

# SWEN438 - DevOps

## Lecture 8 - Lean Manufacturing

Dr David J. Pearce

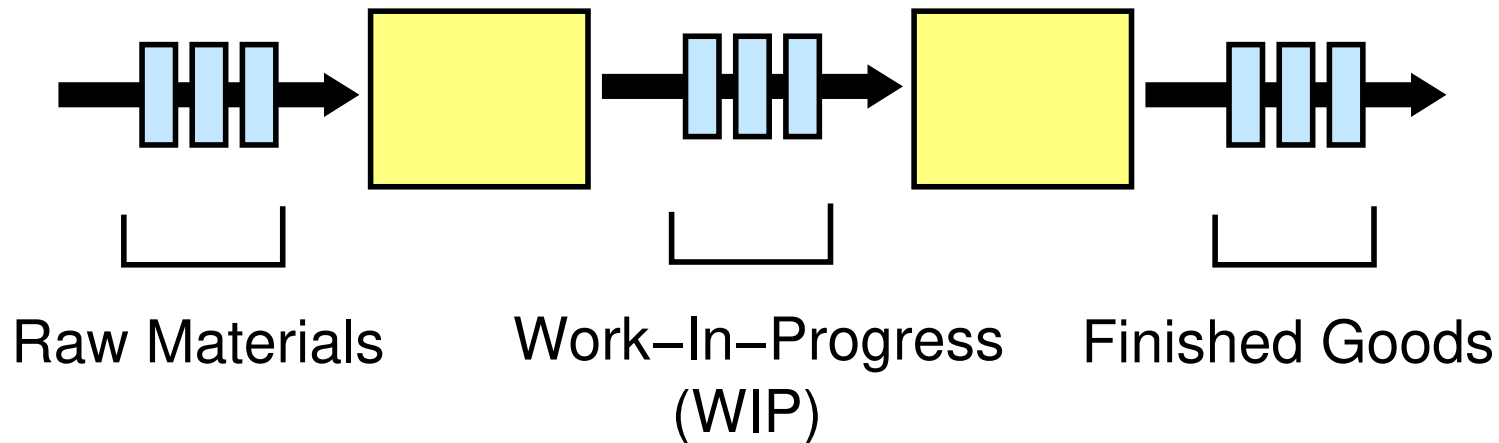
*School of Engineering and Computer Science  
Victoria University of Wellington*

