

Scrum for Full-Scale Manufacturing

Agile Mass Manufacturing

Joe Justice

President Scrum@Hardware Practice, Scrum Inc.

Joe Justice “WE HAVE FOUND TEAM MORALE TO BE A MULTIPLIER FOR VELOCITY.”

- Owner of all-Scrum automotive Manufacturing Company
- Creator of eXtreme Manufacturing Methods
- President of Scrum@Hardware practice at Scrum Inc.



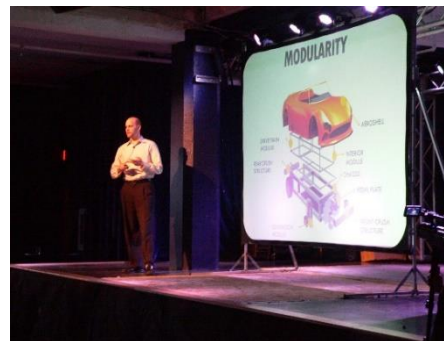
Justice@ScrumInc.com



Forbes



Harvard Business Review



TEDx

x = independently organized TED event

Discovery CHANNEL

scruminc.
the way teams work



CNNMoney.com

FORTUNE

scruminc.

Joe Justice @WikiSpeed

Scrum in Manufacturing: A Motivational Example

F-35 "Joint Strike Fighter" – Traditional Design



- \$143 billion over budget
- Delayed until 2022 (final systems integration)
- Cost of Navy F-35C grew from \$273 million in 2014 to \$337 million by 2015

SAAB JAS 39E "Gripen" – Agile Design



- Cumulative program cost of \$15 billion
- New iteration of all systems released every 6 months
- \$43M cost¹ (20% of F-35)

1. According to Jane's Aviation Weekly, the Gripen is the world's most cost-effective military aircraft

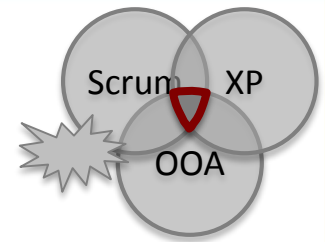
It's so embarrassing, the F35 is now a meme.



The F-35 just got crippled by a computer glitch that won't be fixed for at least 4 more years.

Meanwhile, the program's \$1.5 trillion projected cost is enough to end world hunger for 50 years (\$30 billion/year x 50 = \$1.5 trillion).

Scrum@Hardware



I. Scrum Organization

- a. Roles and Responsibilities
- b. Sprints/Iterative Design
- c. Make Work Visible
- d. Measure Velocity
- e. Continuous Improvement (Lean)

II. XP Engineering Principles

- a. User Stories
- b. Pairing and Swarming
- c. Test Driven Development

XMfg

III. Object-Oriented Architecture

- a. Modular Components
- b. Contract-First Design
- c. Design Patterns
- d. Re-use and Inheritance

IV. Line Setup

- a. Machine Rationalization
- b. Material Selection
- c. Line Skills Selection

Morale is a multiplier for Velocity!

Scale as Competitive Advantage is Declining



Major Auto Company's CNC Machine:
\$100,000,000

Capacity: One dye per day



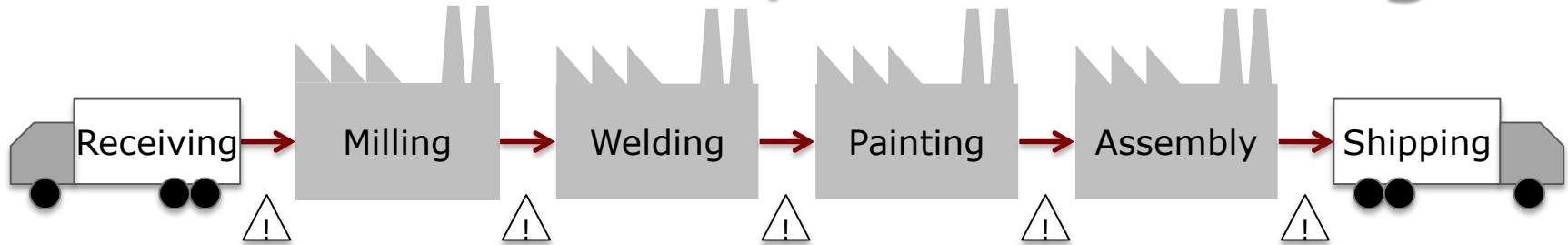
Startup Auto Company's CNC Machine:
\$2,000

Capacity: One dye per day

Source: www.wikispeed.org

That's 1/50,000th the cost

Lean is essential, but not enough!



