

Scrum for Full-Scale Manufacturing

How the Shop Floor Can Keep Up with Scrum R&D

Hosts: Alex Brown
Joe Justice

scruminc.: Who We Are

Scrum Inc. is the Agile leadership company of Dr. Jeff Sutherland, co-creator of Scrum. We are based in Cambridge, MA.

We maintain the Scrum methodology by:

- Capturing and codifying evolving best practices
- Conducting original research on organizational behavior
- Adapting the methodology to an ever-expanding set of industries, processes and business challenges



We also help companies achieve the full benefits of Scrum through our comprehensive suite of support services:

- Training (Scrum Master, Product Owner, Agile Leadership, online courses, etc.)
- Consulting (linking Scrum and business strategy, customizing Scrum)
- Coaching (hands-on support to Scrum teams)
- Publishing and new content development

We run our services company using Scrum as the primary management framework, making us a living laboratory on the cutting edge of “Enterprise Scrum”

Find out more at www.scruminc.com.

Agenda

- Discuss Lean as a jumping off point
 - Lean is great but it can sub-optimize and increase cost to make changes
- Present four XM principles to speed up the manufacturing line
 - Scrum teams as lean cells
 - Contract-first design
 - Shorten supply chains
 - Keep the line flexible
- Address why you CAN do this (debunk objections)
 - Show tooling and suppliers that make it possible
- Share examples from companies that have succeeded
 - Tait Radio
 - Rocket Bunny (WIKISPEED and Tesla)

Scrum in Manufacturing: A Motivational Example

F-35 "Joint Strike Fighter" – Traditional Design



- \$143 billion over budget
- At least another year late (final systems integration)
- Cost of Navy F-35C grew from \$273 million in 2014 to \$337 million by 2015

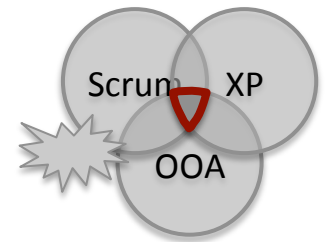
SAAB JAS 39E "Gripen" – Agile Design



- 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

Extreme Manufacturing (XM)



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

"XM"

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

If You Aren't Making Millions of the Exact Same Product,
Speed of Changeover is More Important



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

Capacity: One dye per day



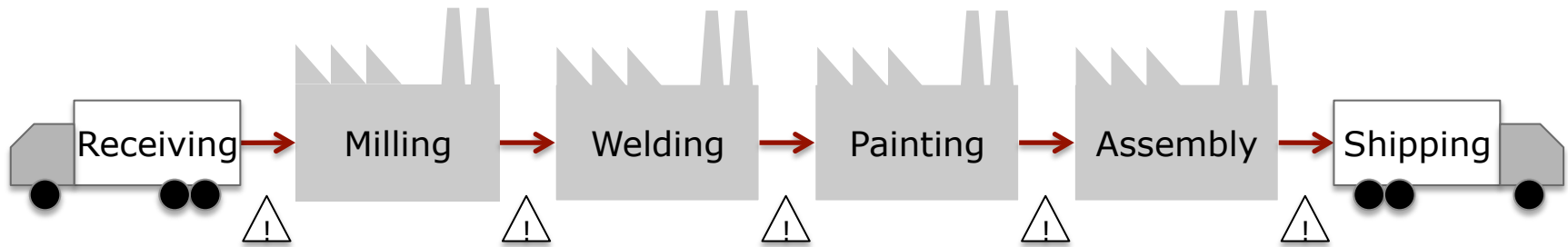
Startup Auto Company's CNC Machine:
\$2,000

Capacity: One dye per day

That's 1/50,000th the cost

Source: www.wikispeed.org

Lean Thinking is the Essential Foundation



Lean: Take a systematic view to maximize value delivery across the entire “value stream” rather than focusing on just one step

Lean: Any activity that does not add value to the end product is WASTE and should be eliminated from the process

Lean: Identify root causes of waste and eliminate them rather than treating symptoms

