIANT COOLING PANELS
Finally, once you have a large group of Intelligent Buildings, what comes next?
Finally, once you have a large group of Intelligent Buildings, what comes next?

Linkage is the next goal in order to create the “Smart City”
What is a Smart City?

A “Smart City” is one that uses network technologies, data analytics, and environmental sensors to allow a layer of intelligence in the operation and use of the city.

Smart Cities enable the following outcomes:

1. Increased efficiency of municipal services.
2. Better anticipation of the needs of residents, businesses, and visitors.
3. Strengthened environmental sustainability.
4. Elevated economic development and productivity.
# Smart City solutions and benefits

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Benefits/Outcomes</th>
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<tbody>
<tr>
<td>Dynamic Electricity Pricing</td>
<td>Demand-based market for power, better balancing during peak loads.</td>
</tr>
<tr>
<td>Flexible Management of Power and Water Network</td>
<td>Remote detection of outages and changes in network status, ability to create alternative routings.</td>
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<td>Real-Time Public Transit Status</td>
<td>Better management of transit fleet, real-time information available to transit-goers via mobile devices and displays</td>
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<tr>
<td>Traffic Congestion Management</td>
<td>Real-time tolling, lane-shifting and parking fees based on dynamic analysis of street congestion.</td>
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<tr>
<td>Mobile Citizen Service Requests</td>
<td>Ability to request city assistance via smartphones, text messaging, and web interfaces.</td>
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<tr>
<td>Free Wireless Access in Public Spaces</td>
<td>Ubiquitous connectivity in parks, plazas, and the public way.</td>
</tr>
<tr>
<td>Centralized Public Safety Operations</td>
<td>Integrated operations center for managing public safety resources.</td>
</tr>
<tr>
<td>Open Data Publication</td>
<td>Increased government transparency and ability of citizens to create unique interfaces to city services.</td>
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What is the difference between a smart city and a smart grid?

A smart grid is only one aspect of a smart city. Having real-time electricity monitoring makes it easier to achieve other non-energy smart city projects, but many smart city initiatives do not require a smart grid to function.

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<th>Smart Grid Preferable</th>
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What are the technologies in a Smart City?

- Personal, mobile interfaces
  - Data visualizations
- Data analytics
- Cloud computing
- Instrumented infrastructure
  - High-speed broadband connectivity
Example: Smart energy in Nova Scotia

The power utility in the province of Nova Scotia, Canada has partnered with Schneider Electric to implement an advanced distribution and outage management system as an integrated smart grid solution to improve operational efficiencies and power outage response and restoration. When completed Nova Scotia Power will be able to efficiently monitor, analyze, and manage its network of nearly 500,000 customers for more rapid response to power outages.
Example: Smart transit in Chicago

The Chicago Transit Authority was the first city in North America to have real-time information available for the location both its bus fleet and trains. Using GPS sensors and axle-rotation dead reckoning, BusTracker and TrainTracker provide website-, mobile phone-, and SMS/text-based information about wait durations and fleet status. Public transit has increased by 17% since the introduction of the Tracking applications.
Example: Smart infrastructure in Skolkovo

The city of Skolkovo outside of Moscow is a 360-hectare campus devoted to innovation and research. It has partnered with Siemens to develop a smart energy system for its buildings where heating, ventilation and air conditioning (HVAC) systems are all controlled from a single source, ensuring user-friendly operation and reduced life-cycle costs. In addition, unified control panels combine fire detectors are capable of “on the spot decisions” and can considerably improve the level of safety on the premises.
Example: Smart municipal services in Chicago

In 2012, prior to hosting the NATO 2012 Summit, the city of Chicago implemented the Windy Grid smart operations system. Windy Grid presents a unified view of city operations to multiple agencies and jurisdictions by plotting historical and real-time data on a single map.

Chicago uses the application to monitor emergency and non-emergency call events, public transit vehicle locations, and social media streams in real-time.
“The real voyage of discovery consists not in seeking new landscapes but in having new eyes.”

– Marcel Proust
THANK YOU