A Vision

- Designers, specifiers and others collaborate on a building information model (BIM) and submit to regulatory authorities for review.

- Regulatory agencies provide coordinated and automated plan review and issue a determination of compliance and permit.

- BIM is a basis for collecting information during construction and can be delivered to the owner as an “as-built.”
An Opportunity

- The building industry annual construction expenditures are on the order of $5 trillion worldwide, of which the U.S. comprises 30%.

- The productivity of the U.S. construction sector has declined over the past 40 years.

- Application and use of IT, particularly BIM and smartCODEs, has the potential to reduce construction costs by over 30%.

- Resource, safety, economic, demographic, environmental and technical forces are driving the need to change how we deliver and maintain buildings.

- Technology can help lead and drive change.
The Big Picture

...the dynamic and **seamless** exchange, updating and maintenance of accurate, useful information on the built environment among all members of the building community throughout the lifecycle of a facility

...a smarter process for managing the lifecycle of a project to enhance public safety

...continual access to and **sharing** of information about a building
Building Information Model

A digital representation of physical and functional characteristics of a building (data)

... a shared knowledge source or database for intelligent information about a facility that can be maintained over time that

... stays with the building forever

... can be seamlessly used by all

... must follow an established standard if BIMs are to contain needed information in a usable format
Building Information Model
Major Medical Facility in California
How close is BIM to reality?
Code Compliance Today
Code Compliance Today

- Linear not circular
- Can be performed independently for each code
- Multiple agencies involved
- Difficulty sharing and collaborating on data
- Does not encourage collaboration with those regulated
- Increased probability of errors
- Less efficient use of time and manpower resources
- Limited application of what IT has to offer
Code Checking

- Architects on average spend almost 50 hours per project on code checking with 11% spending over 100 hours.

1. Interoperability in the Construction Industry
McGraw Hill Construction, October 2007
85% of architects see great potential in and expressed interest in auto code checking.

Owners will increasingly take a leadership role in requiring BIMs due to ability to increase ROI through expediting plan approval and shorter time to occupancy.

Code officials are establishing strategic plans for review and acceptance of BIM submittals.

The fire service is seeing the potential to use BIM as a resource to protect the public.
Building Regulatory Compliance Tomorrow
Project Overview

Diagram showing relationships between SMARTcodes, MCS, BIM ASW, Dictionary, Customer (A/E, Contractor, Building Owner, AHJ, etc.), Manual Code Search, Auto Code Check, Supporting Information, Communications, Market Research, Collaboration, and Building Industry.
Dictionary

- Terms
  - Properties associated with each term
  - Enumerations of properties
  - Data type
  - Units associated with each property

Insulation

- Type
- Material
- Density
- STC
- FS
- SDR
- Thickness
- R-value
- Continuity

Model View Definition (MVD)
**Energy, egress and access dictionary**

**Coordinated with CSI OmniClass and global IFD efforts**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Type| 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | Definition | Code Sections | Synonyms | Data Type | Units | OmniClass Classification | IFC Object/Property | Code
|   |     |     |     |     |     |     |     |     | 1          |            |         |          |       |                    |          | HomoGen |

- **Term**: building envelope
- **Definition**: The basement walls, exterior walls, floor, roof, and any other building element that encloses conditioned space. This boundary also includes the boundary between conditioned space and any exempt or unconditioned space.

- **Term**: wall
  - **Property**: is external
    - **Value**: boolean
    - **Units**: n/a
    - **OmniClass Classification**: n/a
    - **IFC Object/Property**: Post_WallCommon
    - **Code**: HomoGen

- **Term**: insulation
  - **Property**: type
    - **Value**: integer index into enumeration (thermal_block_type)
    - **Units**: n/a
    - **OmniClass Classification**: n/a
    - **IFC Object/Property**: Post_InsulationLayer
    - **Code**: HomoGen

- **Term**: material
  - **Property**: is external
    - **Value**: boolean
    - **Units**: n/a
    - **OmniClass Classification**: n/a
    - **IFC Object/Property**: Post_MaterialLayer
    - **Code**: HomoGen

- **Term**: density
  - **Property**: is external
    - **Value**: integer index into enumeration (thermal_insulation_material)
    - **Units**: n/a
    - **OmniClass Classification**: n/a
    - **IFC Object/Property**: Post_MaterialLayer
    - **Code**: HomoGen
SMARTcodes Protocol and Software