# Assembly Lines

*“The only real **mistake** is the one from which we learn **nothing**”*

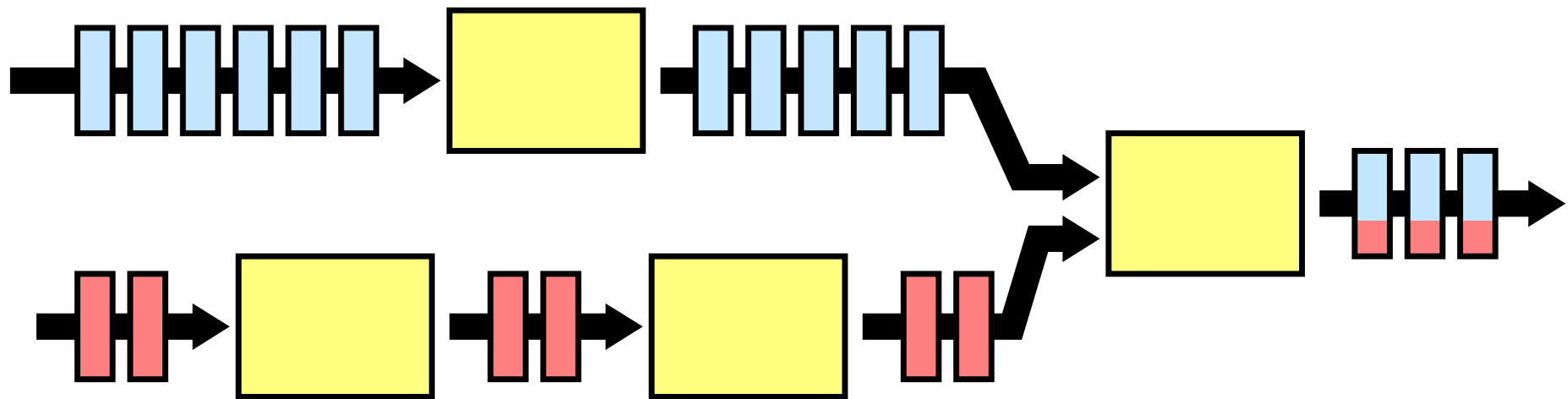
*–Henry Ford*

# Lean Manufacturing



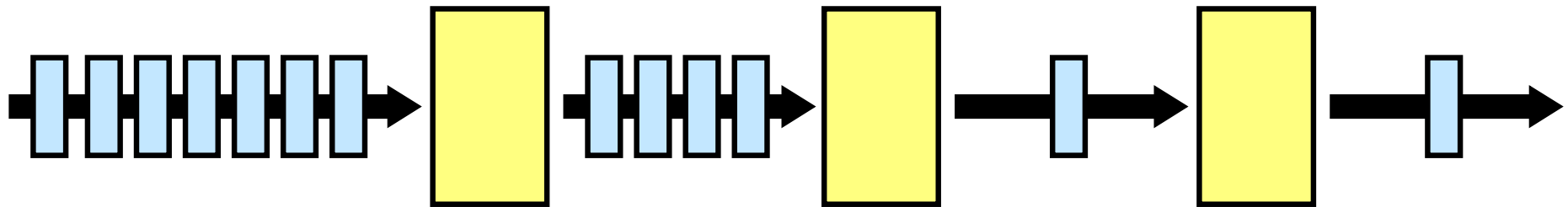
- What is **the goal**?
  - » Produce quality goods with short lead times
- What constrains **the goal**?
  - » Availability of *raw materials*
  - » Slowest *link* in the chain
  - » ... ?

# Lean Manufacturing



Q) *What affects throughput here?*

# Lean Manufacturing



Q) *What is going wrong here?*

# Toyota Production System

*The **Toyota Production System (TPS)** is an integrated socio-technical system, developed by Toyota, that comprises its management philosophy and practices. The TPS is a management system that organizes manufacturing and logistics for the automobile manufacturer, including interaction with suppliers and customers. The system is a major precursor of the more generic “**lean manufacturing**”. Taiichi Ohno and Eiji Toyoda, Japanese industrial engineers, developed the system between 1948 and 1975*

–Wikipedia

- (sometimes called “Just-in-Time” Production)
- *Why was this so successful?*

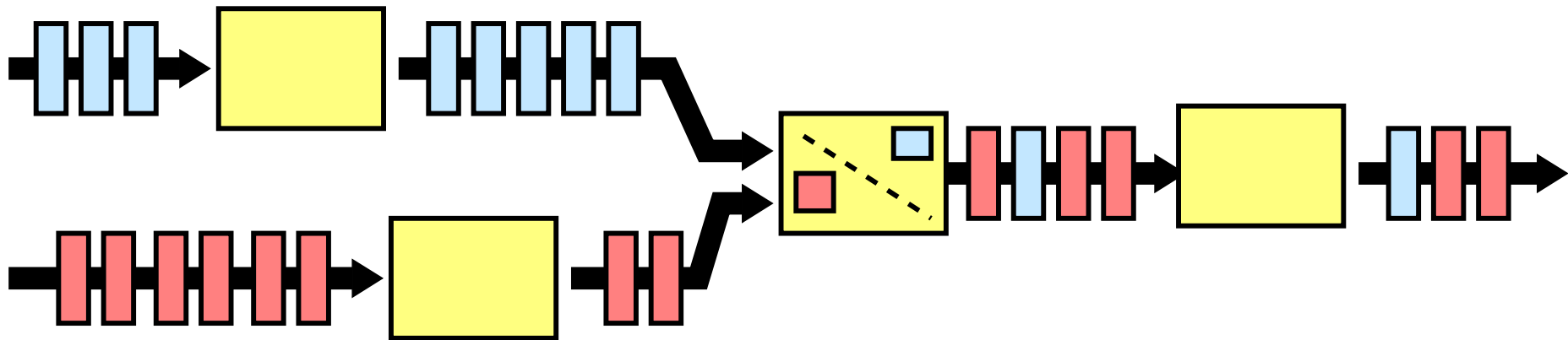
# Toyota Production System (Continued)

*When the demand for a single product is high, dedicating a line to producing each component, as Ford did, is justified. However, at that time in Japan, the market demand was for small quantities of a variety of cars. Therefore, Ohno could not dedicate lines at Toyota.*

– Goldratt, 2009.

