

Bringing the Best of Manufacturing to Construction

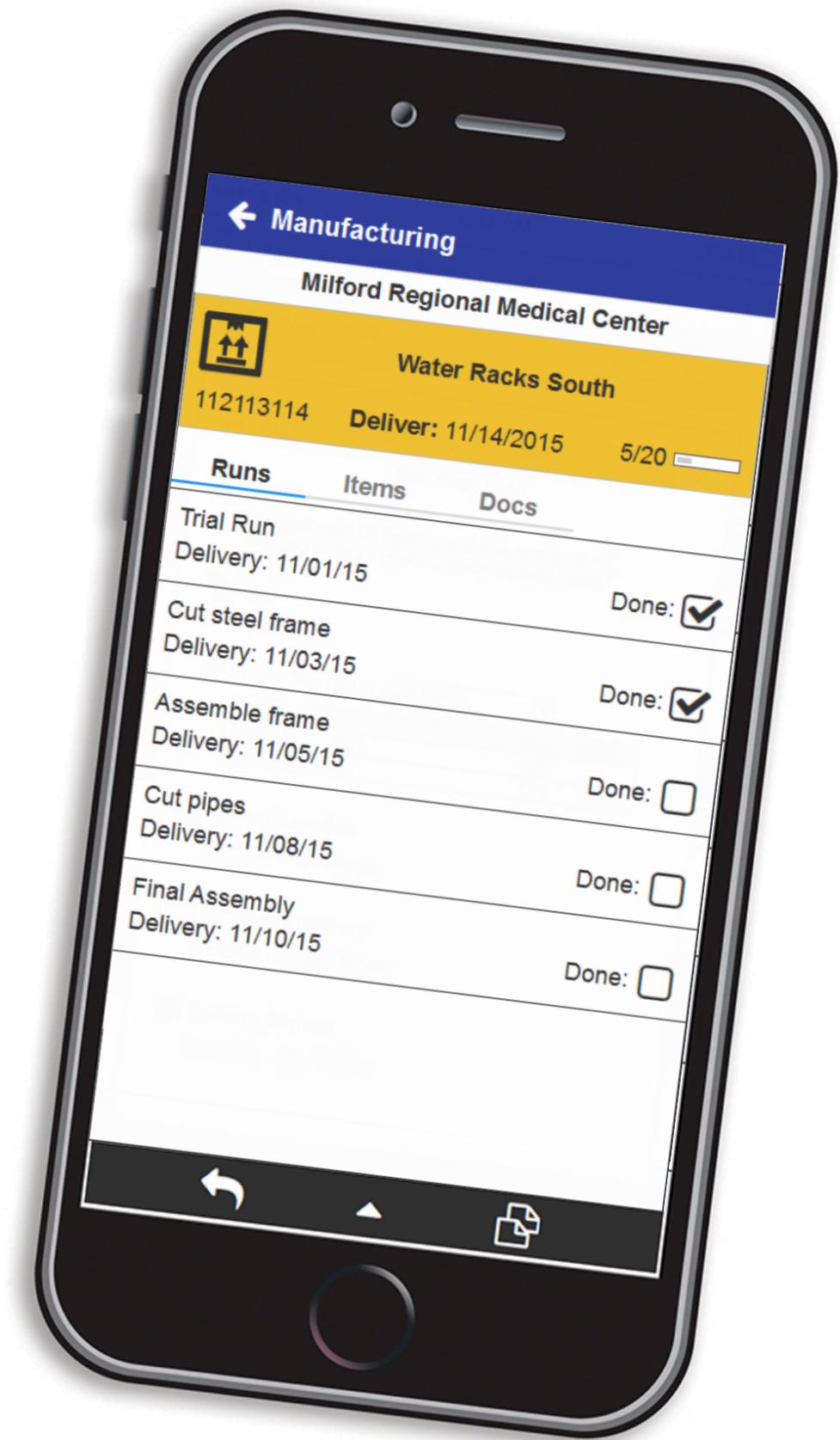
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@ManufactOn @Consigli1905

Class Summary: *Bringing the Best of Manufacturing to Construction*

“Learn about the convergence of manufacturing and construction, and discover the techniques for optimizing construction projects to capitalize on distributed and coordinated manufacturing.”



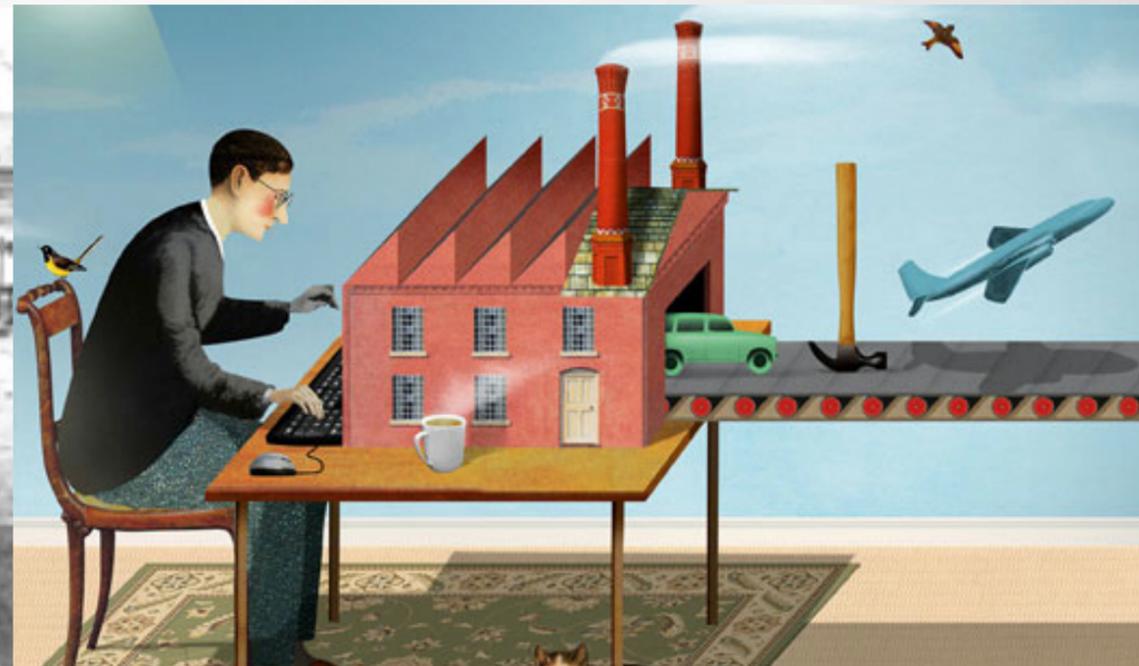
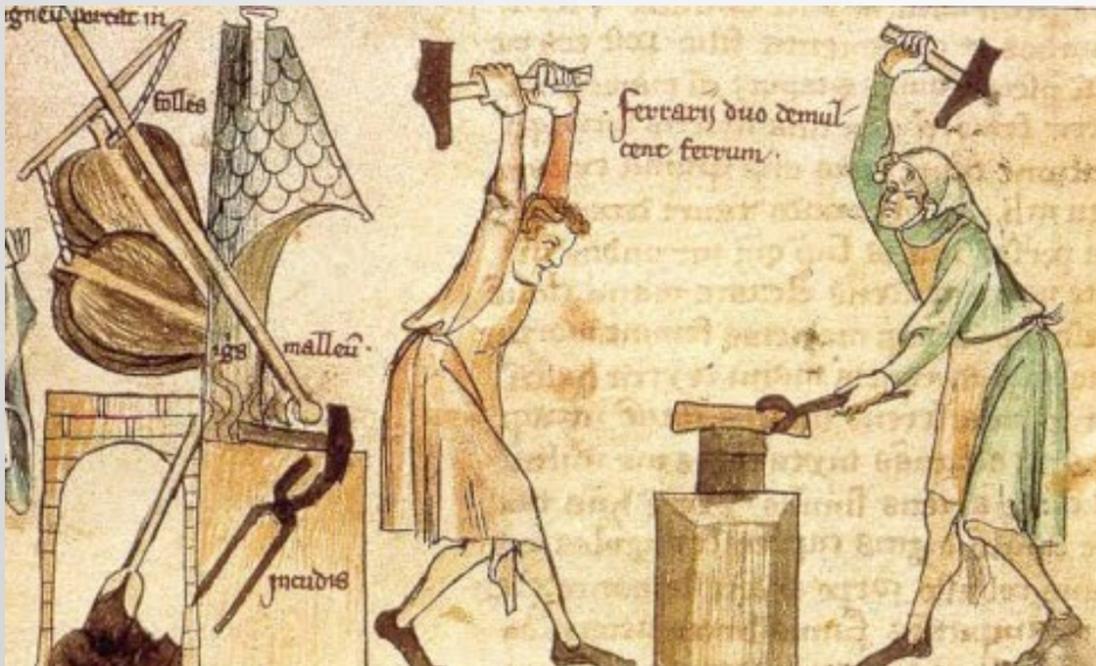
Key Learning Objectives

