



Construction Code and Construction Innovation - Intersection of Progress

Presenter: Colby Swanson & Shaunna Mozingo

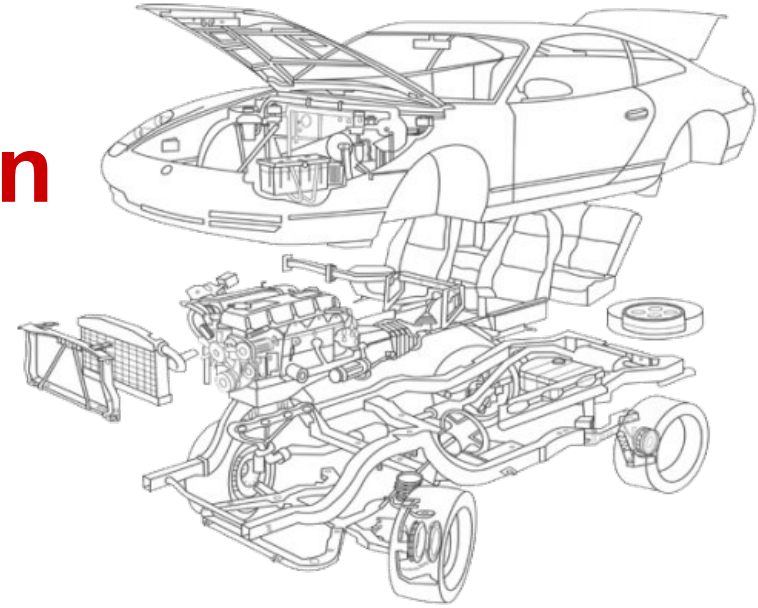
Tuesday, September 12, 2017

9:45 AM - 11:15 AM





Innovation In Housing



“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

Appointed to ICC's Commercial Energy Code Development & Code Correlation Committees (2015 cycle)

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

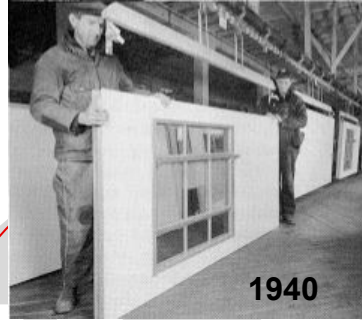
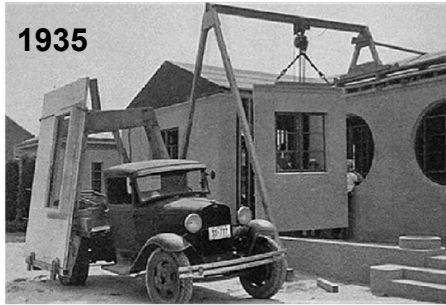
Created Center for Building Excellence at BASF and led long-term construction strategy

Consultancy connecting innovators to executives thru innovation scouting, strategic alliances and business guidance.

Evolution

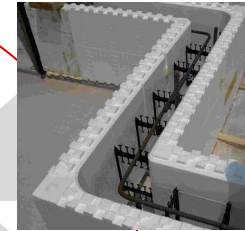
RESIDENTIAL INDUSTRY

“CONSTRAINED EVOLUTION”



1940-50's

- ❑ WEEKS to build a home
- ❑ Home price to income = 2.2



2016

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

2017



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

130 years

Resid. construction has a
~\$80B productivity gap

Feb. 2017 McKinsey&Company

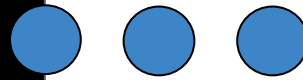
Root Issues



- 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



Root Issue



CONSTRUCTION R&D IS BELOW INDUSTRY STANDARDS

	Total Const. Mar.	Total Constr. Research	% of Total	Builder	Contractor	Material	Gov't	All Others
<u>1984*</u>	\$312B	\$1.2B	0.4%	n/a	\$54M	\$840M	\$200M	\$111M
2016**	\$1.2T	\$10.2B	1.0%	n/a	n/a	\$8B	n/a	n/a

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

= RISK

*“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

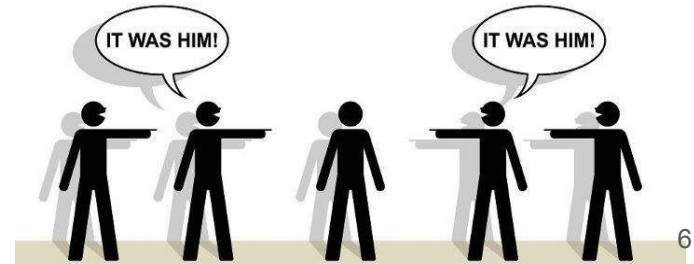
Residential construction procurement is complex:



- 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



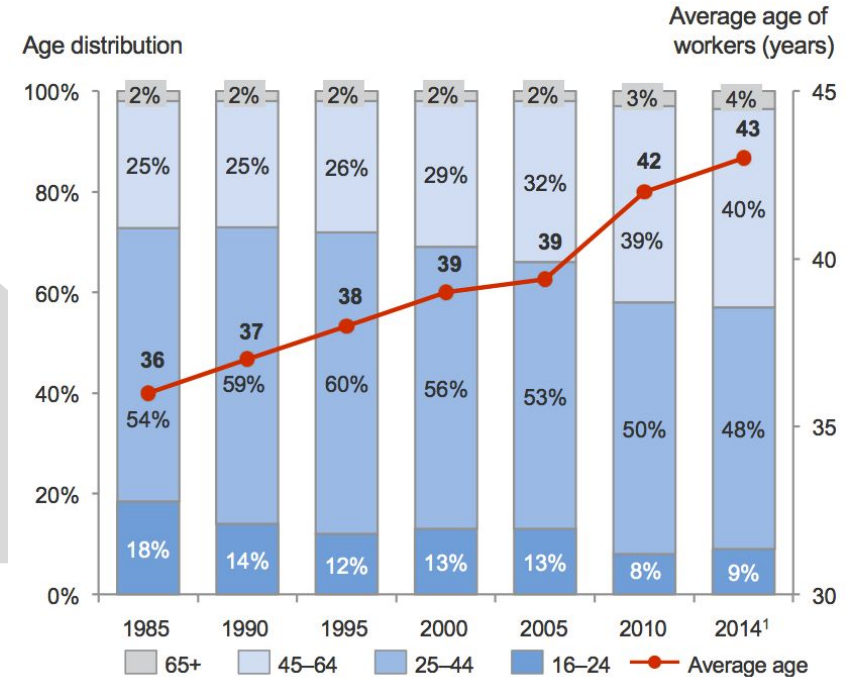
LABOR ISSUES GETTING WORSE

- 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).”

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

Figure 15: Worker Age in the US Construction Sector, 1985-2014⁸²



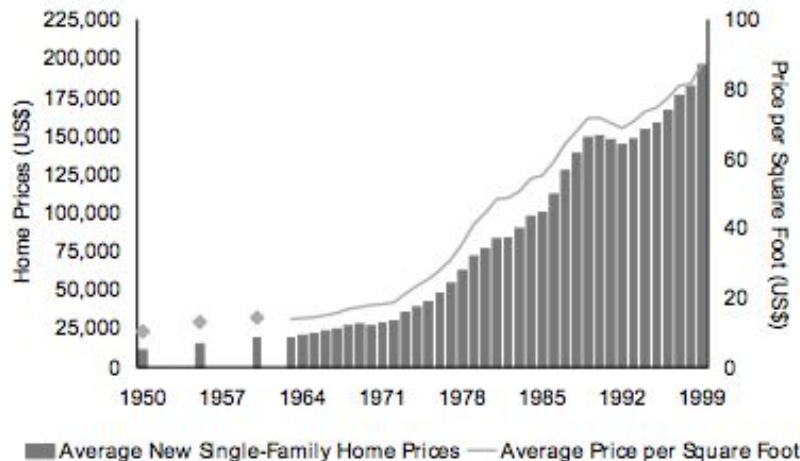
¹ Latest figures available

Source: US Bureau of Labor Statistics; World Economic Forum; The Boston Consulting Group



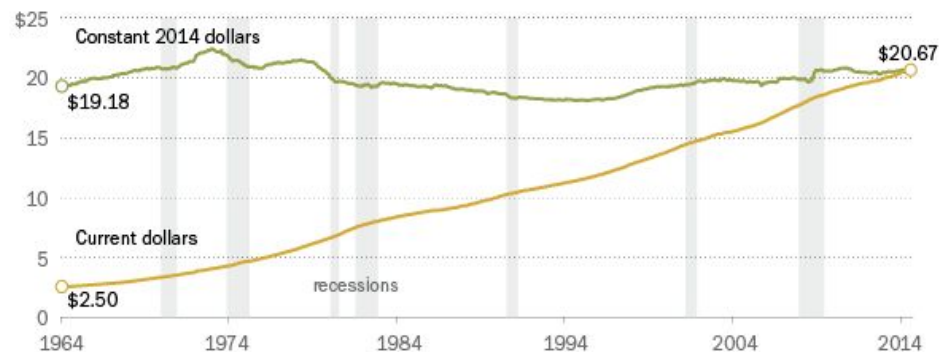
CONSTRUCTION COST RISING, WAGES STAGNATED

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



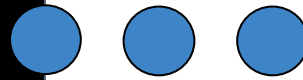
Note: Data for production and non-supervisory employees on private non-farm payrolls.
Source: Bureau of Labor Statistics

PEW RESEARCH CENTER

Year	FHA	Cost / sq.ft.	Reg. Burden (lot/house)
1950	4.2%	\$6	11%
1972	7.0%	\$18	
1999	7.5%	\$87	
2016	4.5%	\$114*	25% (16/9)

*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.