Lean: Reduce waste, without frustrating your customer
+

Agile: Reduce the cost to make change
=

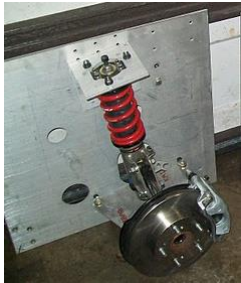
Scrum: The art of doing twice the work in half the time

Lean alone makes an efficient company with no innovation. Innovation is a variance!

Scrum Principles and Practices to Build into the Manufacturing Line



- A Use Scrum teams as lean cells** – Scrum for organization allows teams to improve faster and implement more lean improvements in the same timeframe



- B Object-Oriented Architecture** – be willing to over-build at key points to allow greater flexibility for the overall product and leverage design patterns

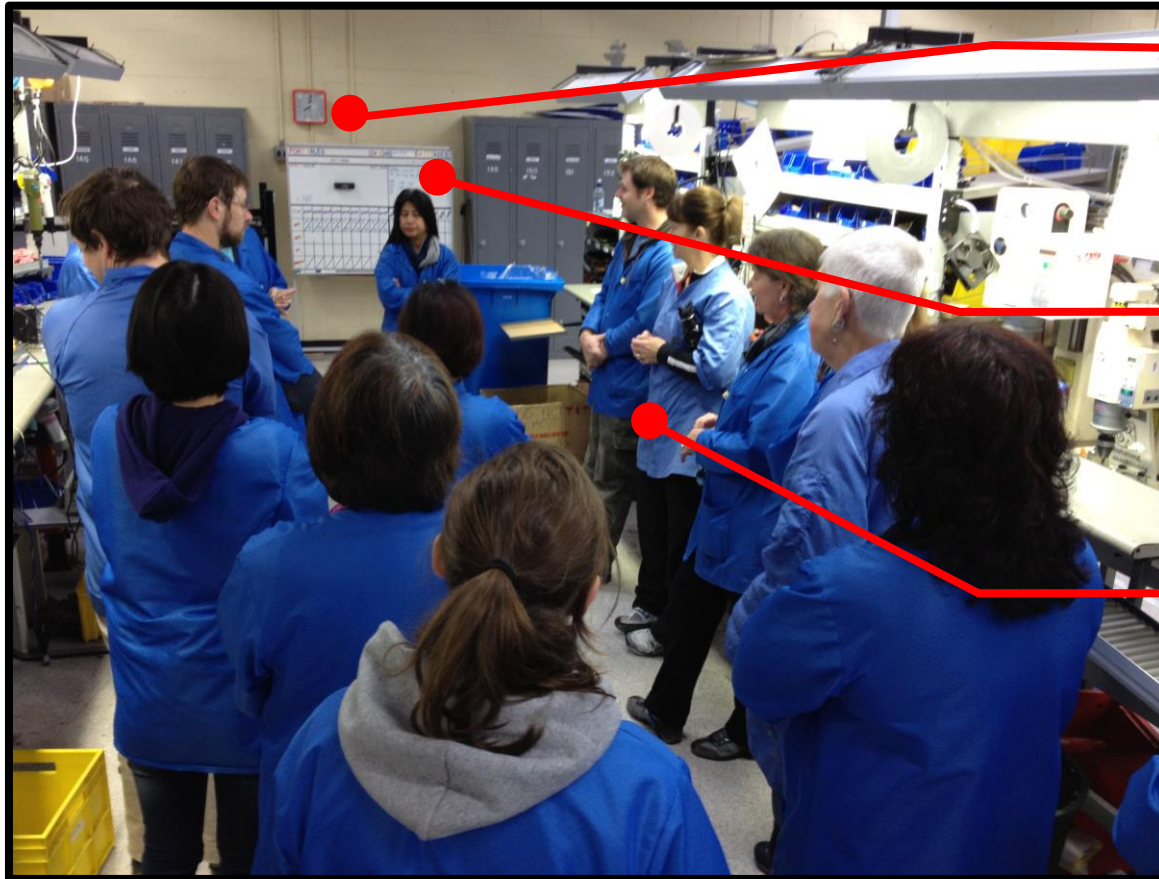
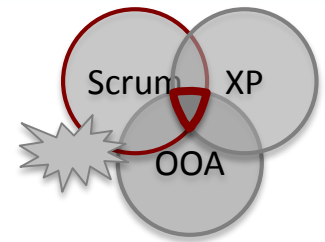


