Construction Code and Construction Innovation - Intersection of Progress

Presenter: Colby Swanson & Shaunna Mozingo

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9:45 AM - 11:15 AM
“It is now past argument that the low-cost house of the future will be manufactured in whole, or in parts, in central factories, and assembled on site. In other words, it will be produced the same way as the automobile.”

- Poet Archibald MacLeish, *Fortune Magazine* in 1932
Shaunna Mozingo
Building Plans Analyst and Building Inspector since 2001
Inspector for DOE’s and China’s Solar Decathlon Competitions
Juror for NREL’s Race to Zero Competition
Educator/Trainer on codes
Energy Code specialist, contract manager, researcher, innovator - Colorado Code Consulting
Recipient of ICC/IMT Standard Bearer’s Award for Excellence in Energy Code Compliance
Recipient of Southwest Energy Efficiency Project’s Leadership in Energy Codes Award

Colby Swanson
Framed houses during high school and college
Started energy efficiency rating Co. and tested/inspected ~20,000 homes in AZ
Building science consultant and forensics expert of large scale failure for national home builders, contractors, product manufacturers
Created Center for Building Excellence at BASF and led long-term construction strategy
Consultancy connecting innovators to executives thru innovation scouting, strategic alliances and business guidance.
RESIDENTIAL INDUSTRY

“CONSTRAINED EVOLUTION”

1887

1935

1940

A 1944 Time Magazine article claimed Gunnison’s “conveyor-belted production methods” produced all the parts of a house in just 25 minutes.

1940-50’s
- WEEKS to build a home
- Home price to income = 2.2

1970

2016
- MONTHS to build a home
- Home price to income = 3.9
- Same materials, same methods

2017

130 years

Resid. construction has a ~$80B productivity gap

Feb. 2017 McKinsey&Company
Highly fragmented and poorly integrated systems

Residential construction is an “insulated” industry lacking “foreign” competition

Construction is a “Legacy” industry actively defending well established economic, political, and cultural paradigms
CONSTRUCTION R&D IS BELOW INDUSTRY STANDARDS

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Const. Mar.</th>
<th>Total Constr. Research</th>
<th>% of Total</th>
<th>Builder</th>
<th>Contractor</th>
<th>Material</th>
<th>Gov’t</th>
<th>All Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984*</td>
<td>$312B</td>
<td>$1.2B</td>
<td>0.4%</td>
<td>n/a</td>
<td>$54M</td>
<td>$840M</td>
<td>$200M</td>
<td>$111M</td>
</tr>
<tr>
<td>2016**</td>
<td>$1.2T</td>
<td>$10.2B</td>
<td>1.0%</td>
<td>n/a</td>
<td>n/a</td>
<td>$8B</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

2.5% - US Industry Standard  
3.5% - Auto  
4.5% - Aerospace
Housing is not a product, it is a process… a messy process
Managing trades and inspections is expensive

“Builders are highly selective innovators… there are a lot of hurdles to cross before a new product or process change is implemented in the current environment.”

“Most of their time and money is spent dealing with supply chain and regulation rather than improving the quality of the final product.”

Procurement Process
Residential construction procurement is complex:

- Thousands of product options
- Availability (labor and products)
- Compatibility (products)
- Building science (system thinking)
- Will the homeowner buy it
- Price fluctuation
- And done on a daily basis

Warranty of Homes

- Everyone deflects blame
- Builder brand is harmed the most
- Ultimate mismatch in risk allocation
LABOR ISSUES GETTING WORSE

- Government policy is reducing immigrant labor
- Poor training and near zero investment in the future

“I would hire 500 electricians today if they were available (not wire pullers, or hole drillers, or hanging fixtures).”