Impetus

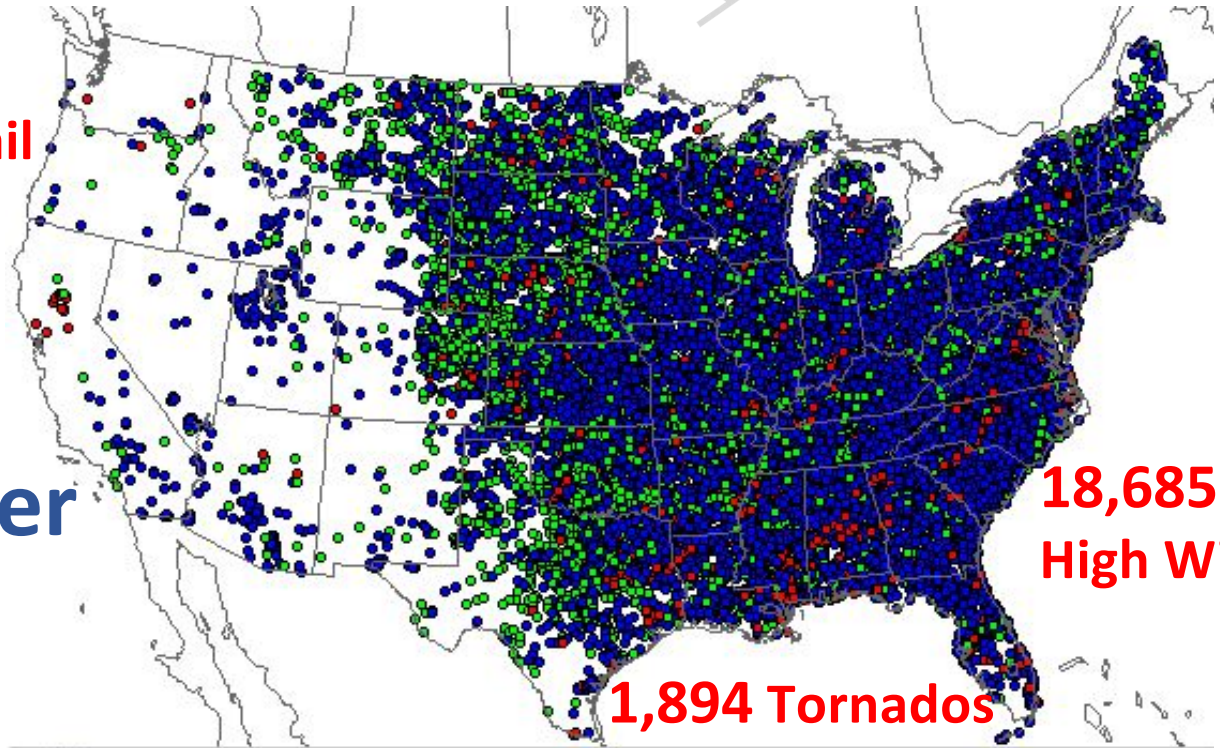


PROPERTY INSURANCE RISK MODELS ARE OBSOLETE

9,417 Large Hail
1" or greater

29,996

Severe Weather
Reports



18,685
High Wind

1,894 Tornadoes

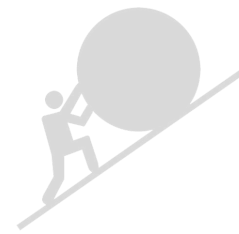
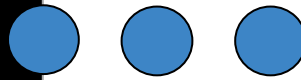


PRELIMINARY SEVERE WEATHER
REPORT DATABASE (ROUGH LOG)

NOAA/Storm Prediction Center Norman, Oklahoma

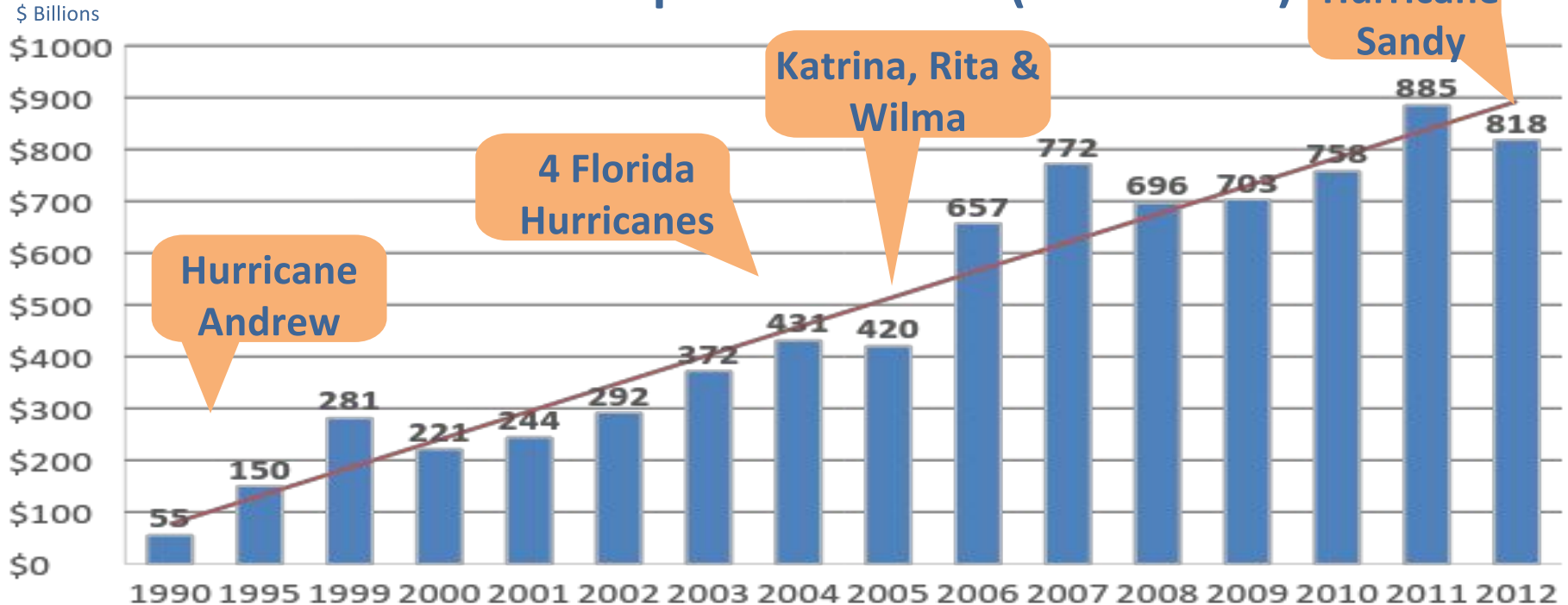
Severe Weather Reports
January 01, 2011 - December 27, 2011

