



**IVORYINNOVATIONS**

**DRAFT VERSION – NOT FOR PRESENTATION**

**Lego Blocks and Robots:  
Turbocharging Housing Production**  
2024 FHC Affordable Housing Conference  
Chad Reed, Director of Programs and Growth



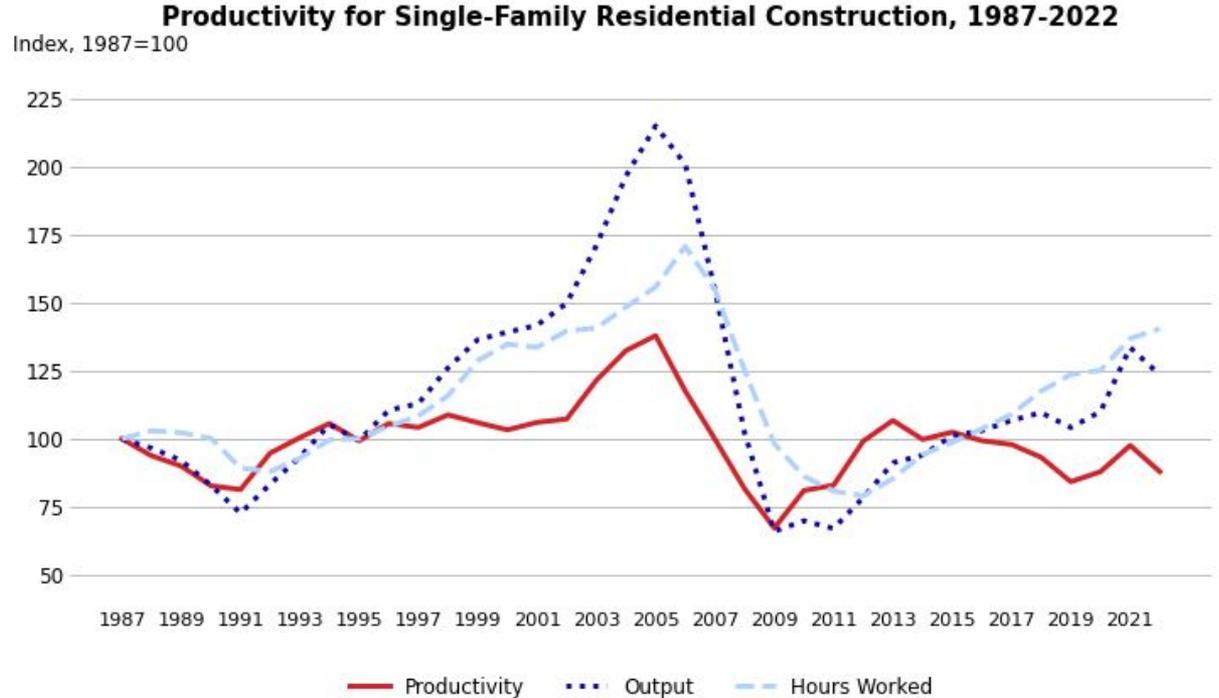
# What is construction innovation?

Novel solutions to improve **productivity**

Productivity =  $output / hours\ worked$

Output = number of housing units

Hours worked = time and money



Source: U.S. Bureau of Labor Statistics

# Why does productivity matter to housing affordability?

**Table 1. SINGLE-FAMILY PRICE AND COST BREAKDOWNS**  
**2022 National Results**

|   |                        |                       |
|---|------------------------|-----------------------|
|   | Average Lot Size:      | 17,218                |
|   | Average Finished Area: | 2,561                 |
| <b>I. Sale Price Breakdown</b>                  | <b>Average</b>         | <b>Share of Price</b> |
| A. Finished Lot Cost (including financing cost) | \$114,622              | 17.8%                 |
| B. Total Construction Cost                      | \$392,241              | 60.8%                 |
| C. Financing Cost                               | \$12,192               | 1.9%                  |
| D. Overhead and General Expenses                | \$32,979               | 5.1%                  |
| E. Marketing Cost                               | \$4,268                | 0.7%                  |
| F. Sales Commission                             | \$23,080               | 3.6%                  |
| G. Profit                                       | \$65,369               | 10.1%                 |
| <b>Total Sales Price</b>                        | <b>\$644,750</b>       | <b>100.0%</b>         |