- C Shorten supply chains** – longer supply chains are more prone to disruption and slower to respond. Short ones can turn around iterations faster



- D Keep the line flexible** – make it as easy as practical to reformat the line in response to process improvement experiments

Scrum Teams as Lean Cells

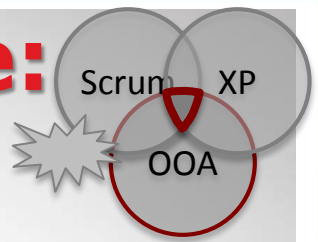


Sprint provides team improvement cadence in addition to Takt time cadence

Retrospective results in at least one Kaizen event per sprint

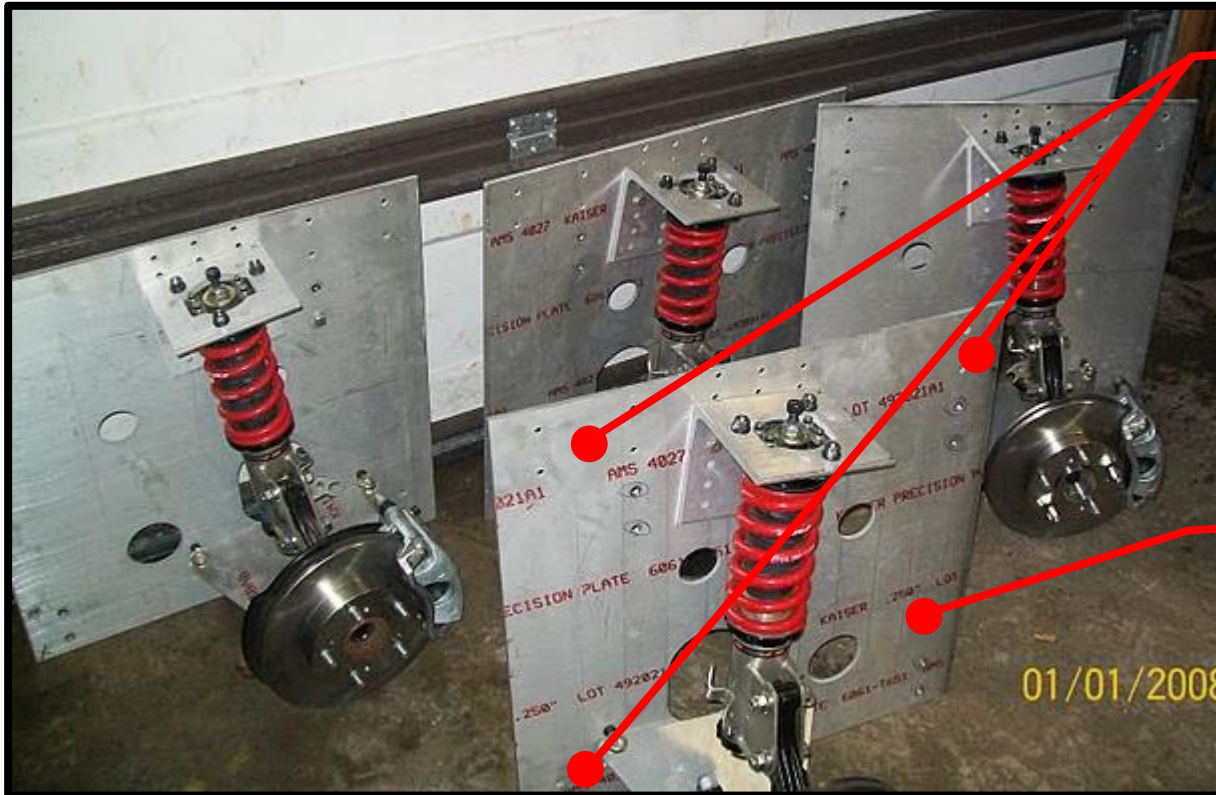
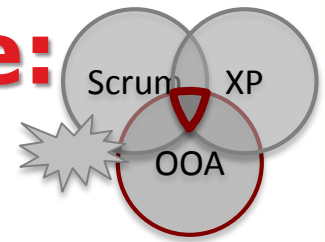
Pre-shift Daily Scrum helps align cell members and coordinate across cells to achieve day's production goals