<table>
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<tr>
<th>Problems</th>
<th>2017 (% expecting to face the problem)</th>
<th>2016 (% that faced the problem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost/availability of labor</td>
<td>82%</td>
<td>78%</td>
</tr>
<tr>
<td>Cost/availability of developed lots</td>
<td>67%</td>
<td>60%</td>
</tr>
<tr>
<td>Impact/hook-up/inspection or other fees</td>
<td>61%</td>
<td>60%</td>
</tr>
<tr>
<td>Building material prices</td>
<td>60%</td>
<td>48%</td>
</tr>
</tbody>
</table>

Figure 15: Worker Age in the US Construction Sector, 1985-2014

1 Latest figures available
Source: US Bureau of Labor Statistics; World Economic Forum; The Boston Consulting Group
CONSTRUCTION COST RISING, WAGES STAGNATED

Average New Single-Family Home Prices and Cost per Square Foot of Housing, 1950 – 1999

Bigger Paychecks, But Little Change in Purchasing Power

Average hourly wages, seasonally adjusted

<table>
<thead>
<tr>
<th>Year</th>
<th>FHA</th>
<th>Cost / sq.ft.</th>
<th>Reg. Burden (lot/house)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>4.2%</td>
<td>$6</td>
<td>11%</td>
</tr>
<tr>
<td>1972</td>
<td>7.0%</td>
<td>$18</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>7.5%</td>
<td>$87</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>4.5%</td>
<td>$114*</td>
<td>25% (16/9)</td>
</tr>
</tbody>
</table>

*In a 2014 Pew Research Center survey from August, 56% of Americans said their family’s income was falling behind the cost of living, up from 44% in September 2007 — just before the recession hit. More than a third (37%) of Americans in the latest poll said their family’s income was staying about even with inflation; only 5% said they were staying ahead of inflation.
PROPERTY INSURANCE RISK MODELS ARE OBSOLETE

9,417 Large Hail
1” or greater

29,996 Severe Weather Reports

18,685 High Wind

1,894 Tornados
PROPERTY INSURANCE RISK MODELS ARE OBSOLETE

U.S. Residual Market Exposure to Loss (1990-2012)

Source: PIPSO; Insurance Information Institute (III)

Residual Market: FAIR and Beach/Windstorm
A lack of consistent performance requirements (code) from one jurisdiction to another makes efficient processes difficult.

2012 → 2015 → 2018 Aggressive Code cycles is challenging trades/builders such that they are playing catch up all the time.

National, State, Muni’s are requiring more concessions from developers / builders … to develop less desirable parcels.

So much code, so little time, so much to do.
EFFECTIVE USE OF THE INTERNATIONAL BUILDING CODE

“The codes are promulgated on a 3-year cycle to allow for new construction methods and technologies to be incorporated into the codes. Alternative materials, designs and methods not specifically addressed in the code can be approved by the code official where the proposed materials, designs or methods comply with the intent of the provisions of the code (see Section 104.11).”
EFFECTIVE USE OF THE INTERNATIONAL RESIDENTIAL CODE

“It is important to understand that the IRC contains coverage for what is conventional and common in residential construction practice. While the IRC will provide all of the needed coverage for most residential construction, it might not address construction practices and systems that are atypical or rarely encountered in the industry. …

In other words, the IRC is meant to be all inclusive for typical residential construction and it relies on other codes only where alternatives are desired or where the code lacks coverage for the uncommon aspect of residential construction. Of course, the IRC constantly evolves to address new technologies and construction practices that were once uncommon, but now common.”
C101.3: This code shall regulate the design and construction of buildings for the use and conservation of energy over the life of each building…

C101.3 states further that the code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve the conservation of energy over the life of the building.

C101.5.1 gives the code official permission to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of the code.

C102: Alternate must meet intent of the code and for Residential be at least equivalent to prescribed requirement.
Roadmap from “Innovation Resistance” to “Success”

Meeting the Intent of Code
What can you turn in to the code official to show that you meet the intent of the code you are trying to comply with?

Tested Materials?
If you have a material you want to use, does it need to be tested? Has it been tested? Are the tests equal to other recognized tests in the code?

Has it been done before?
Can you show where the innovation or something similar has been used before? Can you show why it is even needed?