At the end of this class, you will:

1. Know how manufacturing evolved to today's vision of highly distributed manufacturing
2. Understand parallels to construction's vision for highly distributed manufacturing and steps to get there
3. Understand drivers and constraints to maximizing prefab on construction projects
4. Know how construction companies are adopting technologies and methodologies today to achieve highly distributed manufacturing



Industrial History 101: How Manufacturing Has Evolved to Today's Vision of Highly Distributed Manufacturing



Industrial History 101: Pre-Industrial Manufacturing and Construction

Pre-industrial production, 1300 to 1750:

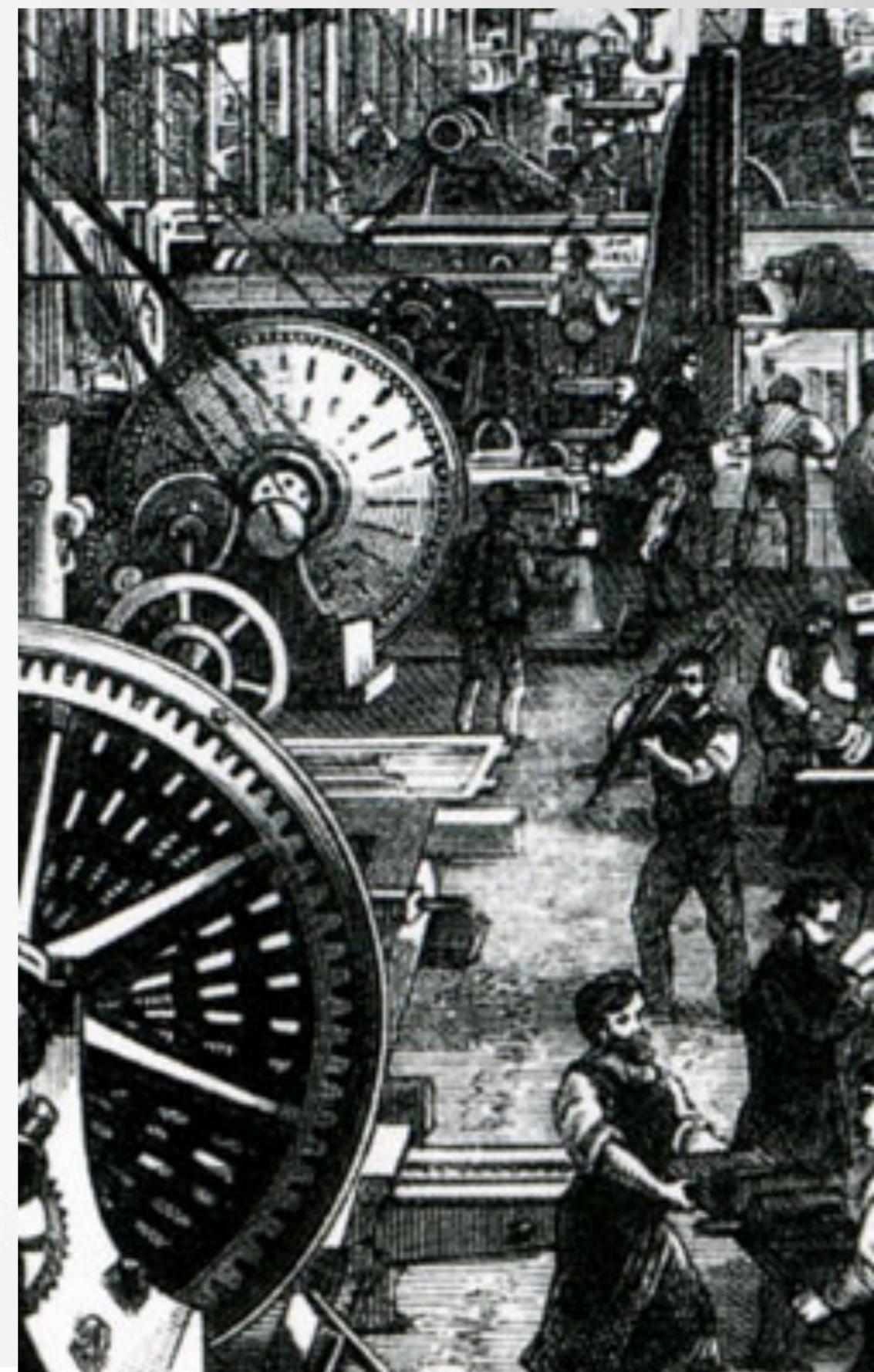
- Individual, skilled craftsmen
- Cottage industries
- Custom production
- Master builders
- Custom construction



Industrial History 101: The First Industrial Revolution

Highlights of the First Industrial Revolution,
18th and 19th centuries:

- Birth of the factory
- Began with mechanization of textile industry
- Impact of better steam engines
- Efficient water power
- Custom/hand labor begins to be replaced
- Huge gains in productivity
- Industrial growth concentrated in urban areas



Industrial History 101: The First Industrial Revolution

Effects of First Industrial Revolution
on construction:

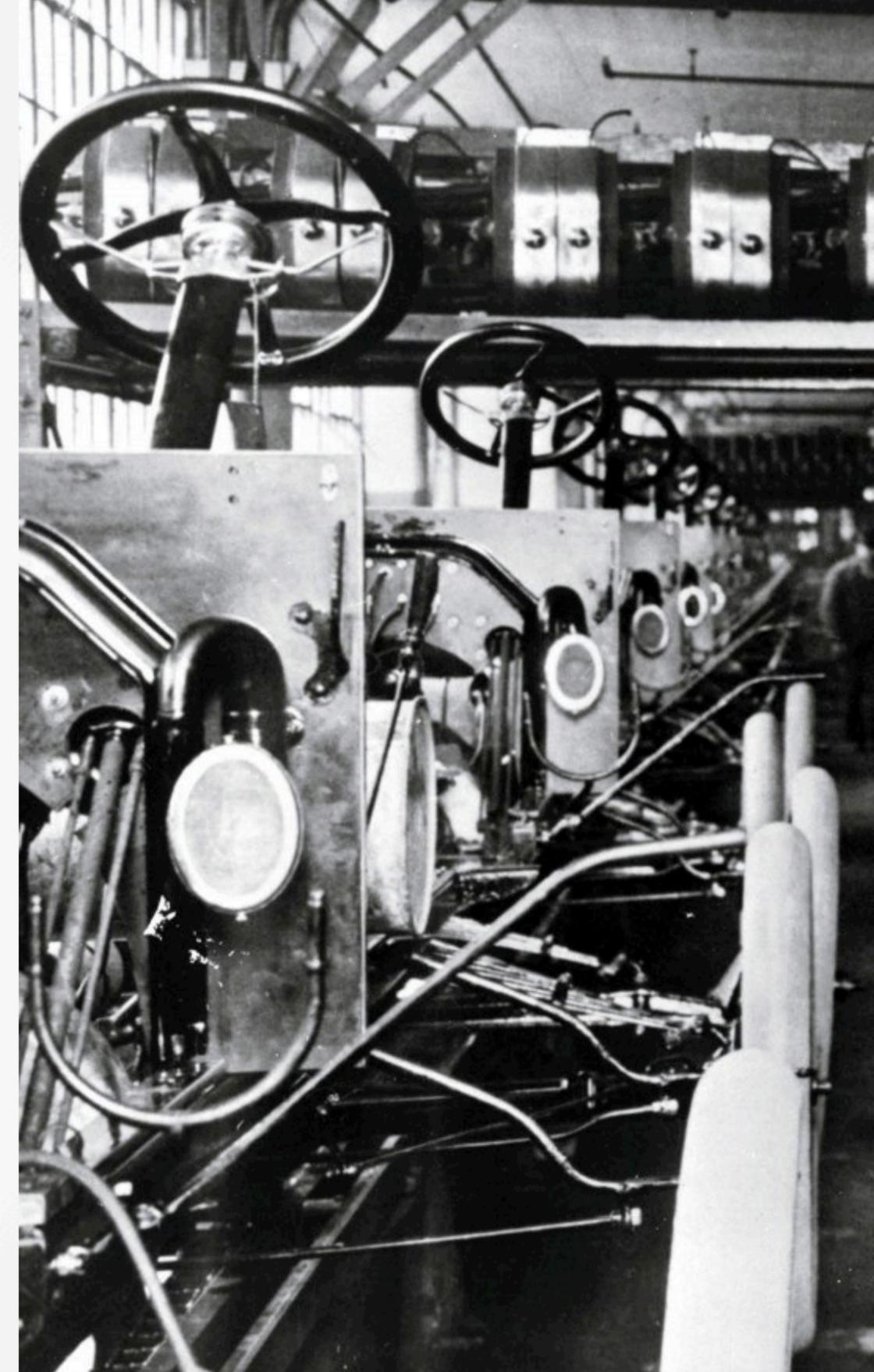
- Little impact on construction methods
- Continued work of skilled craftsmen
- Custom design and construction