B Object-Oriented Architecture: Contract-First Design



- Volvo's SPA, or Scalable Product Architecture, announced August 13th, 2014
- This Contract-First Design reduces cost to produce many descendent designs
- The next step? Reduce the cost to change the manufacturing process
- For that, we need to add Known Stable Interfaces

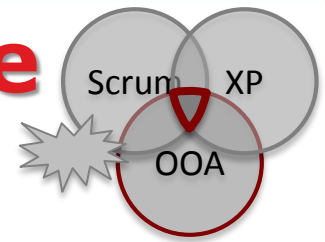
B Object-Oriented Architecture: Known Stable Interfaces



Pre-negotiated physical and data connections permit greater design versatility, and loose production coupling

Interfaces deliberately over-designed to reduce need for disruptive re-negotiation

B Object-Oriented Architecture Design Patterns and Inheritance



- Don't re-invent the wheel
 - If a proven solution has worked well in the past, start with that and modify as needed



- Reduce complexity – Find solutions that work for multiple aspects of the problem
 - Eg. If a particular bolt works as a fastener in one location, use the same bolt in all similar situations



Scrum Supply Chains for Added Responsiveness

Long and complicated Supply Chains increase...

WIP Inventory and Working Capital



Supply Chain Risk

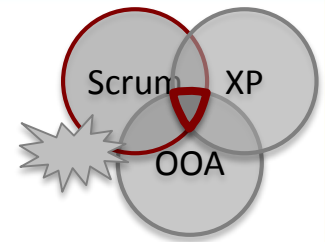


Feedback Cycles





Keep the Line Flexible



Long changeover time to switch the physical line limits the ability to experiment with new process improvements

Designing the line equipment to be flexible accelerates continuous improvement and supports multi-product manufacturing

Some companies go as far as to mount all equipment on casters to drive flexibility

Top Reasons Companies Say They Can't Do This

- 1 "Our product is too complicated to not plan everything meticulously in advance"
- 2 "Our quality expectations are too high to not follow a documented and unvarying plan"
- 3 "We have already made large investments in fixed machinery and tooling"
- 4 "Our product design is too tightly coupled to iterate modules without changing the entire design"
- 5 "Our vendors are not Agile enough to support this approach"
- 6 "Key steps of the manufacturing process require too long a lead time to fit in sprints"

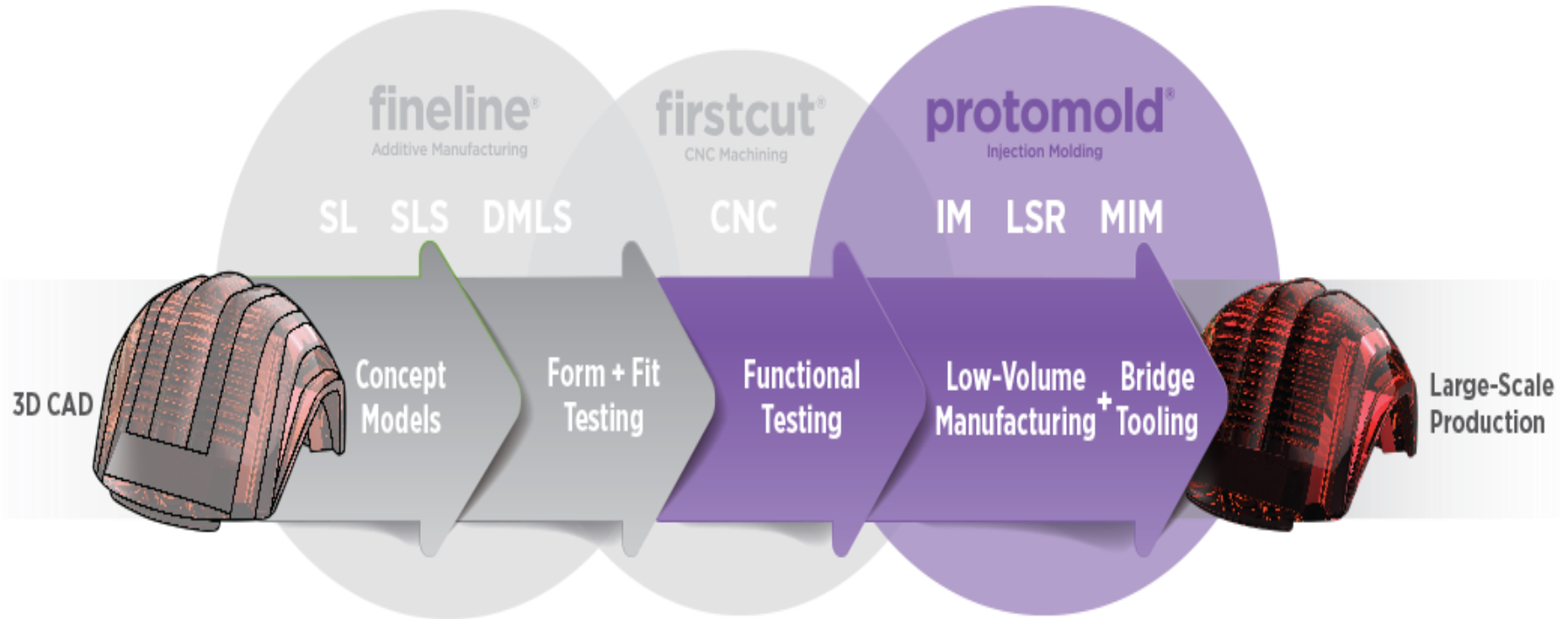
I. Fundamental misunderstanding of agile principles