Document Everything
Document your processes, procedures, conversations, successes and failures. Turn it all in.
Innovation Path

PRODUCT

Evaluation Report (ESR®)

PMG Listing (PMG®)

VAR Environmental Report (VAR®)

CODE OFFICIALS APPROVAL

Most Widely Accepted and Trusted

ES
ICC EVALUATION SERVICE
What would it take for you to approve it?
How can our decisions promote or hinder innovation?

"I'm very creative and creative people are not afraid to fail."
What to do?

• Innovation is happening
• Are we holding things up?
• What can we do to make sure codes don’t hinder the process?
• How do we “CYA” for things we just aren’t sure about?
**INDUSTRY DISRUPTION**

1. **Software platforms** *rapidly* scale and *drive* the business
2. **Sidestep** existing business models
3. **Deliver** “*direct value*” more efficiently

**2008** - Airbnb launches.

- **7 years**

**2015** - Tesla enables hands-free control for highway/freeway driving in a single software update - overnight.

**2016** - nuTonomy & Grab launch consumer trial of self-driving taxi service in Singapore.

- **7 years**

**2009** - Ride-sharing service disrupts 80 year-old taxi system.

**2016** - Generates $6.5B in revenue, valuation of $60B.

**1961** - Stanford technology uses cameras to follow a white line. (Used in current SDC’s)

**55 years**

**2017** - Valuation of $30B, 2nd only to Marriott ($35B).

**Innovation Traits**

- Software platforms *rapidly* scale and *drive* the business
- **Sidestep** existing business models
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Momentum

21st CENTURY
CONSTRUCTION TOOLS
INNOVATIVE TECHNOLOGY
Volumetric Wireless Power for Living Spaces

- Quasistatic Cavity Resonant
- Copper tube in middle of aluminum skinned room
- Safely transmit up to 1,900 watts to a coil receiver with 40%-95% efficiency
INNOVATIVE MATERIAL
bioMASON - mobile factory

- Bricks are GROWN ON-SITE in 2-3 days in mobile manufacturing containers
INNOVATIVE MATERIAL
CLICK ROCK® - Modular drywall

Ideal Application: Coffered ceilings, columns, etc.

INNOVATIVE MATERIAL

NewTile - Modular tile

- 5X faster than tile
- No mortar
- Backsplash Tub & Shower Surrounds

It's 5x faster than using and installing standard tile.
INNOVATIVE INTEGRATED TECHNOLOGIES

ProtoCore™

shear panels

MASTERCORE

framing

MASTER BATHROOM

HVAC
electric subpanel

FAMILY BATHROOM

LAUNDRY

PREFAB UTILITY CORE

UTILITY CONNECTION

WET SPACES

SAMSUNG

PROTO HOMES
INNOVATIVE TECHNOLOGY

MonoPath

- Large Format Engineered OSB Panels
- 10X Faster Shell
- Panel Size: 8’ x 24’ x 1 ⅛”
INNOVATIVE TECHNOLOGY

Method: *Large Format OSB*

- Home is 100% wrapped with weather barrier and insulation
- OSB floor left exposed
- OSB door/window cutouts become counter-top and stair treads.
“VALUE SHIFT”
Labor → Materials → Off-Site
INNOVATIVE BUSINESS MODEL

84 LUMBER

- Distribution channel is testing in-house home construction
- Launches line of Tiny Houses (DIY = $7K → Finished = $50K)
INNOVATIVE BUSINESS MODEL
Method: Off-Site Builders

Open Source Ecology
Innovation

INNOVATIVE INTEGRATED TECHNOLOGIES
Space Construction: Rockets

1960 - $500 M

2006 - $350 M

2016 - $57 M
MADE IN SPACE AND LOWE’S PARTNERSHIP

Together, Made In Space and Lowe’s will be bringing tools to space and technology to Earth.
Collaboration will be the tip of the spear in our information world ... staying connected to the neural network of ideas, expertise, innovation, and consumers.