Lean: Build quality into each step of the manufacturing process to avoid the waste of rework

However, Lean can make it more expensive to change the line. As speed to change becomes more important than scale, this risks sub-optimizing lifecycle value delivery

XM 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

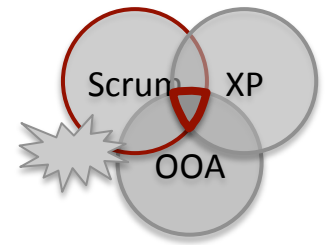


- C Shorten supply chains** – longer supply chains are more prone to disruption and slower to respond. Short ones can turn around iterations faster



- 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

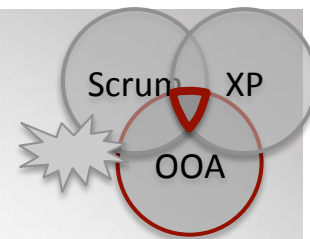


Sprint provides team improvement cadence in addition to Takt time cadence

Retrospective results in at least one Kaizen event per sprint

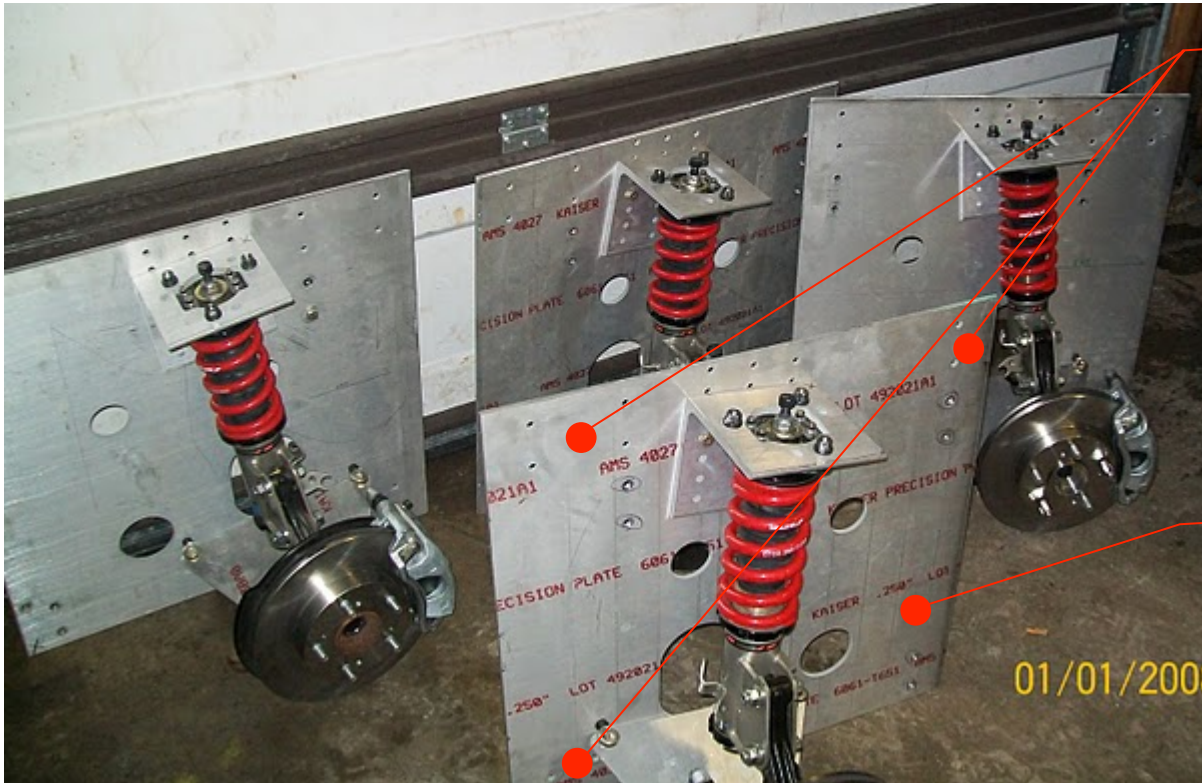
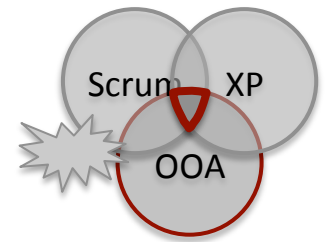
Pre-shift Daily Scrum helps align cell members and coordinate across cells to achieve day's production goals

