



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



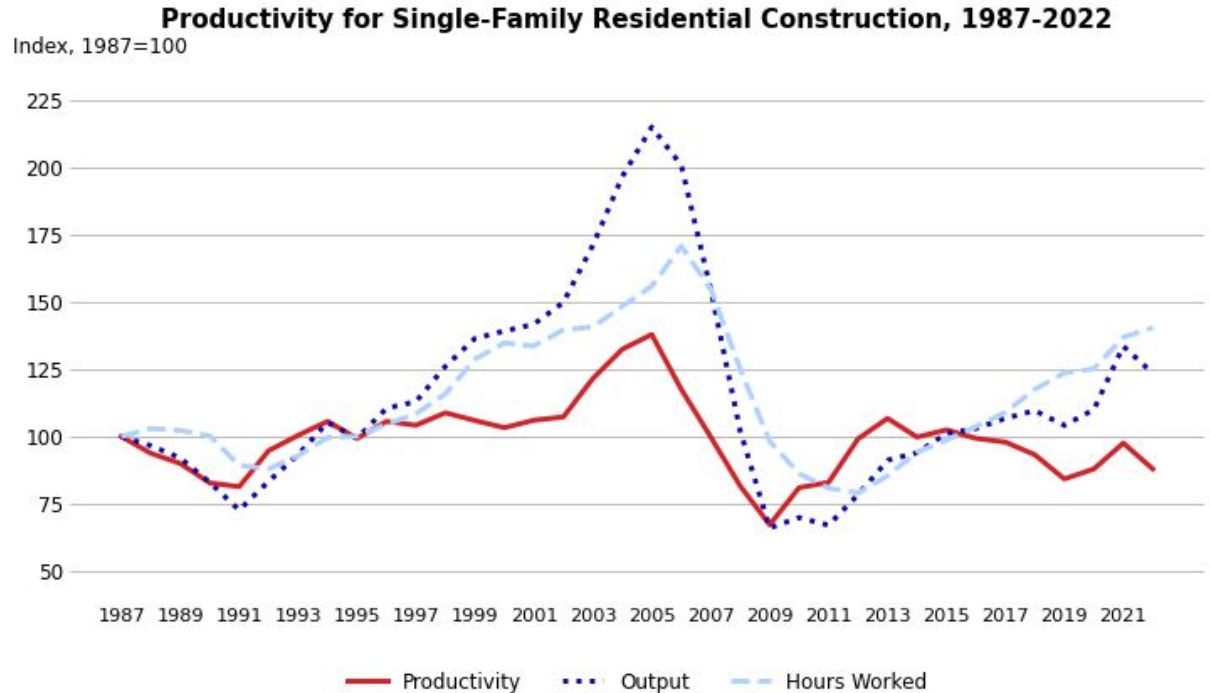
What is construction innovation?

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 |
| I. Sale Price Breakdown | Average | Share of Price |
| 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% |
| Total Sales Price | \$644,750 | 100.0% |