Updated: Tuesday December 27, 2011 16:35 CT



PROPERTY INSURANCE RISK MODELS ARE OBSOLETE

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



REGULATORY ENVIRONMENT

- 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.”



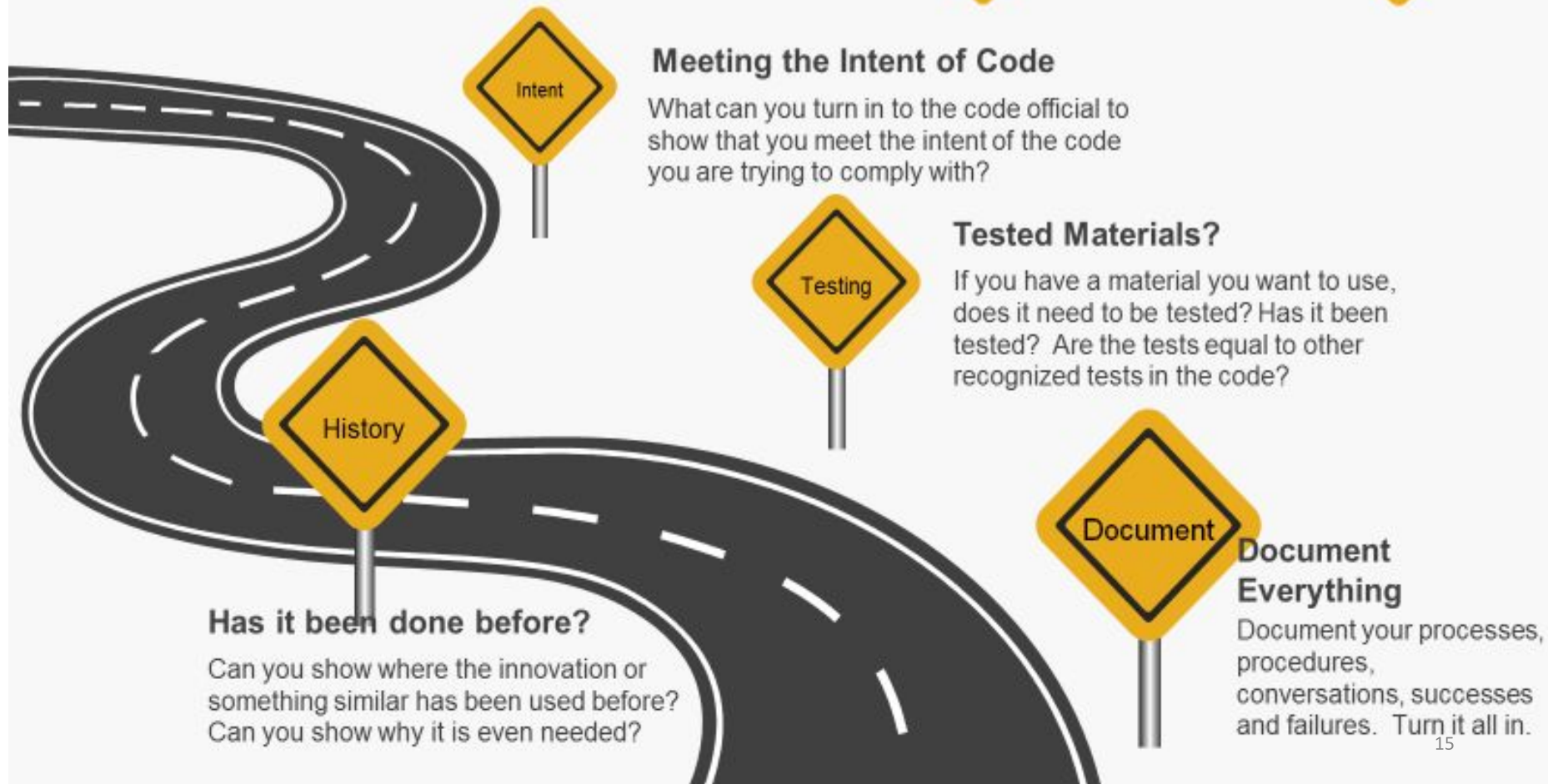
C101.3: This code shall regulate the design and construction of buildings for the use and conservation of energy over the life of each building...