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

Object-Oriented Architecture: Known Stable Interfaces

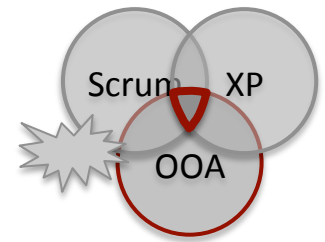


Pre-negotiated physical and data connections permit greater design versatility, and loose production coupling

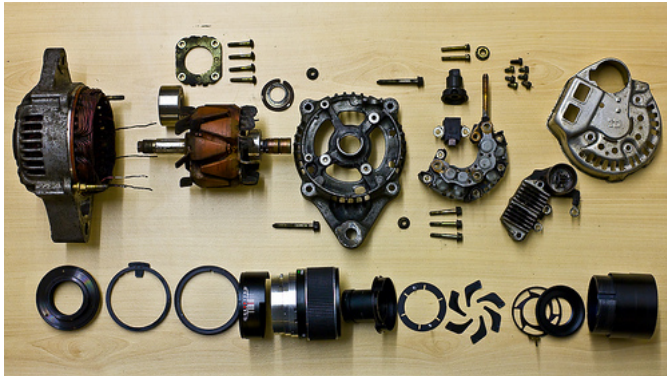
Interfaces deliberately over-designed to reduce need for disruptive re-negotiation

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



Shorten Supply Chains for Added Responsiveness

Long and complicated Supply Chains increase...

WIP Inventory and Working Capital



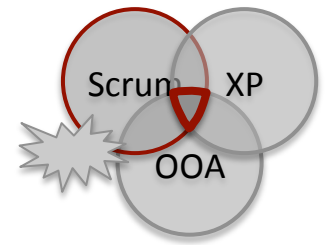
Supply Chain Risk



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"

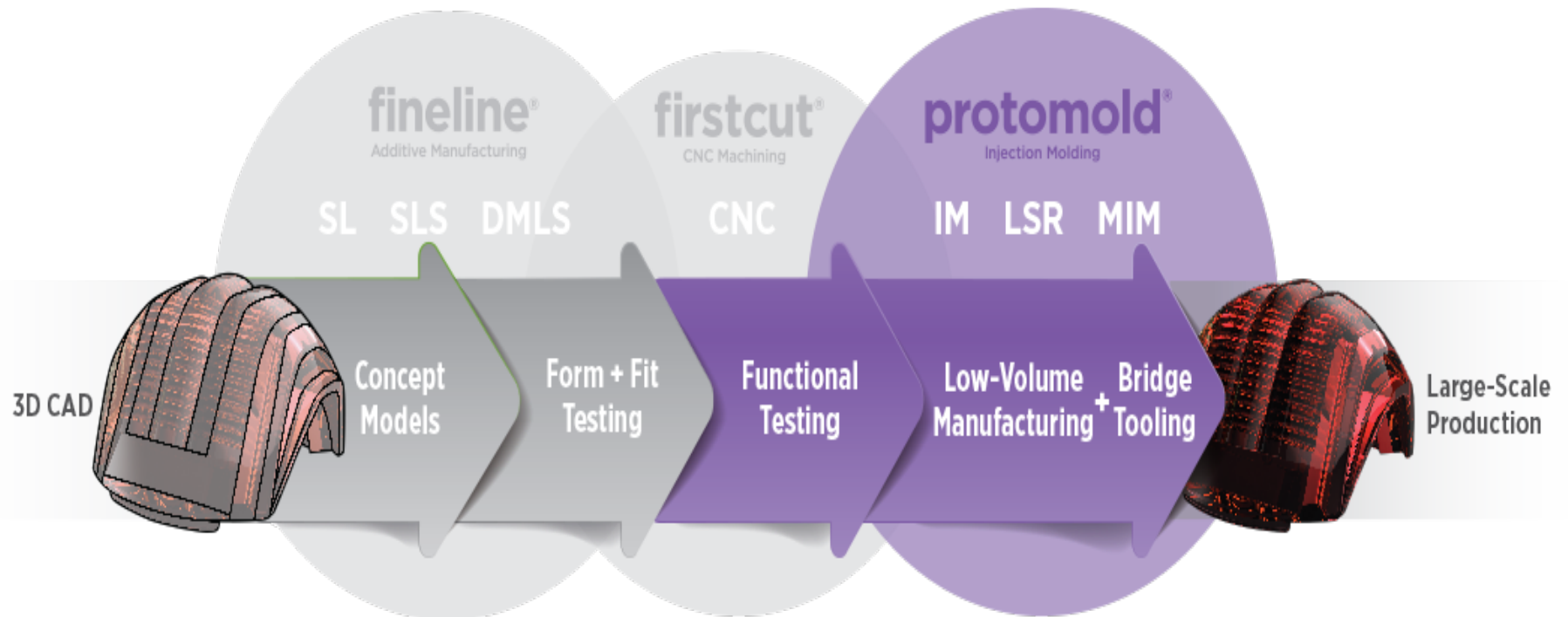
I. Fundamental misunderstanding of agile principles