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

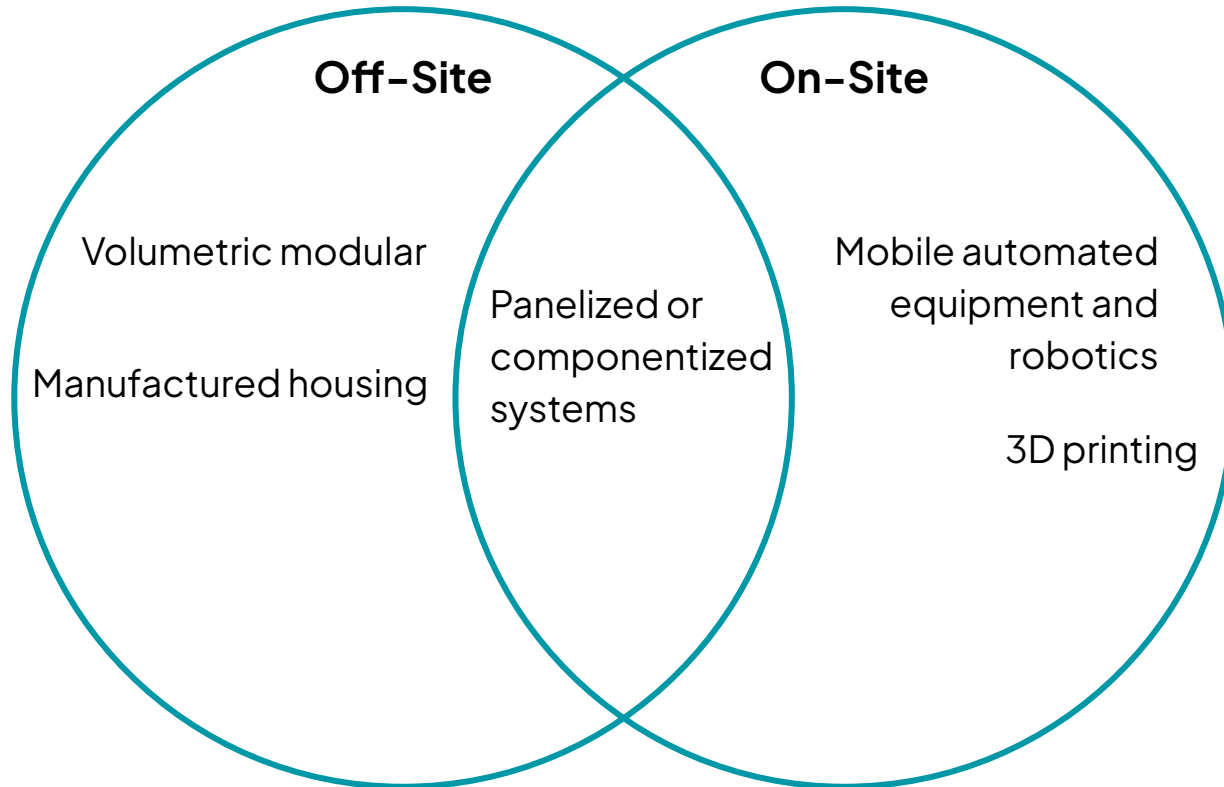
More units of housing for the same amount of time and money

(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



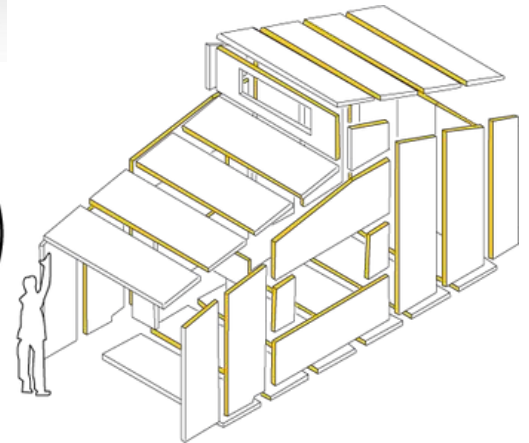
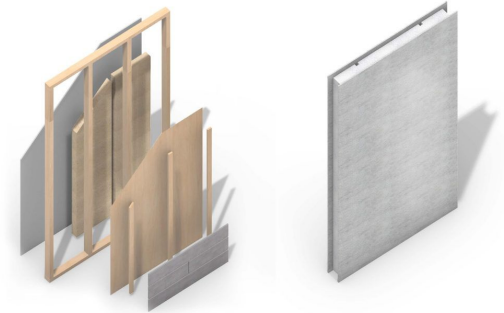
Innovative construction methods: **Volumetric modular**

- 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 |
|--|---------------------------|------------------------|-------------|---|
| Manufactured housing | | | | Implicit regulatory barriers, social stigma |
| Volumetric modular | | | | Easier unit replication for multifamily |
| Panelized or componentized systems | | | | Compromise between customization and prefab efficiency |
| Mobile automated equipment and robotics | | | | High upfront cost necessitates large volume of projects |
| 3D printing | | | | Concrete intensive projects only |

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

- 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.