✓ SMARTcodes protocol - completed and validated

✓ SMARTcodes builder – v1.0 completed and tested
✓ **IECC SMARTcodes** – envelope and lighting drafted and “plug and play” with different MCS validated

✓ **Egress and accessibility drafted**

✓ **Successful collaboration with two MCS for their application and use of SMARTcodes**

✓ **Successful collaboration with four BIM software vendors**
Demonstration

✓ Availability of multiple BIMs for application and use in demonstrations and testing

✓ Launch of enhanced online demonstration of auto code check and manual code search
Automated Code Checking
Automated Code Checking

### IECC 505 Electrical Power & Lighting Systems
#### 505.5.2 Interior lighting power allowances

**Results**

**Failed components**  
- 06 Sixth Floor
- Office

**Space 5.10: CONFERENCE ROOM[14]**  
- Value of Space 5.10: CONFERENCE ROOM (4) does not fulfill the requirement lighting power density ≤ 3.7 W/sq ft.  
- Total lighting power is 1,500 W.  
- Space area is 738.53 sq ft

### BIMstorm LAX

#### Building Model: National Association of Realtors - National Headquarters

#### Jurisdiction: Los Angeles, CA

#### Organization: International Code Council

**Date: 31-Jan-06**

---

<table>
<thead>
<tr>
<th>Rule</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC 502 Building Envelope Requirements</td>
<td></td>
</tr>
<tr>
<td>502.1.1 Insulation and fenestration criteria</td>
<td>Violations</td>
</tr>
<tr>
<td>502.2.1 Building envelope requirements - Opaque Assemblies</td>
<td>Violations</td>
</tr>
<tr>
<td>(502.2.1) Above grade walls</td>
<td>Not checked</td>
</tr>
<tr>
<td>(502.2.4) Below grade walls</td>
<td>Not checked</td>
</tr>
<tr>
<td>(502.3.3) Fenestration requirements - Fenestration</td>
<td>Passed</td>
</tr>
<tr>
<td>(502.4.1) Air leakage - Windows &amp; Doors</td>
<td>Not checked</td>
</tr>
<tr>
<td>(502.4.2)(a) Air leakage - curtain walls</td>
<td>Not checked</td>
</tr>
<tr>
<td>(502.4.2)(b) Air leakage - entry doors</td>
<td>Not checked</td>
</tr>
<tr>
<td>(502.4.4) Outdoor air intake &amp; exhaust</td>
<td>Not checked</td>
</tr>
<tr>
<td>(502.4.5) Loading dock weather seals</td>
<td>Not checked</td>
</tr>
<tr>
<td>(502.4.6) Vestibules</td>
<td>Passed</td>
</tr>
<tr>
<td>502.4/5 Recessed luminaires</td>
<td>Passed</td>
</tr>
<tr>
<td>502.5 Moisture control</td>
<td>Passed</td>
</tr>
</tbody>
</table>

---

### IECC 505 Electrical Power & Lighting Systems

#### (505-2.1) Interior lighting controls
- Not checked

#### (505.2.2.1) Lighting reduction controls
- Not checked

#### (505.2.2.2) Automatic lighting shutdown
- Not checked

#### (505.2.2.2.1) Occu count override
- Not checked

#### (505.2.2.2.2) Holiday scheduling
- Not checked

#### (505.3) Emergency lighting
- Not checked

#### (505.4) Exit signs
- Not checked

#### (505.5.2) Interior lighting power allowances
- Violations

#### (505.7) Electrical energy consumption
- Not checked

---

Powered by Solidi Model Checker
Why SMARTcodes?

- Improved services
- High quality code searching
- Guided shortlists
- Automatic checking of proposals
Each building code is a tree of tests

Each building project is made up of elements and spaces

For the project to pass the code, every element must pass the test

Question: how does a wall pass the plumbing requirements?
Answer: by showing it doesn’t apply.
What’s a check?

- A check is any section or sub-section that can be passed or failed. Hence the symbol and box.

- Question: what is in a code that is not checks?
  - Answer: titles, definitions...
What do you mean by highlighting?