II. Current impediments that can be addressed iteratively over time

III. Key issues requiring creative thinking to solve

Even Cheaper for Plastics:

Protomold



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

Suppliers that Make this Possible: Electronics

RushPCB



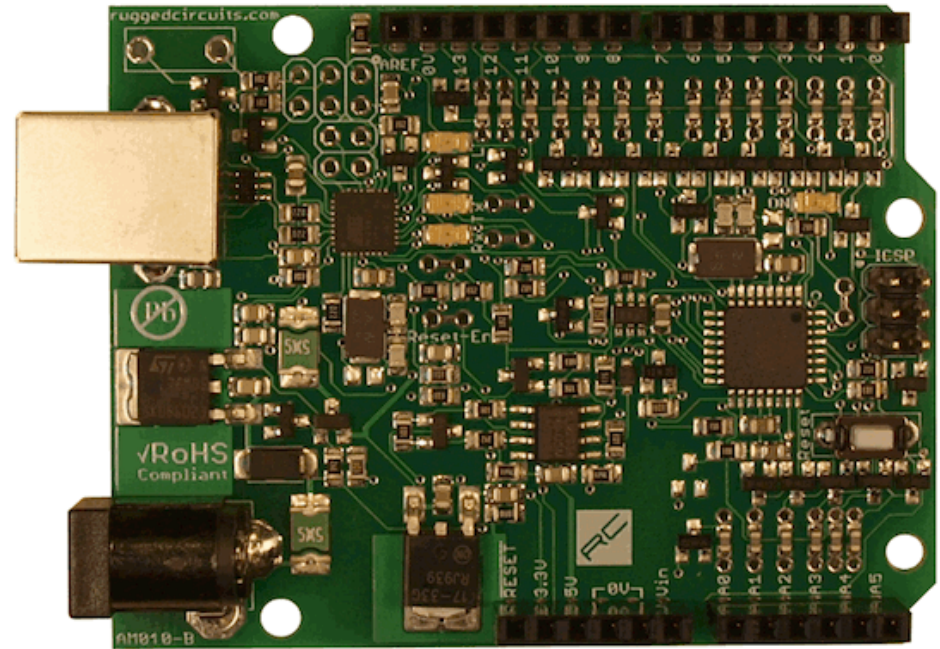
PCBs ASSEMBLED IN
24 HOURS

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

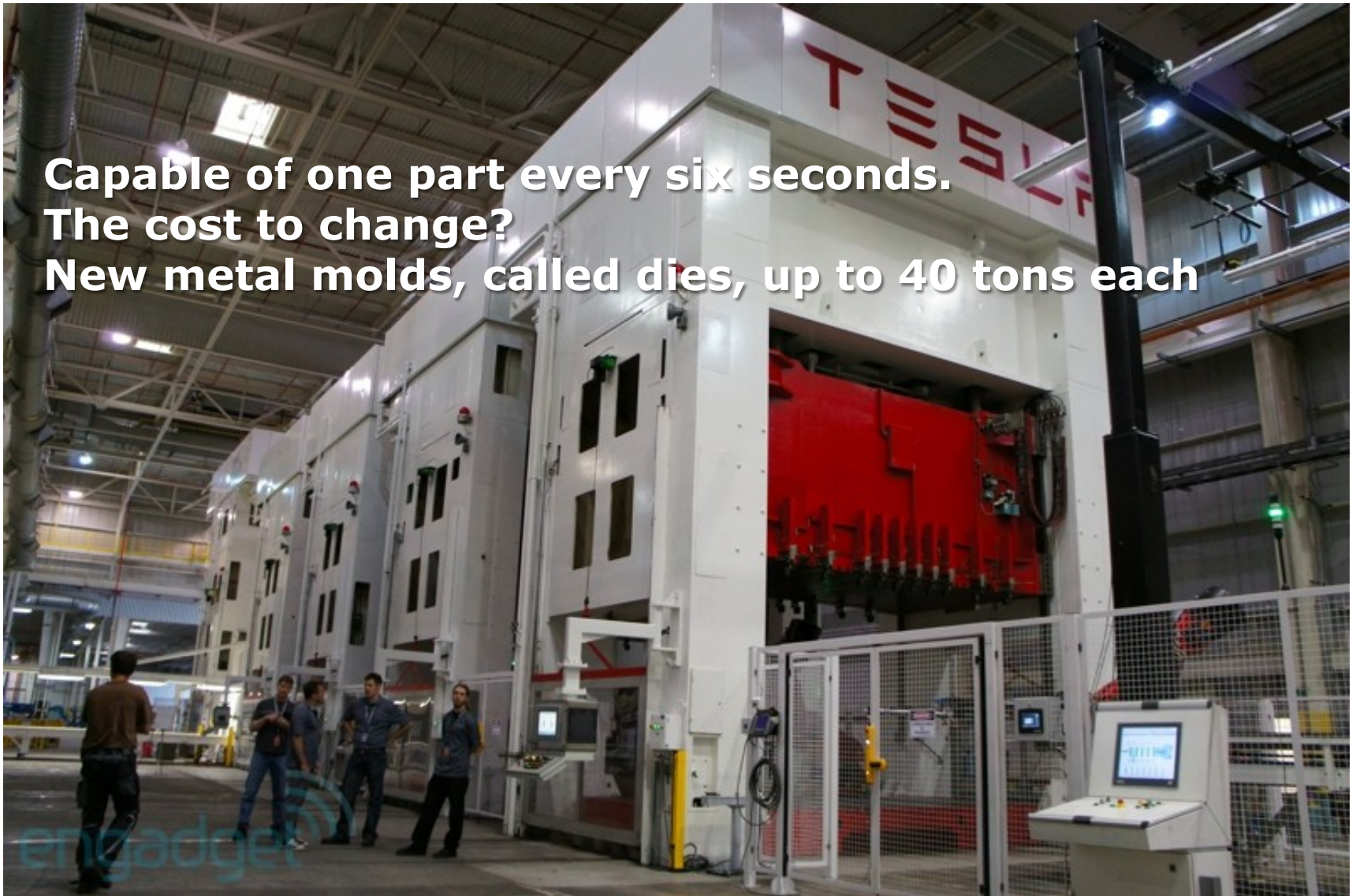
Partners that Make this Possible: Full Ecosystem

Local Motors



A Lean Production Cell:

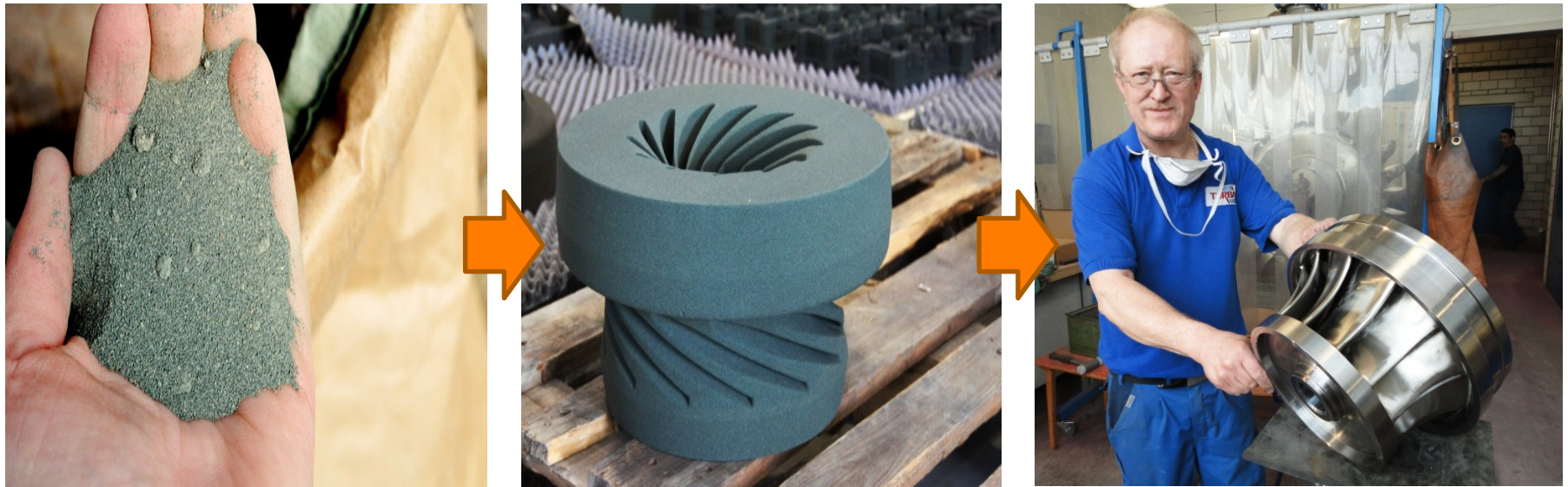
Capable of one part every six seconds.
The cost to change?
New metal molds, called dies, up to 40 tons each



Suppliers for 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 inside each sprint

Subtractive Rapid Prototyping (SRP)



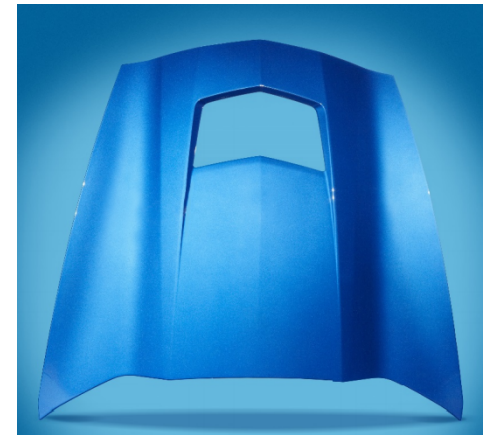
- Roland MDX-40A
- \$8k USD, 12"x12"x4"
- Quiet for desk office use
- 28x gives similar work area



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

Reducing the Time to Change Molds: Change your Production Each Sprint with your Own Molds

Globe Industries



- Line-Speed composites: 17minutes part-to-part.
- 1 minute tool exchange time.
- \$1M USD tool.