Industrial History 101: The Second Industrial Revolution

Highlights of Second Industrial Revolution,
early 20th century:

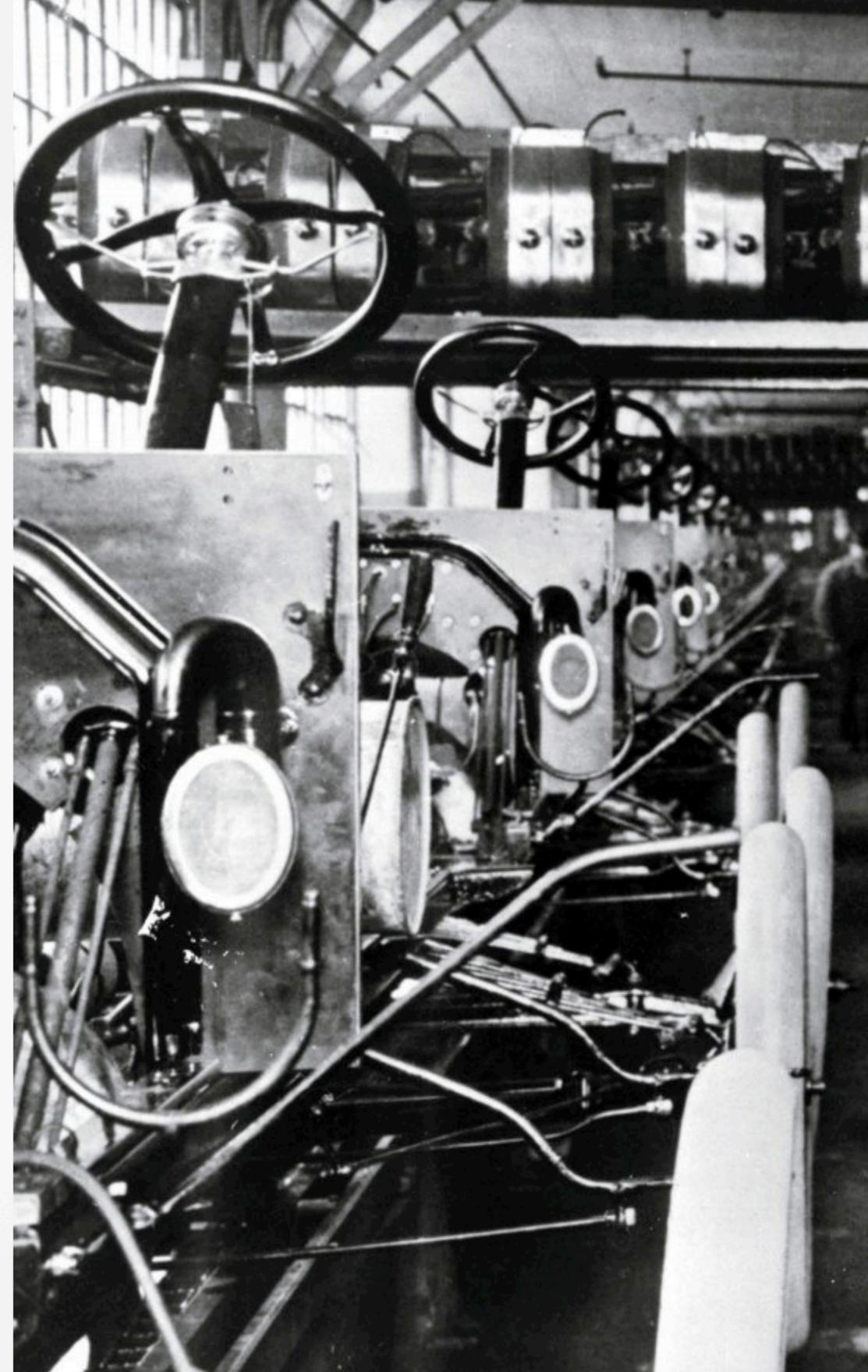
- Moving assembly lines
- The age of mass production
- Wide-scale adoption of earlier innovations: telegraph, railroads, gas and water supplies
- Beginning of unprecedented movement of people and ideas



Industrial History 101: The Second Industrial Revolution

“Any customer can have a car painted
any color he wants—as long as it’s black.”

— Henry Ford, founder *Ford Motor Company*



Industrial History 101: Effects of WWI + II and Beyond

Further standardization and efficiencies:

- Emergence of Lean manufacturing—origin in the “Toyota Production System,” influenced by Henry Ford and the model of the American supermarket
- Lean emphasizes reducing wasted resources—time, transportation, staff, materials, motion, money, poor quality that needs re-work
- Beginnings of the digital revolution



Industrial History 101: The Second Industrial Revolution

Effects of Second Industrial Revolution,
on construction:

- Like First Industrial Revolution,
little benefit for building design and construction
- Mass production—the gift of the Second
Industrial Revolution—not a fit for building
design and construction



Learning from Manufacturing Today: Parallels to Construction's Vision for Highly Distributed Manufacturing



Today: The Third Industrial Revolution

Highlights of Third Industrial Revolution, from mid-20th century to today:

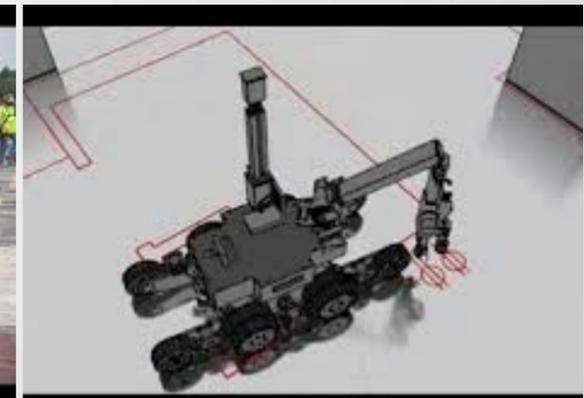
- The digital revolution's effect on manufacturing
- A convergence of technologies: new software; new materials; robotics; 3D printing; Cloud-based services, tools and teams
- Result: manufacturing freed from limitations of mass production
- “Manufacturing of the future will focus on mass customization.” *The Economist*



Today: The Third Industrial Revolution

Initial effect of Third Industrial Revolution on construction:

- Digital, mobile, cloud-based tools
- Customized manufacturing supports the customization required for building construction
- Prefabrication not limited to mass production
- Complex designs possible through more sophisticated BIM capability.
- Robotically controlled or assisted tools



Today: The Third Industrial Revolution

Lean Manufacturing's influence on construction:

- Emphasis on reducing waste of resources—time, transportation, staff, materials, motion, money, poor quality that needs rework
- Continuous improvement
- Emphasis on collaboration, integrated project delivery with team-wide buyin
- Growing use of tools/methods that support Lean construction: building information modeling (BIM), and prefabrication of building components