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”



Intent

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?

Testing

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?

History

Has it been done before?

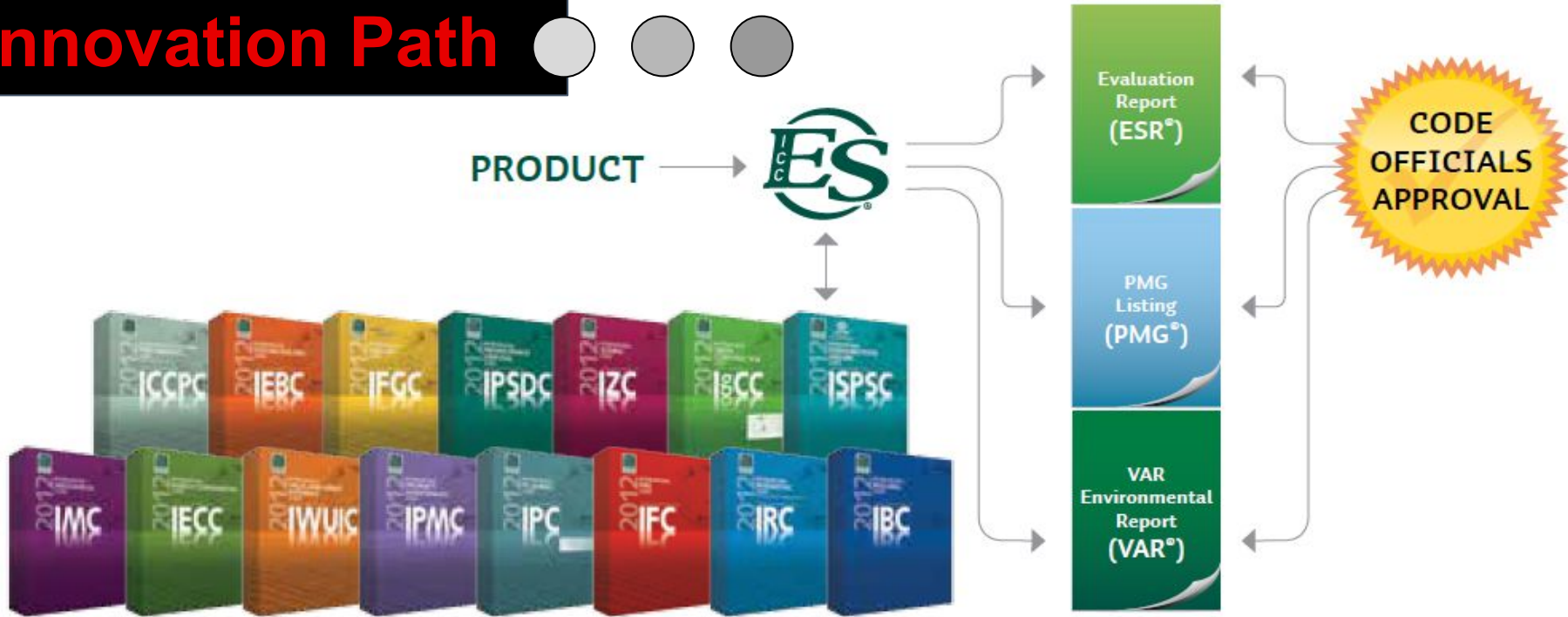
Can you show where the innovation or something similar has been used before?
Can you show why it is even needed?

Document

Document Everything

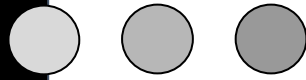
Document your processes, procedures, conversations, successes and failures. Turn it all in.

Innovation Path



ICC EVALUATION SERVICE

Most Widely Accepted and Trusted



What would it take for you to approve it?

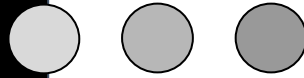




"I'm very creative and creative people are not afraid to fail."

How can our decisions promote or hinder innovation?

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

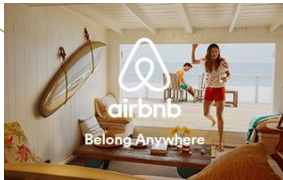
1. Software platforms *rapidly* scale and *drive* the business
2. Sidestep existing business models
3. Deliver “*direct value*” more efficiently



2008 - Airbnb launches.

↑
7 years
↓

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



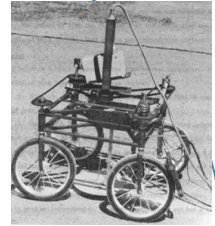
2009 - Ride-sharing service
disrupts 80 year-old taxi system.

↑
7 years
↓

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



1961 - Stanford technology uses
cameras to follow a white line.
(Used in current SDG's)



↑
55 years
↓

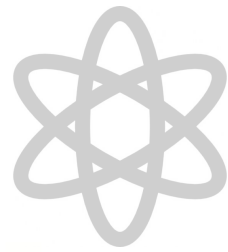
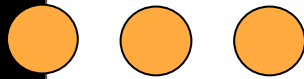
2015 - Tesla enables hands-free control for
highway/freeway driving in a single software
update - overnight.