Construction cost = appx. 40% labor, 60% materials

# Why does construction innovation matter to housing affordability?

Construction innovation increases productivity

Increased productivity = greater output per hour worked

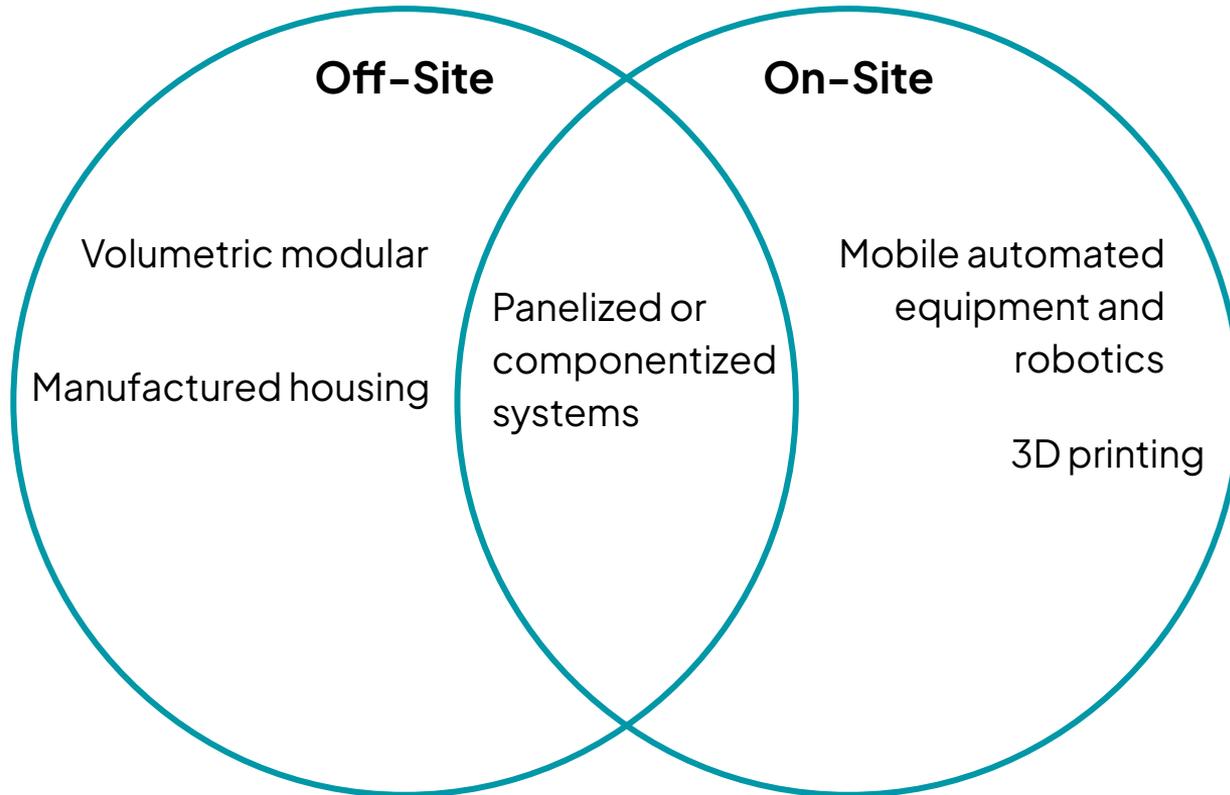
**More units of housing for the same amount of time and money**

(Material and labor innovations matter too)

# Innovative construction methods

- Volumetric modular
- Manufactured housing
- Panelized or componentized systems
- Mobile automated equipment and robotics
- 3D printing

# Innovative construction methods



# Innovative construction methods: **Manufactured housing**

- Built to federal building code (HUD code)
- Usually installed without a crane
- Single-family
- Example: Clayton Homes



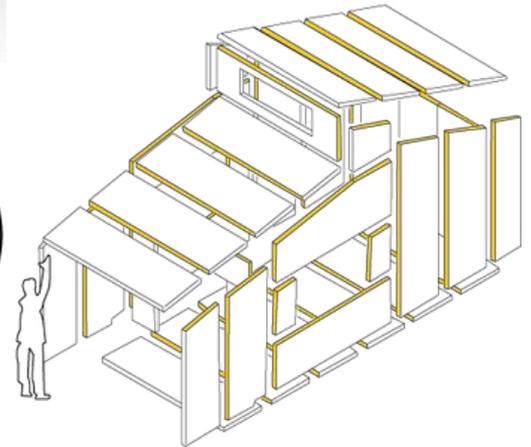
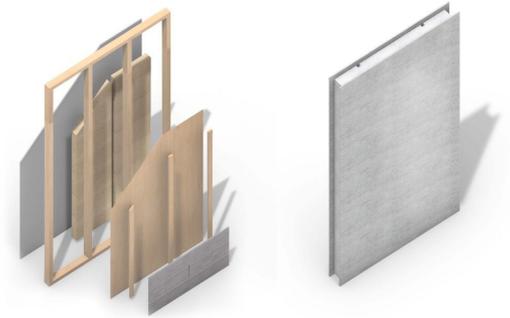
# Innovative construction methods: **Volumetric modular**

- Entire rooms or building sections built in a factory
- Crane-set on site
- Single or multifamily
- Example: VBC (Volumetric Building Companies)



# Innovative construction methods: Panelized/componentized systems

- Varying degrees of prefabrication but less than modular or manufactured
- Can be a single component or a full building system
- Single or multifamily
- Example: Onx or RENCO



# Innovative construction methods: **Mobile automated equipment/robotics**

- Small but growing sector
- Usually focused on a single task or trade
- Generally geared towards large multifamily
- Example: Canvas



# Innovative construction methods: 3D printing

- Automated concrete placement
- Two types: robotic arm and gantry system
- Usually single-family
- Example: Apis Cor



# Innovative construction methods: Overview

- Automated concrete placement
- Two types: robotic arm and gantry system
- Usually single-family
- Example: Apis Cor

| Construction Method                            | Number of trades impacted | Ease of Implementation | Versatility | Other considerations                                    |
|--|---------------------------|------------------------|-------------|---|
| <b>Manufactured housing</b>                    | High                      | High                   | Low         | Implicit regulatory barriers, social stigma             |
| <b>Volumetric modular</b>                      | High                      | Low                    | High        | Easier unit replication for multifamily                 |
| <b>Panelized or componentized systems</b>      | High                      | High                   | High        | Compromise between customization and prefab efficiency  |
| <b>Mobile automated equipment and robotics</b> | Low                       | High                   | High        | High upfront cost necessitates large volume of projects |
| <b>3D printing</b>                             | High                      | Low                    | Low         | Concrete intensive projects only                        |

## Conclusion: Lots of good ideas, not a lot of implementation

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- Total market share of non-site built single-family homes (modular and panelized) was at 2% of single-family in 2021. **Why?**
  - Code Requirements.
  - Higher upfront costs in multiple locations compared to traditional construction.
  - General contractor's limited knowledge in assembly processes, which adds more cost.
  - New ideas are always risky at first, building knowledge through implementation.