II. Current impediments that can be addressed iteratively over time

III. Key issues requiring creative thinking to solve

Scrum Plastics in One Sprint:

Protomold



- Prototype parts or molds same-day
- Volume parts or molds same-week
- \$1-\$10k per mold

Scrum Electronics in One Sprint

RushPCB



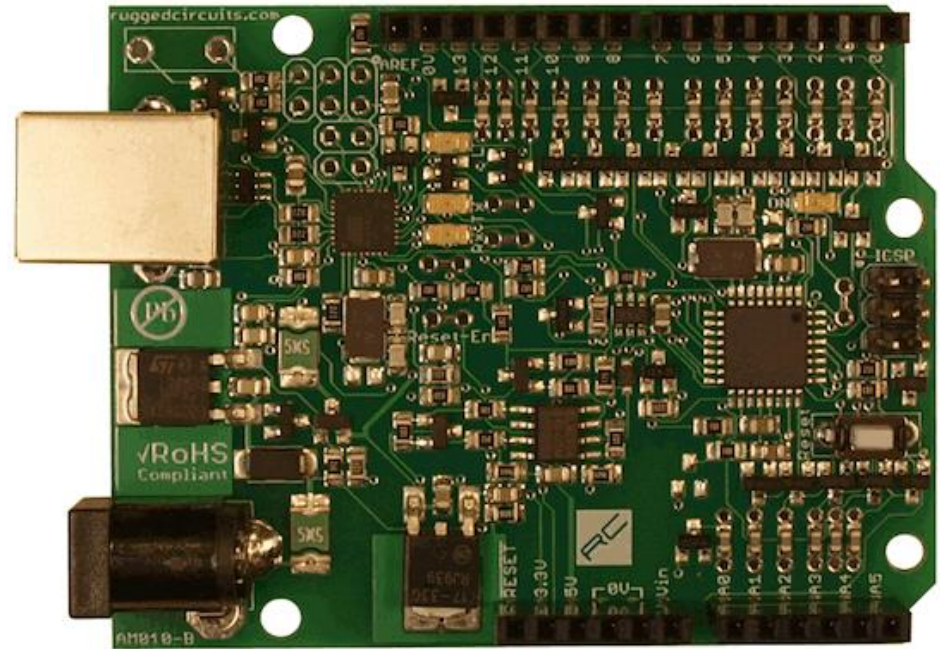
PCBs ASSEMBLED IN
24 HOURS

Prototype PCB assembly fast. Kitted and Turn-Key options available.
Quote and order online, any time.

[Click Here to Order](#)

- 2-layer circuit boards in 5 days for \$10
- Up to 8 layer circuit boards

RuggedCircuits



- Military and aviation grade hardening
- In stock same day \$40
- USB programmable, Arduino compatible