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



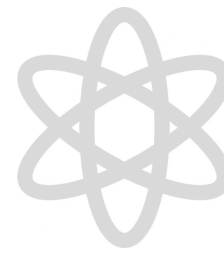


shifthappens



21st CENTURY CONSTRUCTION TOOLS

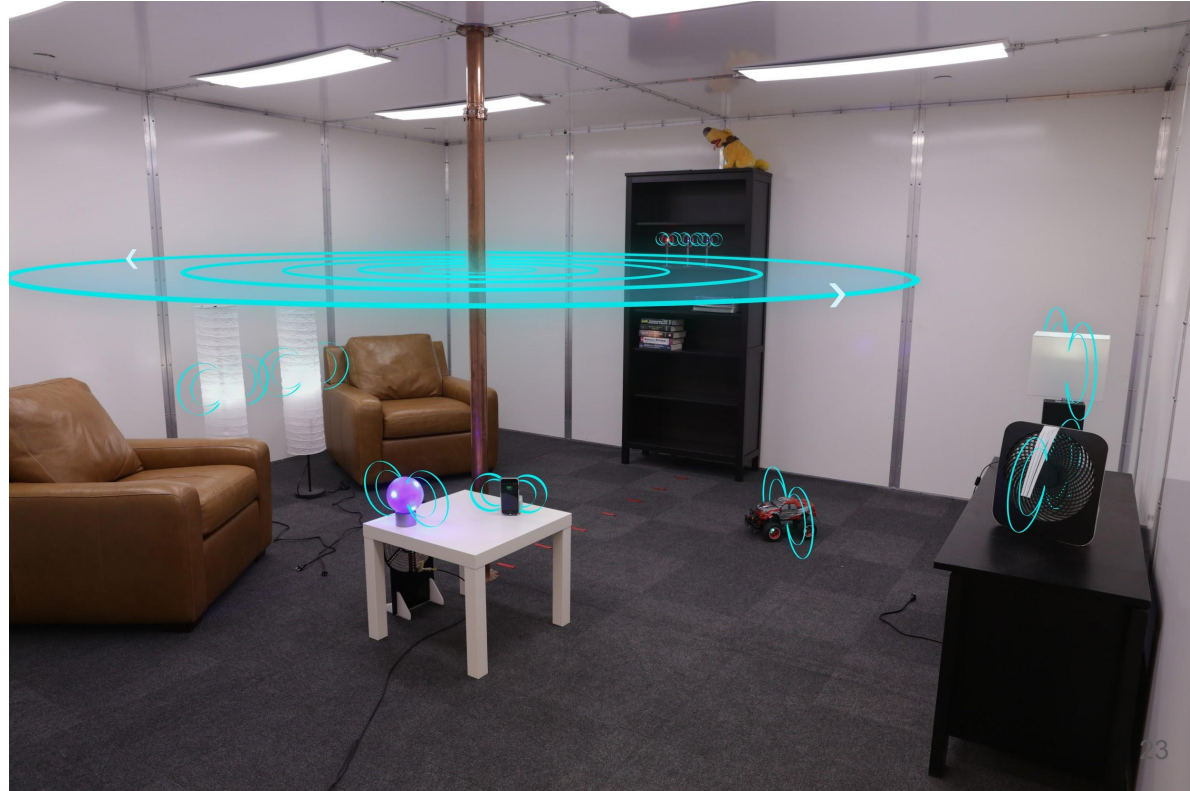




INNOVATIVE TECHNOLOGY

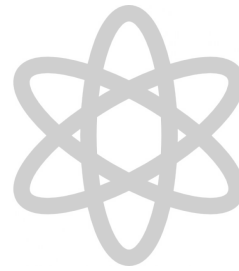
Volumetric Wireless Power for Living Spaces

- Quasistatic Cavity Resonant
- Copper tube in middle of aluminum skinned room
- Safely transmit up to 1,900 watts to a coil receiver w/ 40%-95% efficiency



Disney Research
THE SCIENCE BEHIND THE MAGIC

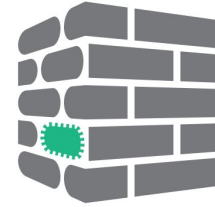
Innovation



INNOVATIVE MATERIAL

bioMASON - mobile factory

- Bricks are **GROWN ON-SITE** in 2-3 days in mobile manufacturing containers



bioMASON
building with nature



Innovation



INNOVATIVE MATERIAL

CLICK ROCK® - *Modular drywall*



Ideal Application: Coffered ceilings, columns, etc.