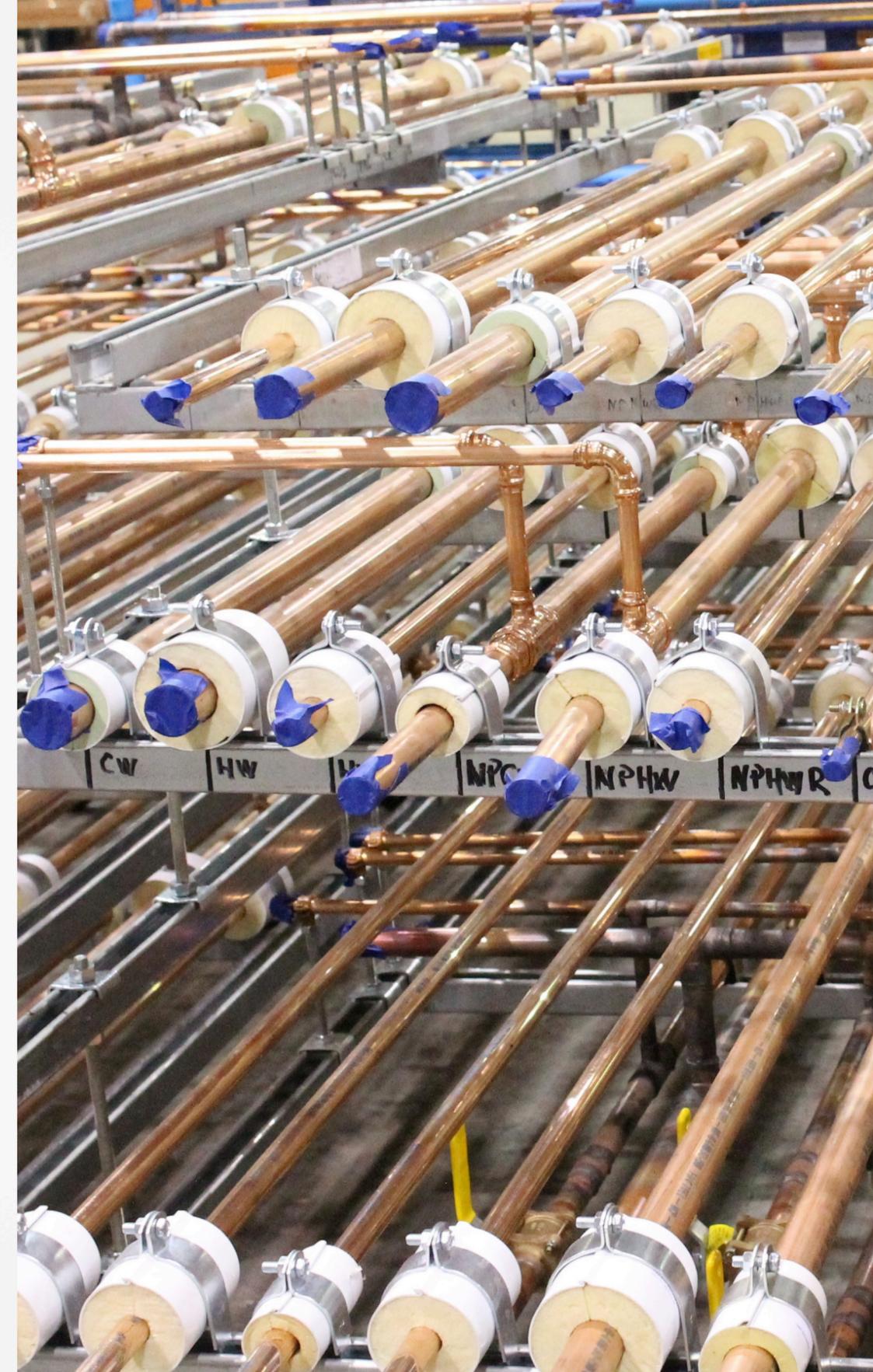
Today: The Third Industrial Revolution

A few quick images of Third Industrial Revolution techniques in construction.

From yesterday's Voorbij (Amsterdam) presentation on innovation: it takes 24 hours to 3D print a concrete house but they can produce precast concrete panels for 18 houses in the same timeframe.



Current State of Prefabrication: Understanding the Drivers and Constraints to Maximizing Prefab on Construction Sites



Trend: The Industrialization of Construction—aka—Prefab

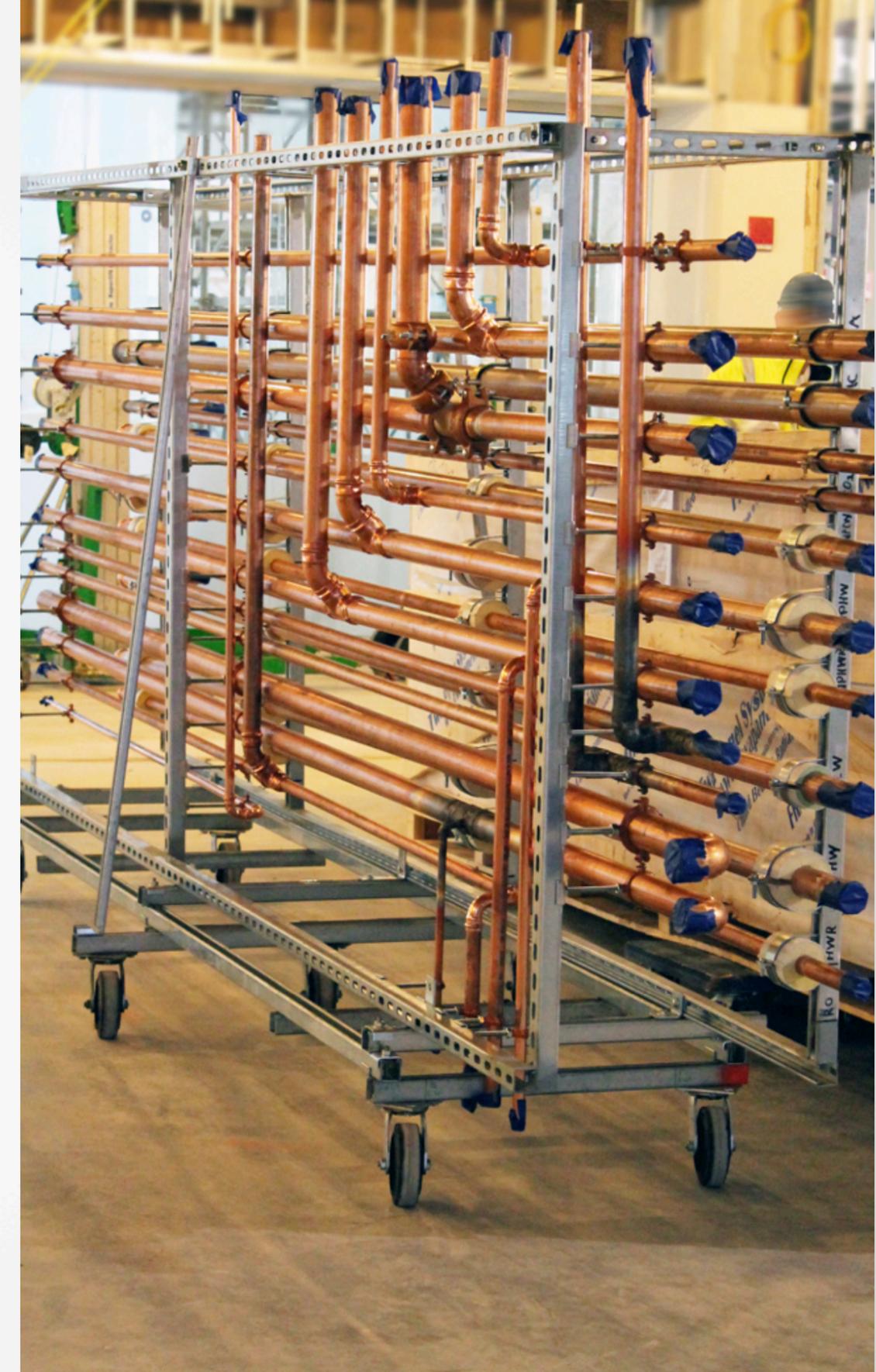
“Model-driven prefabrication and the accelerating use of modular building elements are the leading edge of a tectonic shift in how construction projects will be designed, assembled and maintained.”

From SmartMarket Report: *Business Value of BIM for Construction in Major Global Markets*, from McGraw Hill Construction, 2013



Prefabrication Today: Benefits

- Higher quality construction
- Faster and more efficient installations
- Safer, cleaner construction sites
- Reduces materials deliveries; site traffic
- Better construction work environment



Prefabrication Today: Drivers

- Supports competitive project cost
- Offers a competitive edge in markets calling for prefabrication and modularization, i.e., hospitals, hospitality, education
- Helps address shortages of skilled construction labor
- Makes the most of BIM's benefits— allowing for greater coordination of design with construction
- Increases productivity and safety
- Complements Lean project delivery goals



Prefabrication Today: Constraints

- Resistance to change
- Disruption to established processes
- Additional space required for fabrication
- Lack of purpose-built supporting tools/software



Prefab Trends: Room for Growth

2013 Stats from FMI's 2013 Survey: *Prefabrication and Modularization in Construction*

- 48% of mechanical and electrical contractors had 11% of current work accomplished through prefab assemblies
- 35% of mechanical prefab is being planned during design phase—up from 2010's 11%
- 40% of surveyed contractors consider their prefab capabilities part of their strategic initiative



Prefab Trends

- On the horizon: the “socializing” of prefab’s planning/implementation
- Prefab following a similar path as BIM:
 - Larger Subcontractors
 - Early adopters: CM’s
 - Information sharing from/with Design teams
 - M/E/P design



A CM's Prefab Lab

Milford Regional Medical Center, Milford, Mass.