Scrum the entire partner ecosystem

Local Motors



Scrum in mass manufacturing

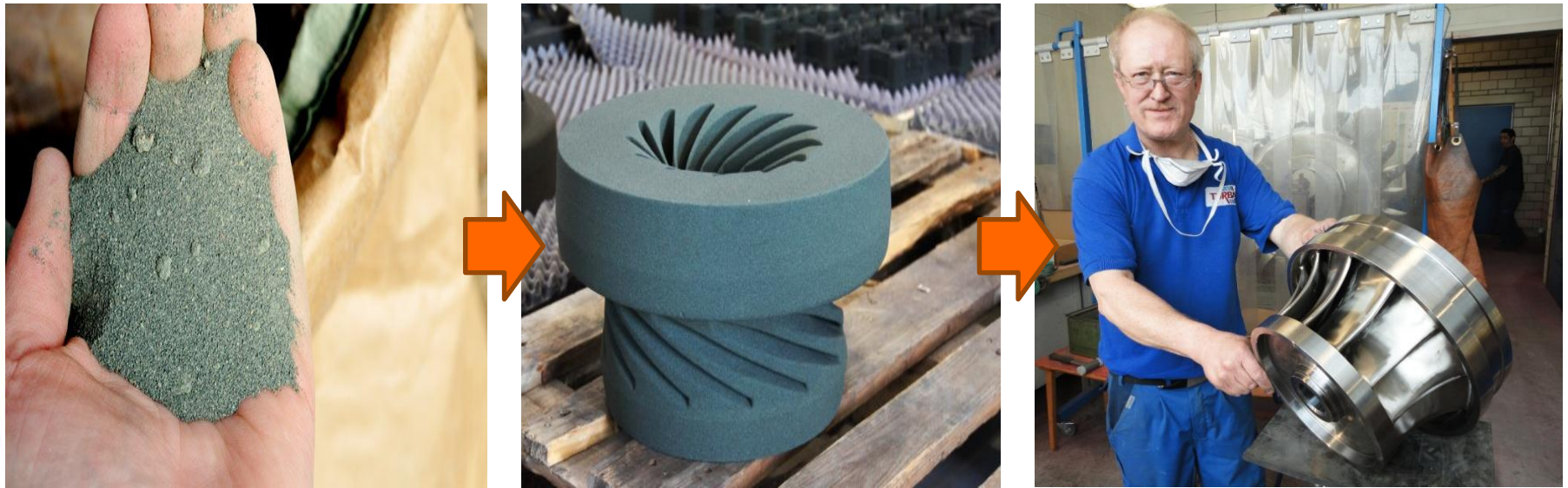
Capable of one part every six seconds.
The cost to change?
New metal molds, called dies,
up to 40 tons each



Scrum your Production Molds

Molds Shipped to you Within a Sprint

3d Green Sand Casting



- Volume metal castings same-week
- Fastest, cheapest, quality metal tooling

Even Better, Make your own Molds: Make your own molds in the Scrum Room

Subtractive Rapid Prototyping (SRP)



- Roland MDX-40A
- \$8k USD, 12"x12"x4"
- Quiet for desk office use
- 28x gives similar work area

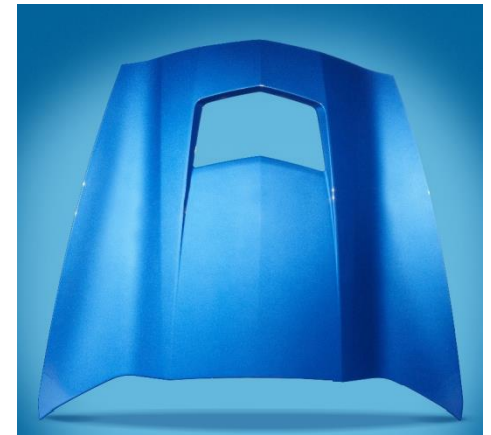


- Okuma M560-V
- \$120k USD, 41"x22"x18"
- Requires trained operator
- Durable, but costly repairs

Even Better, Scrum high performance composites

Change your Production Each Sprint with your Own Molds

Globe Industries



- Line-Speed composites: 9 minutes part-to-part.
- 1 minute tool exchange time.
- \$1M USD tool.