Even Better, Entirely Skip Molds and Press

Cincinnati BAAM

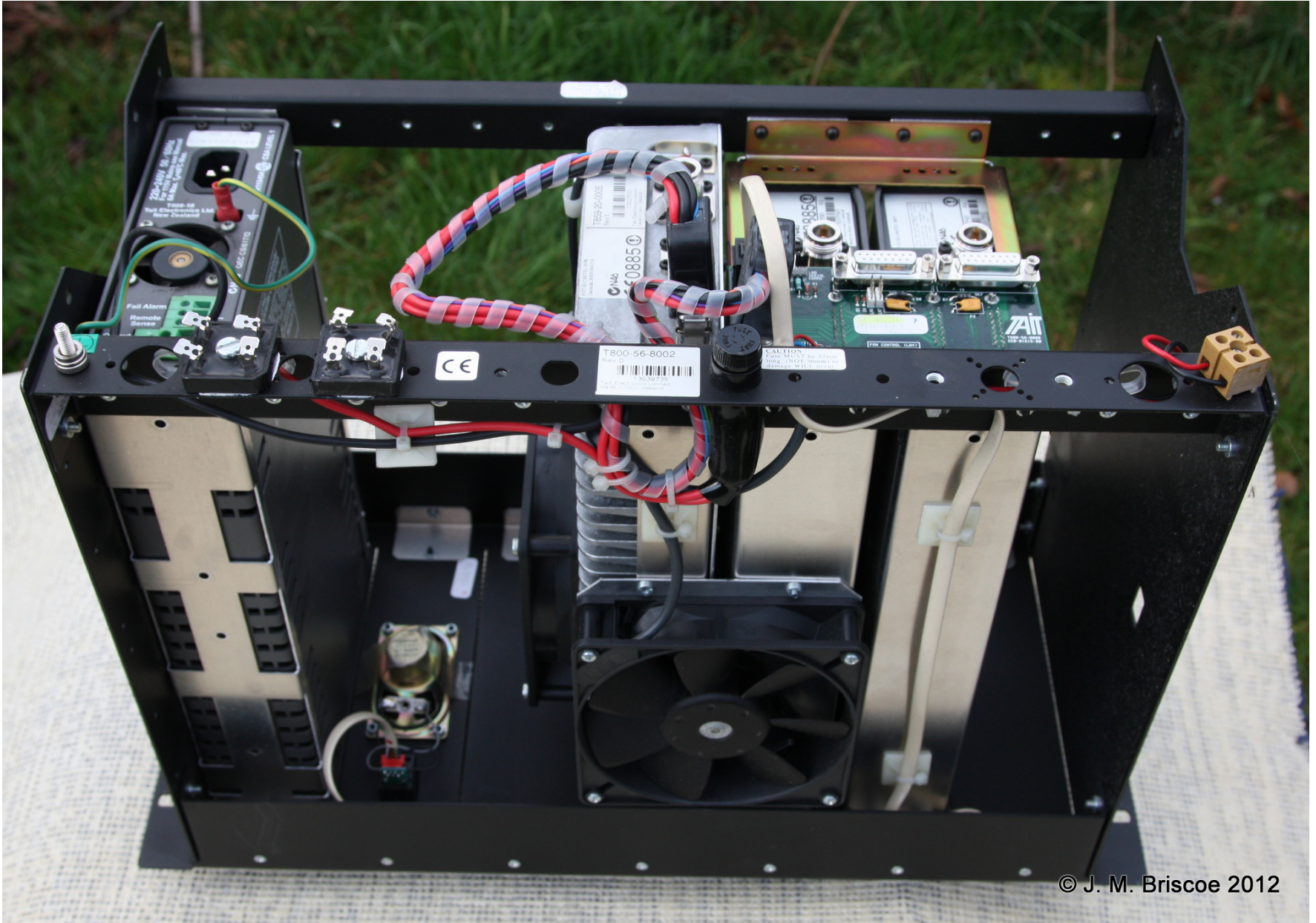


- Production structural parts same day
- Carbon Filament reinforced 3d printing

Example: Tait Radio

Christchurch, New Zealand





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XM = Scrum In Hardware Design



SCRUM TEAM

XM = Scrum In Mass Manufacturing



SCRUM TEAM

XM Requires XP To Be Safe At High Speed



Whole Company Agility: The Retrospective



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

Conclusions

- As market responsiveness becomes more important than scale, adding agility to manufacturing is essential
- XM enhances Lean with Scrum and other 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?

Questions?



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