- Highlighting underlines phrases in four different colors. *Behind the highlighting we store the exact meaning, using terms from a dictionary.*

- Question: what does a check have to contain?
- Answer: a requirement
What are the four colors for?

Highlight any phrase that means ...

• more scope as a ‘select’
• less scope as an ‘applies’
• ‘shall’/’must’ as a ‘requirement’
  • NB alternative Requirements
• ‘unless’ as an ‘exception’
  • NB composite Exceptions
These cases are quite common and will be discussed later:

- Two or more alternative Requirements
  - ... MUST DO THIS OR DO THAT.
- Two or more composite Exceptions
  - ... UNLESS THIS AND THAT
Example: ICC IECC 2006 502 5

502.5 Moisture control. (Mandatory).

All **framed** walls, **floors** and **ceilings** not **ventilated** to allow moisture to escape shall be provided with an approved vapor retarder having a **permeance rating of 1 perm (5.7 f#151; 10 **?128;?11** kg/Press.m**<sup>2</sup>) or less**, when tested in accordance with the desiccant method using Procedure A of ASTM E96. The vapor retarder shall be **installed on the warm-in-winter side of the insulation**.

Exceptions:

1. **Buildings located in Climate Zones 1 through 3** as indicated in Figure 301.1 and Table 301.1.

2. In **construction where moisture or its freezing will not damage the materials**.

3. Where other **approved means to avoid condensation** in unventilated framed wall, floor, roof and ceiling cavities are provided.
Question: why has someone bubbled the ASTM reference?

Answer: because this is not a part of the requirement – it’s a definition of a ‘perm’ and its measurement.

Question: why is the ‘approval’ bubbled?

Answer: because this can not be checked except by an officer.
What goes behind an atom?

- **Specific Topic of Interest**
  - building element
  - vapor barrier

- **Property to be tested**
  - permeance

- **Comparison**
  - less than

- **Target Value**
  - 1.0

- **Unit of measure.**
  - perm
What information must be in the BIM?

- buildingSMART IFC (ISO 16759) – IFC for short
- Coordination View MVD – project, site, building, storeys, spaces, walls and slabs, beams, columns, footings, windows, doors and openings, mechanical, electrical and plumbing parts, and their relationships... as commonly produced already,
- Plus...
- Zone and System group definitions
- Ceiling elements and Plenum spaces
- Extra sets of information on ...
  - Element and Opening
  - Project, Site, Building, Storey, Space
  - Zone and System
  - Type, Material Layer Set, Material Layer, Material
  
...

Availability of a contemporary and current BIM as a data resource for emergency responders and others during the life of the building

- Use the BIM as an information resource to capture change orders, construction information and commissioning data to yield an as-built BIM

- Maintain and enhance the BIM representing the building as operated and make it available when issues arise that demand timely and accurate information on a building
E-government

- Facilitate current processes and develop new processes based on application of IT
  - Plans will evolve from hard copy to e-submission of 2Ds to BIMs
  - Conduct virtual reviews in 3D and 4D automatically
ePermitting Strategy
Mecklenburg County, NC

Electronic Plan Submittal (EPS) Five Year Technology Strategy
Including Building Information Modeling (BIM) Strategy

- Homeowner Internet Permits: June 2007
- Mechanical Electrical Plumbing (MEP) Internet Permits: Start September 2007


Commercial Electronic Plan Review Includes:
- Electronic Signoff
- 2D Electronic Review
- BIM Concept

Manual Drawing Conversion Bin: 2005

Office BIM Phase II: 2009
Field BIM Phase III: 2010

ICC Smart Codes Integration: 2008

Leads to Owner Managed Permitting + Long Term Development Goal
Create Your Own Project Critical Path
Future Outlook for e-Government

- Standards for BIMs, communication and data interaction
- A new design and construction process founded on interoperability
- e-Government software and portals for BIM submittal and auto checking
- More timely and accurate review and approval of plans
- More timely and robust construction review and record availability
- Better buildings and increased public safety
Availability of BIMs creates an opportunity for auto code checking and related products and services.

Availability of SMARTcodes and auto code checking can drive demand for and use of BIMs.
Thank You!
Any Questions?

ICC
500 New Jersey Avenue
6th Floor
Washington, DC 20001

Stephen Benedict
Design + Construction Strategies, LLC