Best: skip molds. Produce production structural parts in your Scrum Room

Cincinnati BAAM



- Production structural parts same day
- Carbon Filament reinforced 3d printing

Mission Bell Winery

Madera, CA

60 acres of Scrum Wine



Leadership decides it's time to Scrum



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All stakeholders propose goals and missions



Single Prioritized enterprise backlog == Happy Chief Product Owner



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Champagne Team Launch



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Scrum Room



Scrum Room

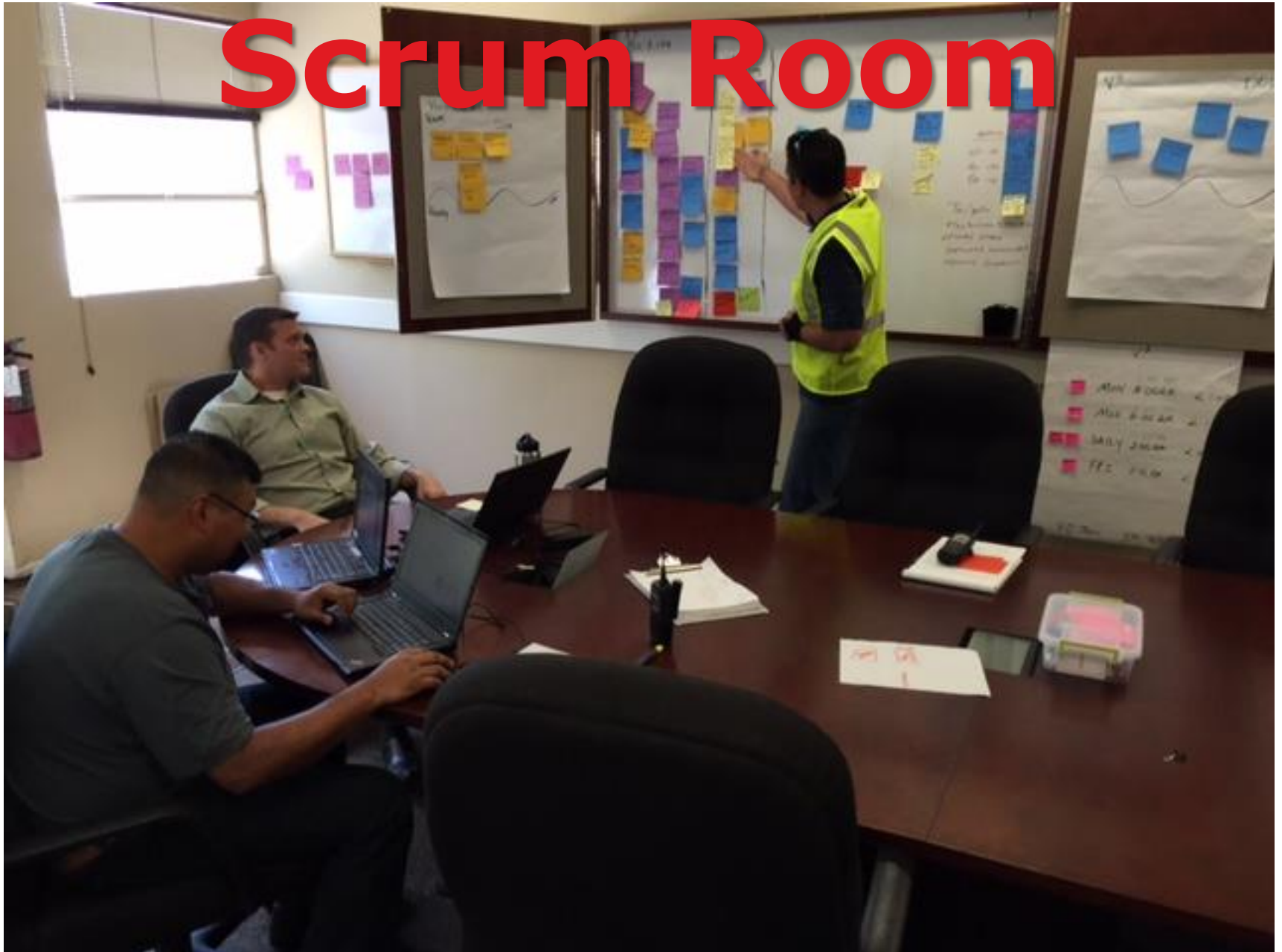


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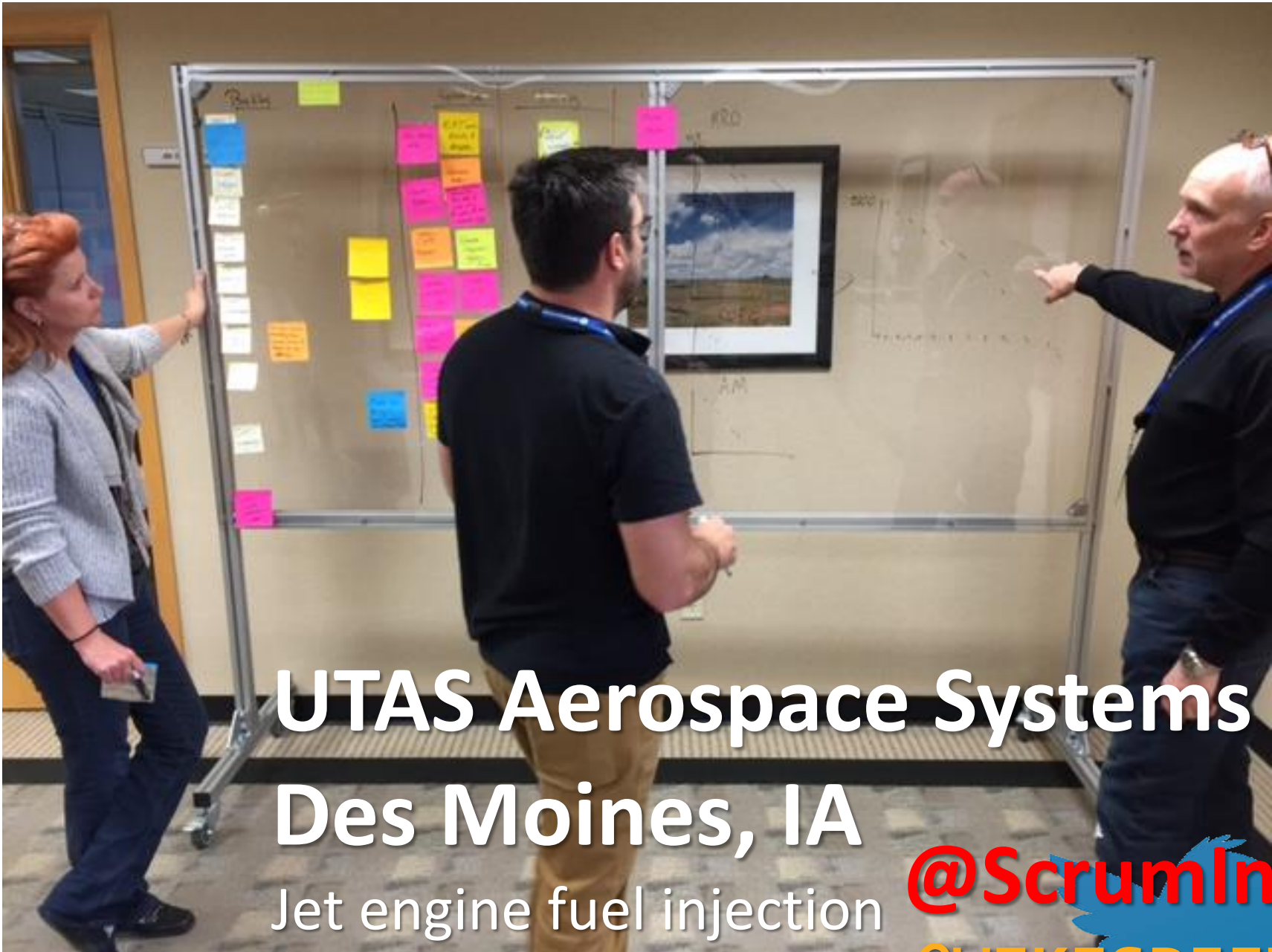
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Information Radiator





UTAS Aerospace Systems Des Moines, IA

Jet engine fuel injection

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KVH Satellite Systems Middletown, RI

Scrum Maritime Data and streaming

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Profile of a Disruptive Supplier: Rocket Bunny and Liberty Walk



From Idea to Customer in 1 Sprint

1) Scan



2) CAD, post to Facebook



3) Machine Foam Mold



4) Build and Race



5) Polish and Show



6) Sell Sell Sell



Suppliers are doing this now. If your suppliers can't do this...find different suppliers

Scrum@Hardware

- **As market responsiveness becomes more important than scale, adding agility to manufacturing is essential**
- **Scrum enhances Lean with Agile practices to the physical R&D and manufacturing world**
- **Four practices should be of interest to manufacturers:**
 - **Scrum teams as Lean cells**
 - **Contract-First Design**
 - **Shorten supply chains**
 - **Keep the line flexible**
- **All of the reasons you think you can't do this have already been solved**
- **Companies are starting to leverage Agile manufacturing to succeed in the market. Is your competitor one of them?**

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Questions?

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