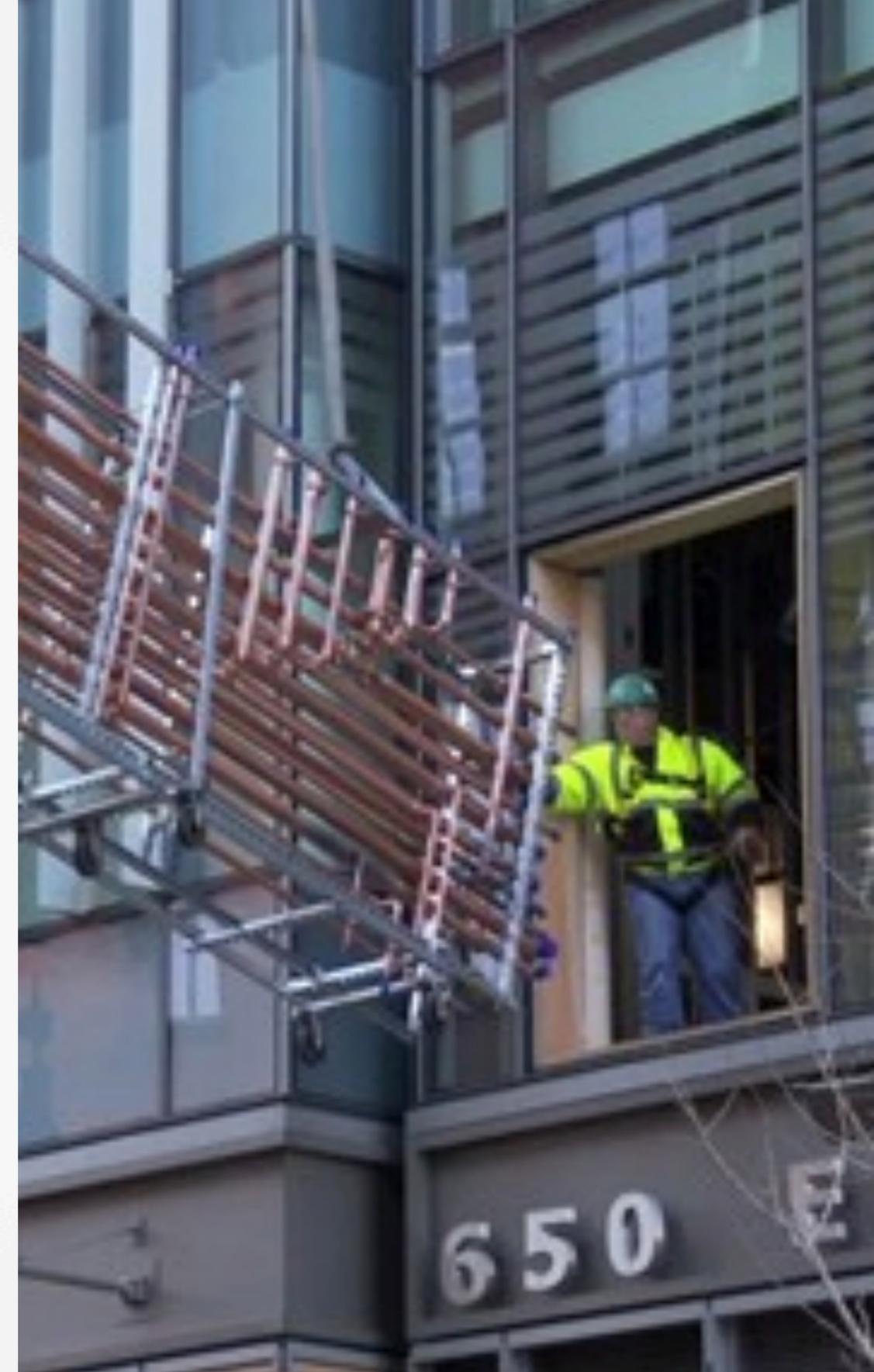
- Transformed warehouse into a facility to support customized pre-fab for a 115,000 sq. ft. Emergency Department and ICU expansion
- Mechanical and plumbing subcontractor collaboration
- Prefab: M/E/P racks
 - 48 racks @ 20 l.f. each
 - 700 man hours offsite
 - Avg. 3 hours/rack for installation
 - Med gas piping tested during prefab



Prefab: Ipsen Bioscience, Inc.

Ipsen, Kendall Square, Cambridge, Mass.

- 44,000 sq. ft. life science laboratory fit-out
- Prefab: M/E/P systems
 - M/E/P piping; bathroom plumbing modules
 - Pre-measured, pre-cut and pre-labeled wiring
 - A month saved; no lost time accidents
 - Part of Lean Project Delivery: “Nothing Hits the Ground”



Prefab: Starboard Place

Starboard Place, Boston, Mass.

- 48,000 sq. ft., four-story, 54-unit wood/masonry residential
- Prefab: Walls
 - 11,785 linear feet of pre-fabricated wall sections, for bearing and non-bearing walls
 - Framing reduced by three weeks
 - Pre-numbered walls and sub-flooring streamlined installation
 - Helped with minimal lay down area: 12,000 sf. footprint on 15,000 sf site



One Prefab example: TG Gallagher

Company Overview

- Full service mechanical contractors serving New England, since 1940
- 200 field employees: pipefitters, service technicians
- 65 office employees, including 16 BIM staff
- Annual volume for 2014 and 2015: \$105 million



One Prefab example: TG Gallagher

Growing Commitment to Prefab

- **2003:** First prefab project—Mass General Hospital’s Yawkey Center—leased 2000 sq. ft. fab space
- **2010:** Built 3,000 sq. ft. fab shop at Cambridge HQ
- **2011:** Moved into 25,000 sq. ft. leased shop
- **2013:** Bought and moved into 40,000 sq. ft. fab shop
- **2014:** 15% of overall trade hours spent in fab shop
- **2015:** Partner in incubation of new “social prefab” software