<http://www.click-rock.com/13/try-click-rock/>

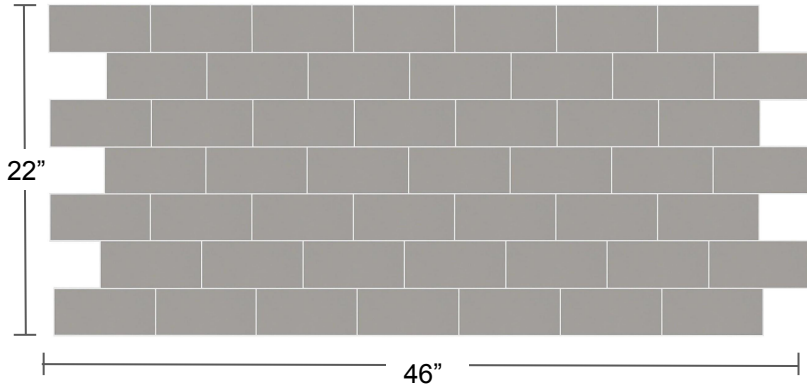




INNOVATIVE MATERIAL

NewTile - Modular tile

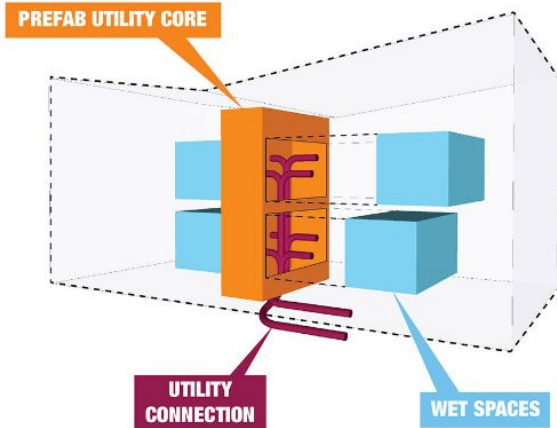
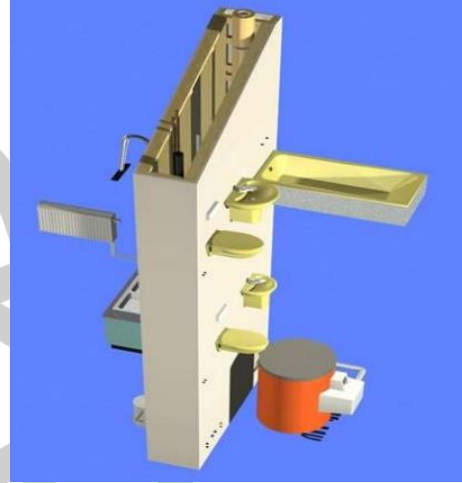
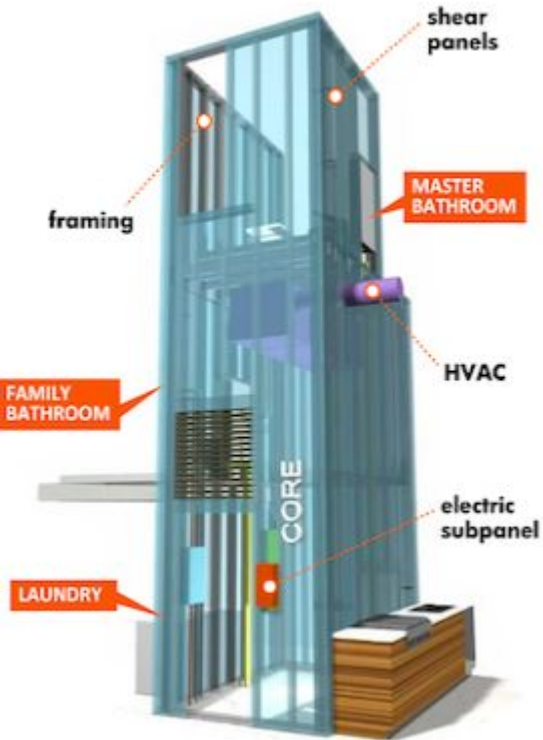
- 5X faster than tile
- No mortar
- Backsplash Tub & Shower Surrounds





INNOVATIVE INTEGRATED TECHNOLOGIES

ProtoCore™



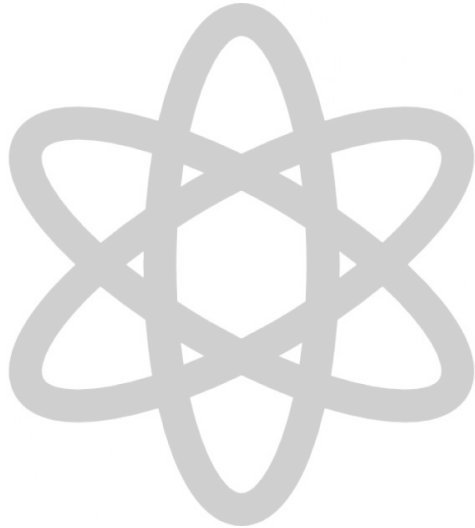
PROTO HOMES



INNOVATIVE TECHNOLOGY

MonoPath

- Large Format Engineered OSB Panels
- 10X Faster Shell
- Panel Size: 8' x 24' x 1 1/8"

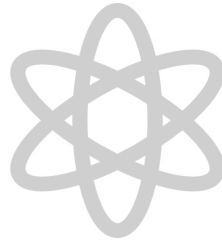




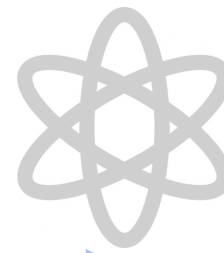
INNOVATIVE TECHNOLOGY

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.