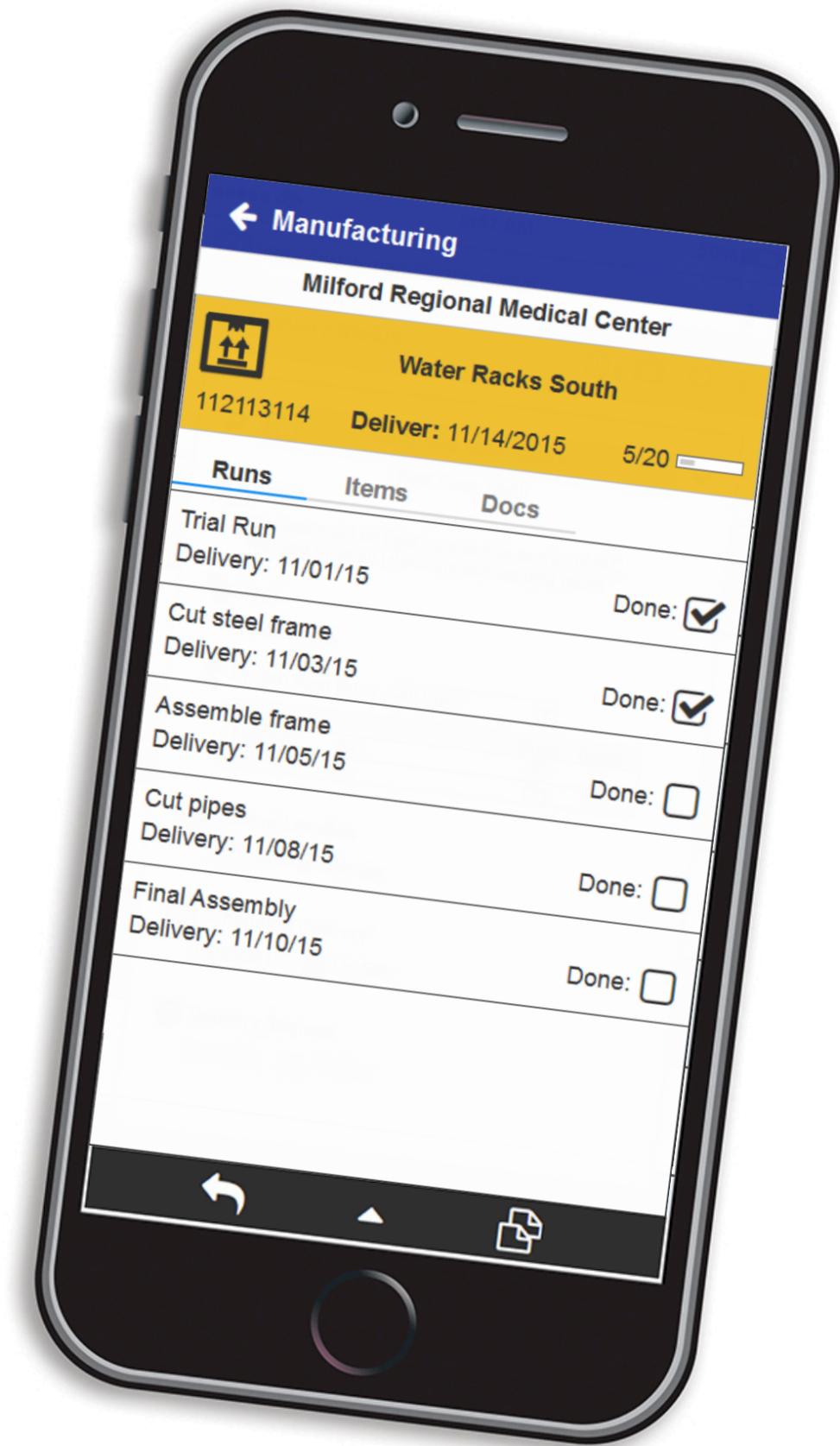
Vision for Today and Tomorrow: How Construction Companies Can Adopt Technologies and Methodologies to Achieve Highly Distributed Manufacturing

Beyond Bathroom Pods: A Vision for Prefab's Future

We have an opportunity to accelerate this development.

Roadblocks/challenges:

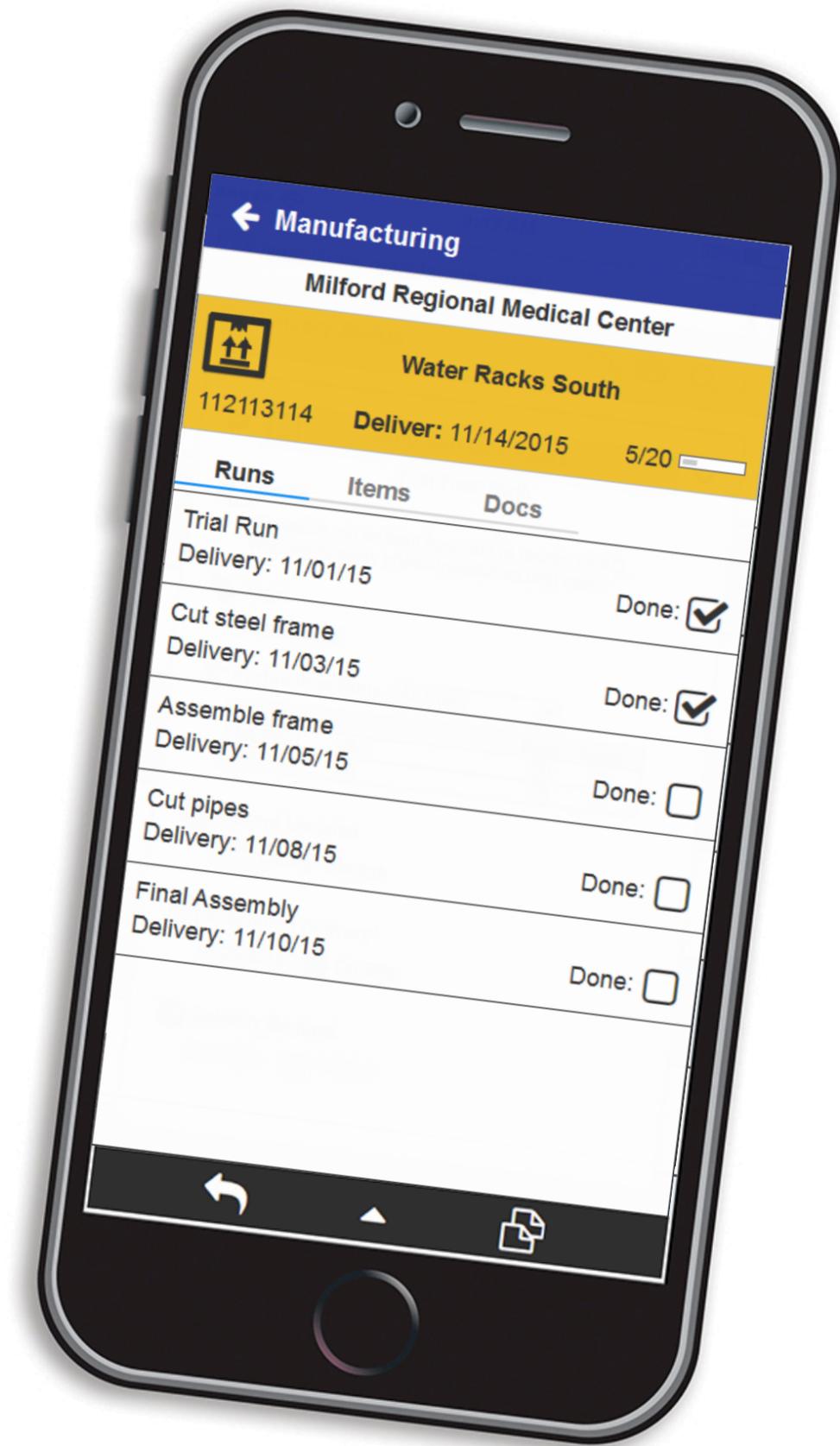
- Communication: hard to know what the status of any particular item is without a phone call.
- No existing supply chain management system to track construction items, components or materials. Excel is still the standard.
- Need better integration between existing software to follow the path from design through fabrication to construction.



Beyond Bathroom Pods: A Vision for Prefab's Future

Opportunities:

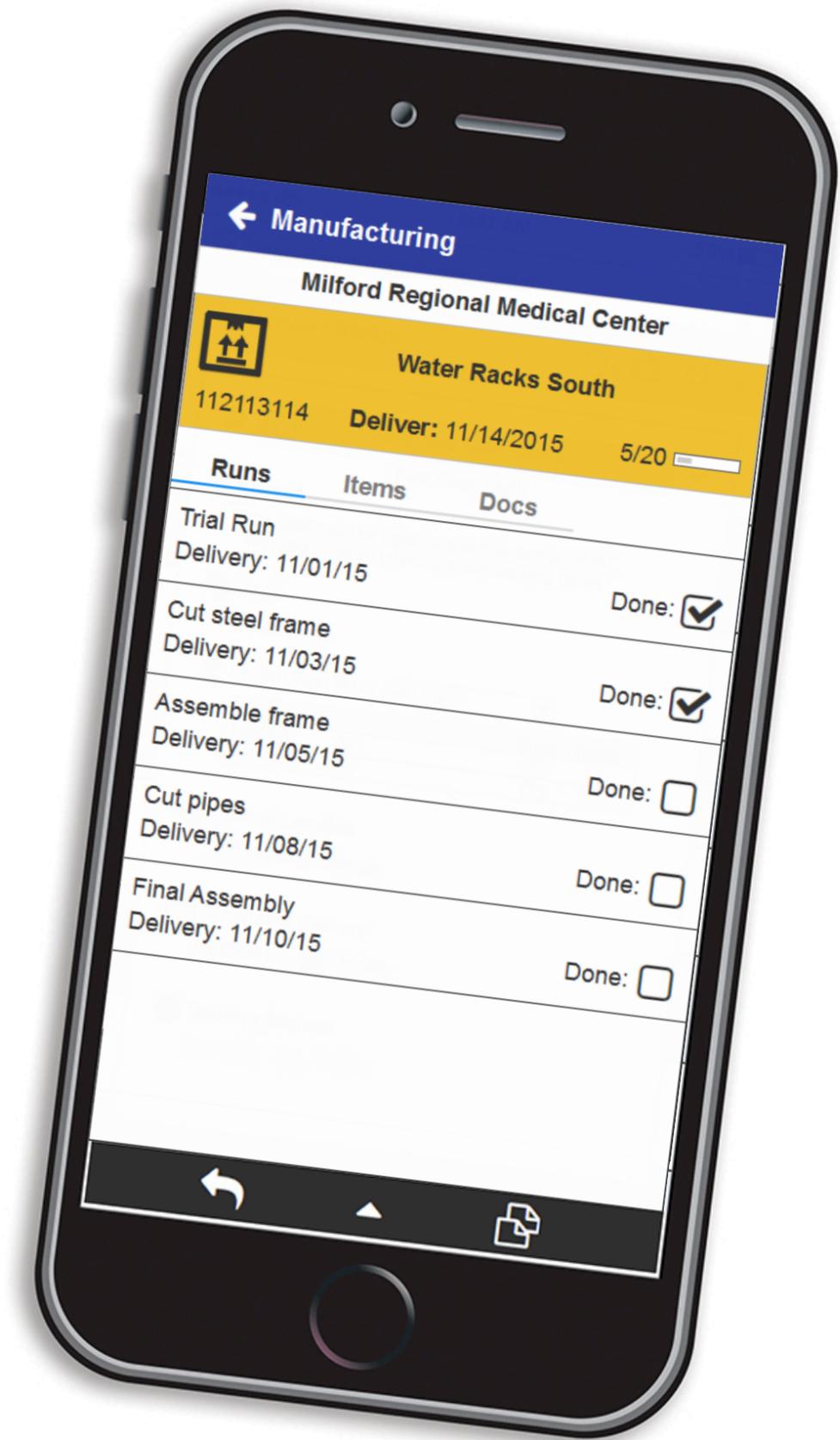
- Collaboration is happening, teams are expecting to have to share information
- Mobile, cloud-based platforms make communicating among teams easier



Bringing A Vision To Life

The development and incubation of ManufactOn is an effort to 'fast forward' the prefab trend in construction.

- Began with a 'what's next' conversation
- Open access to CM and subcontractor
- Touchstone is practicality
- Aligned with Autodesk products



Introducing ManufactOn for Social Prefab



Coordination

- Find opportunities
- Coordinate prefab work

Prefab Planner

Manufacturing

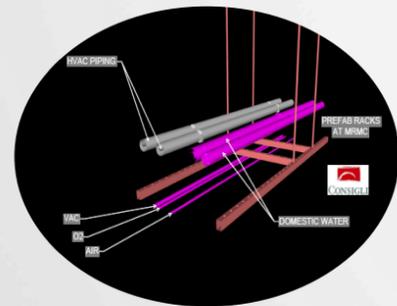
- Detail-out prefab
- Manufacture

Production Manager

Delivery

- Monitor progress
- Control delivery

Supply Chain Manager



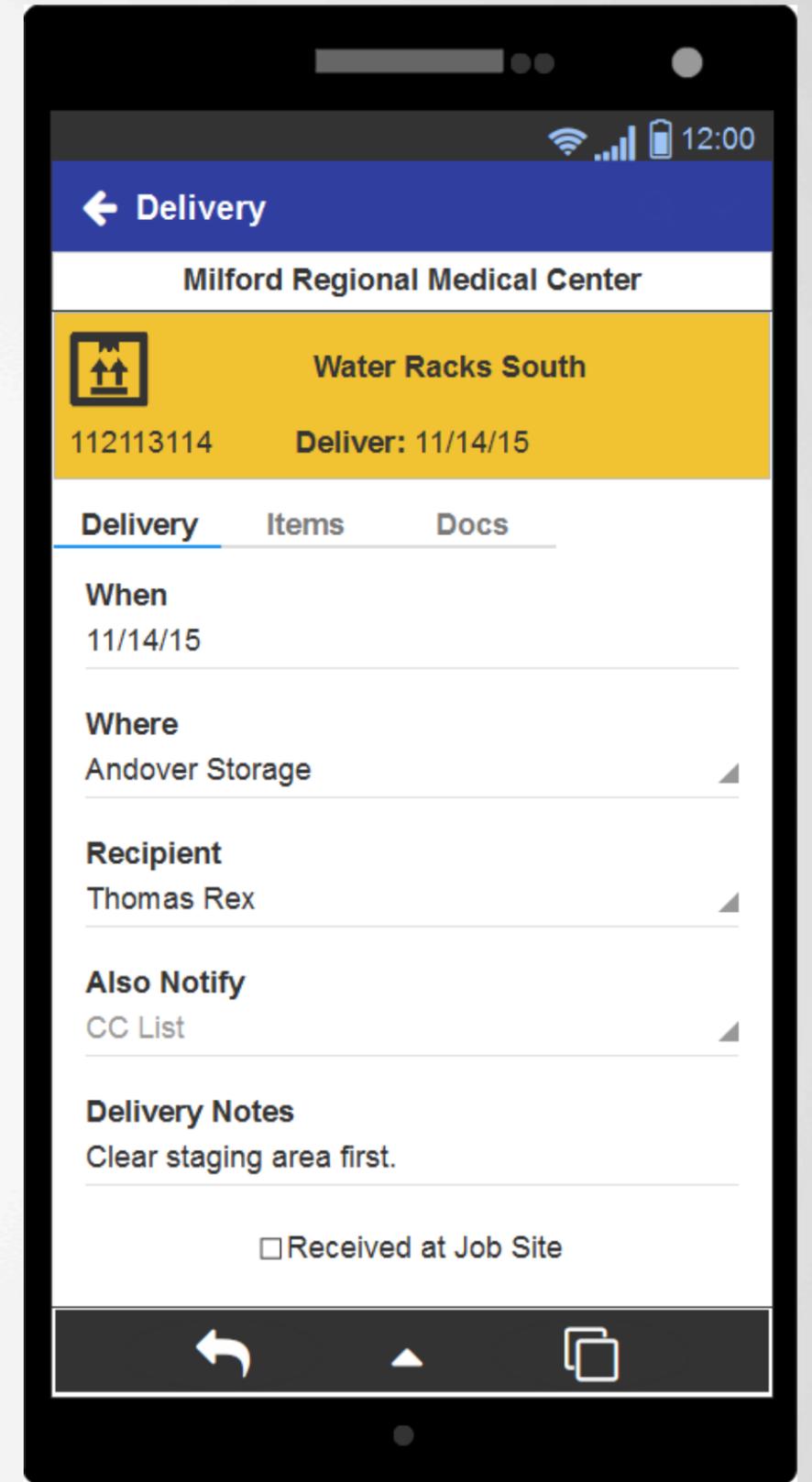
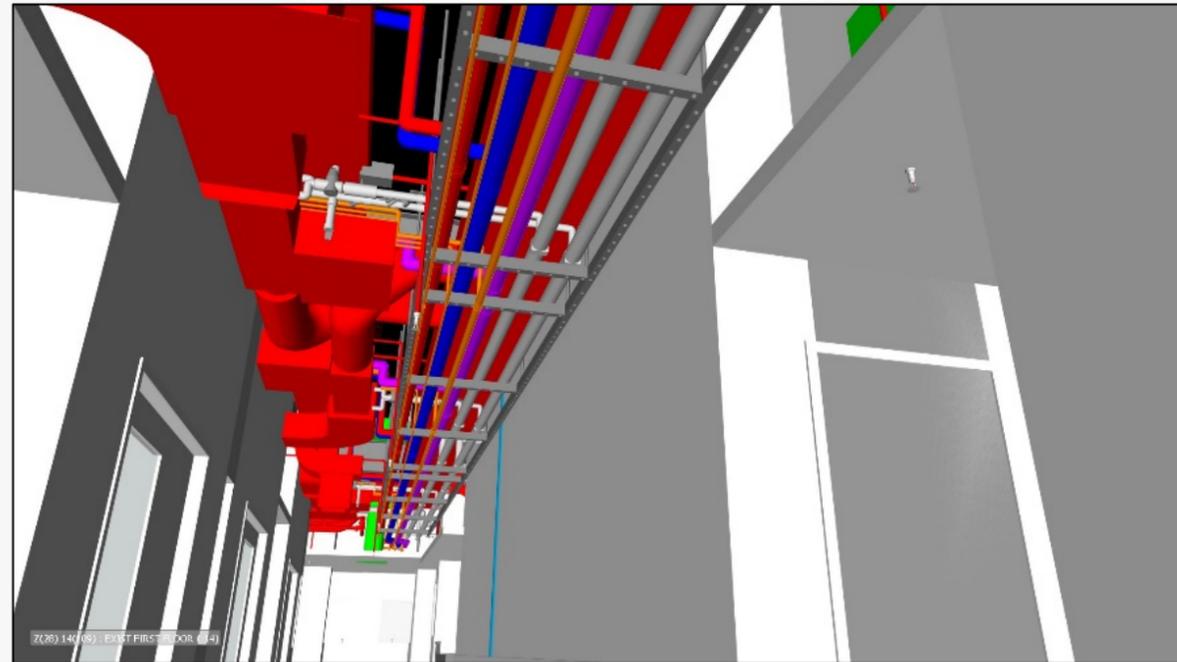
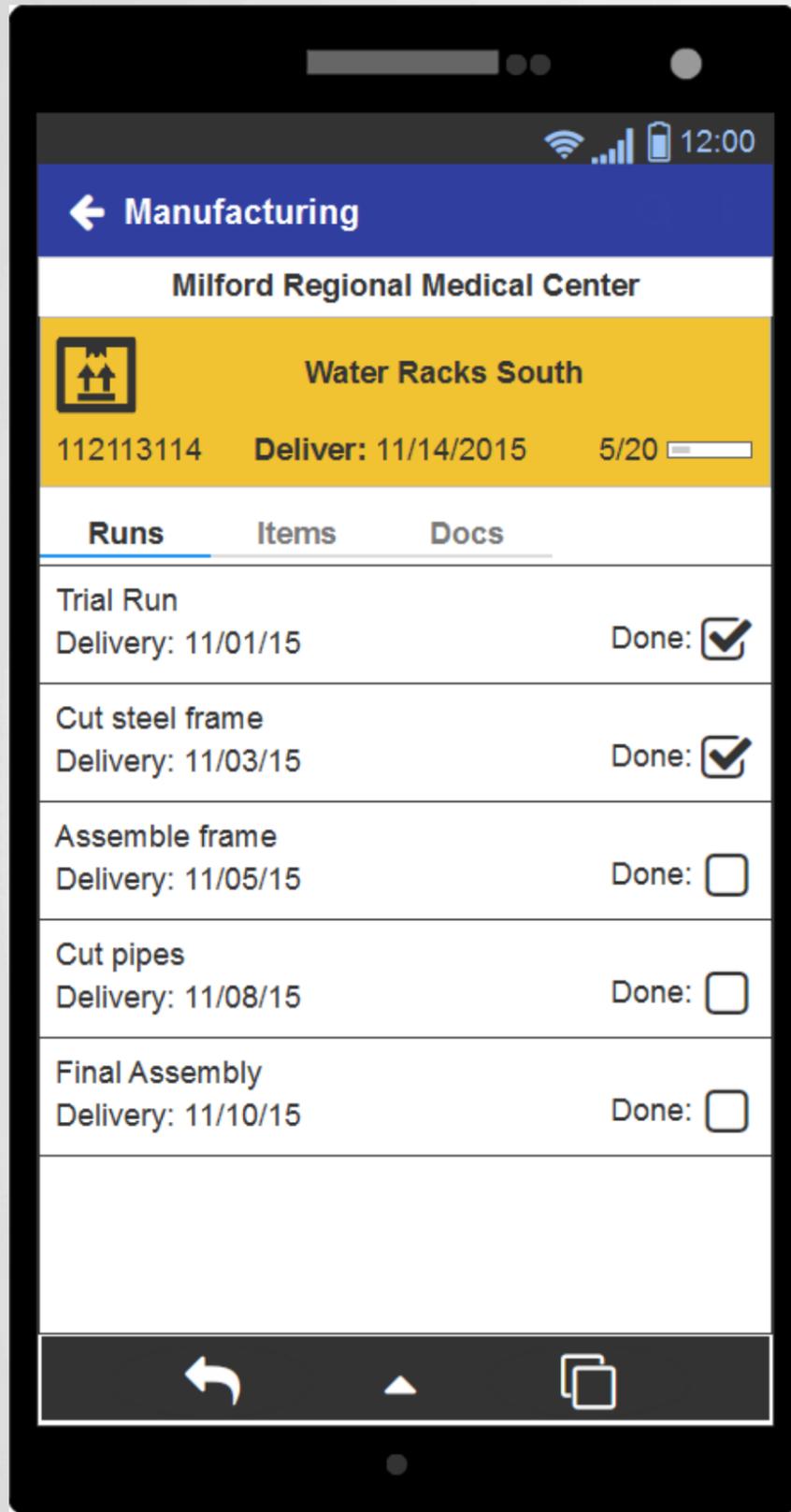
ManufactOn Beta