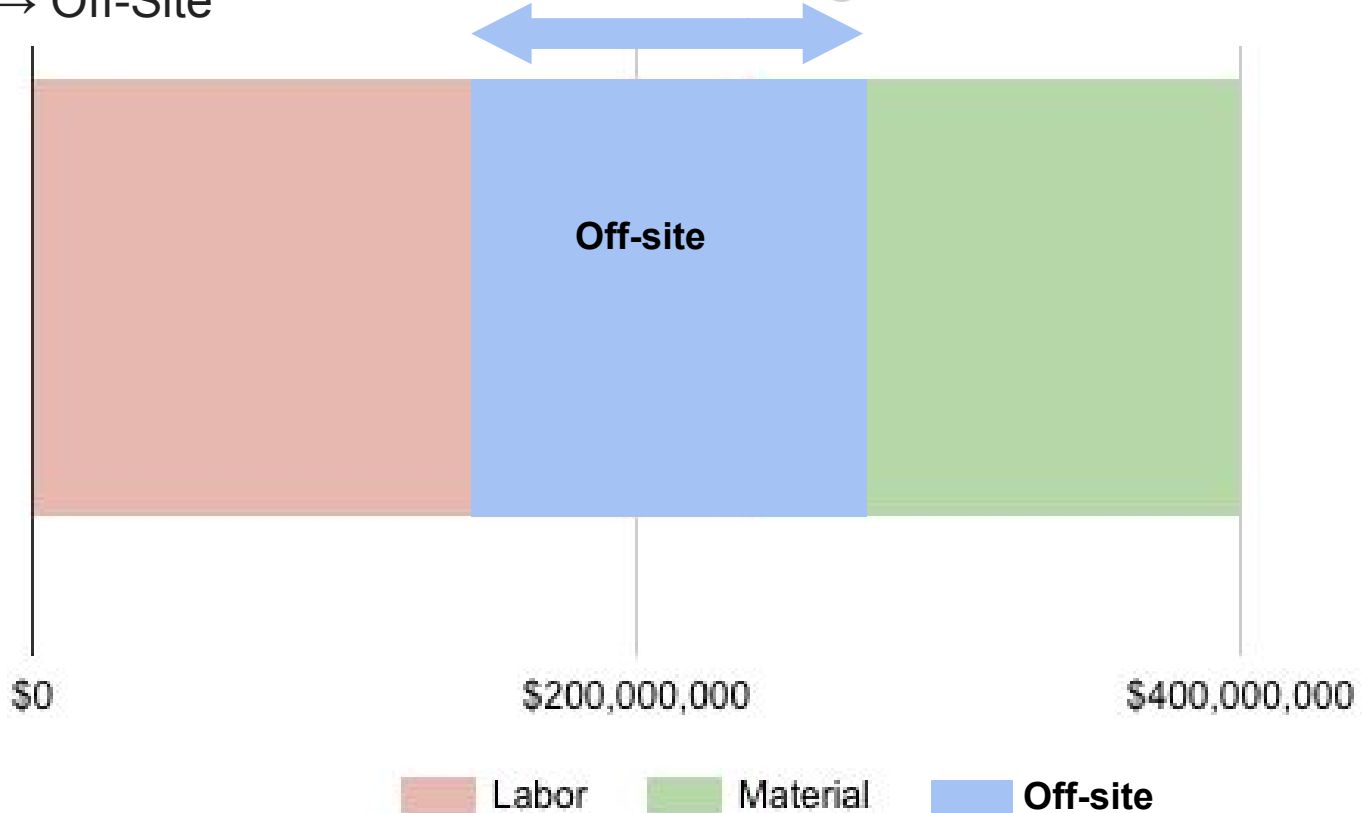


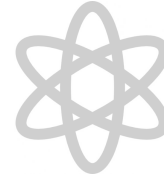
Innovation



“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)



THE ROVING



THE SHONSIE



THE DEGSY



THE COUNTRYSIDE

Innovation

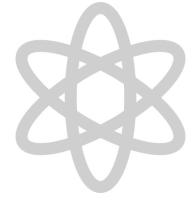


Open Source Ecology

MOMENTUM
INNOVATION
GROUP

INNOVATIVE BUSINESS MODEL

Method: *Off-Site Builders*



Innovation



MOMENTUM
INNOVATION
GROUP

INNOVATIVE INTEGRATED TECHNOLOGIES



1960 - \$500 M



2006 - \$350 M



2016 - \$57 M



MOMENTUM
INNOVATION
GROUP

Space Construction

MOMENTUM
INNOVATION
GROUP

MADE IN SPACE AND LOWE'S PARTNERSHIP

Together, Made In Space and Lowe's will be bringing tools to space and technology to Earth.

PRESS RELEASE

Momentum

DISRUPTIVE INNOVATION IS ...

Collaboration will be the tip of the spear in our information world ... staying connected to the neural network of ideas, expertise, innovation, and consumers