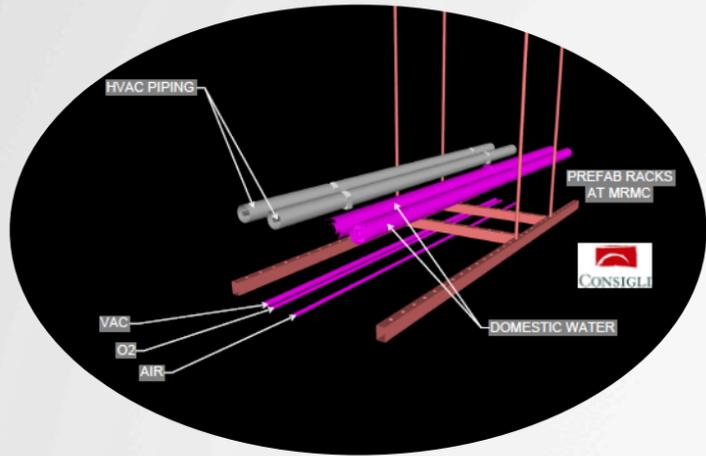
https://demo.manufacton.com/#/supplychain/55e49653fce07eda71b717f4/

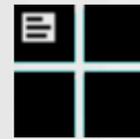
PRODUCTION STATUS DELIVERY STATUS CHECKLIST

Show 10 entries Search:

ID	NAME	COMPANY	COORDINATION DATE	DELIVERY DATE	STAGE	MANUFACTURED	ACTIONS																														
-	Water Racks South	ManufactOn	11/02/2015	11/14/2015	Manufacturing (Not Started)	40%	PAUSE																														
<p>RUNS ITEMS</p> <table border="1"> <thead> <tr> <th>RUN</th> <th>PREFAB ITEMS</th> <th>START</th> <th>FINISH</th> <th>DONE</th> </tr> </thead> <tbody> <tr> <td>Trial Run</td> <td>Rack004 Rack005 Rack006</td> <td>10/30/2015</td> <td>10/30/2015</td> <td>✓</td> </tr> <tr> <td>Cut steel frame</td> <td>Rack004 Rack005 Rack006</td> <td>10/31/2015</td> <td>11/01/2015</td> <td>✓</td> </tr> <tr> <td>Assemble frame</td> <td>Rack004 Rack005 Rack006</td> <td>11/01/2015</td> <td>11/03/2015</td> <td></td> </tr> <tr> <td>Cut pipes</td> <td>Rack004 Rack005 Rack006</td> <td>11/03/2015</td> <td>11/06/2015</td> <td></td> </tr> <tr> <td>Final assembly</td> <td>Rack004 Rack005 Rack006</td> <td>11/06/2015</td> <td>11/08/2015</td> <td></td> </tr> </tbody> </table>								RUN	PREFAB ITEMS	START	FINISH	DONE	Trial Run	Rack004 Rack005 Rack006	10/30/2015	10/30/2015	✓	Cut steel frame	Rack004 Rack005 Rack006	10/31/2015	11/01/2015	✓	Assemble frame	Rack004 Rack005 Rack006	11/01/2015	11/03/2015		Cut pipes	Rack004 Rack005 Rack006	11/03/2015	11/06/2015		Final assembly	Rack004 Rack005 Rack006	11/06/2015	11/08/2015	
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+	Storm Cast Iron	ManufactOn	11/11/2015	11/25/2015	Quality Assurance (In Progress)	100%	PAUSE																														
+	Zone Valve Boxes	ManufactOn	11/24/2015	11/27/2015	Manufacturing (Not Started)	100%	PAUSE																														
+	Level 2 Water Heaters	ManufactOn	12/01/2015	12/04/2015	Detailing		PAUSE																														





 *Prefab Planner*



 *Production Manager*



 *Supply Chain Manager*

Thank You

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