- For **dedicated production lines**, Henry Ford pioneered efficient approaches.
- For **non-dedicated production lines**, TPS pioneered efficient approaches.

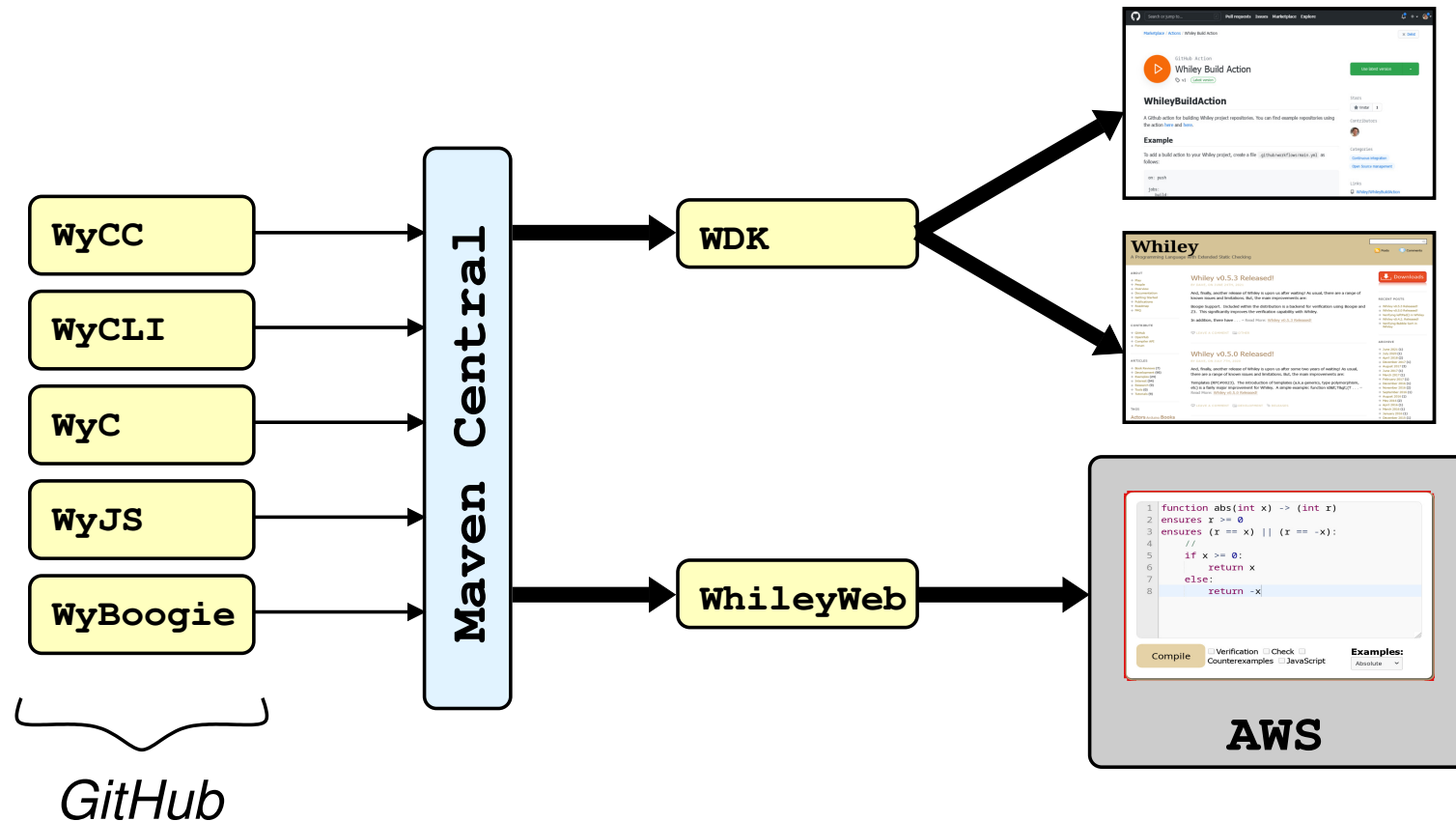
# Non-Dedicated Production Lines



- **Multiple products** generated from one line
- Certain machines on line are **multi-function**
- Change machine to another function incurs **setup cost**

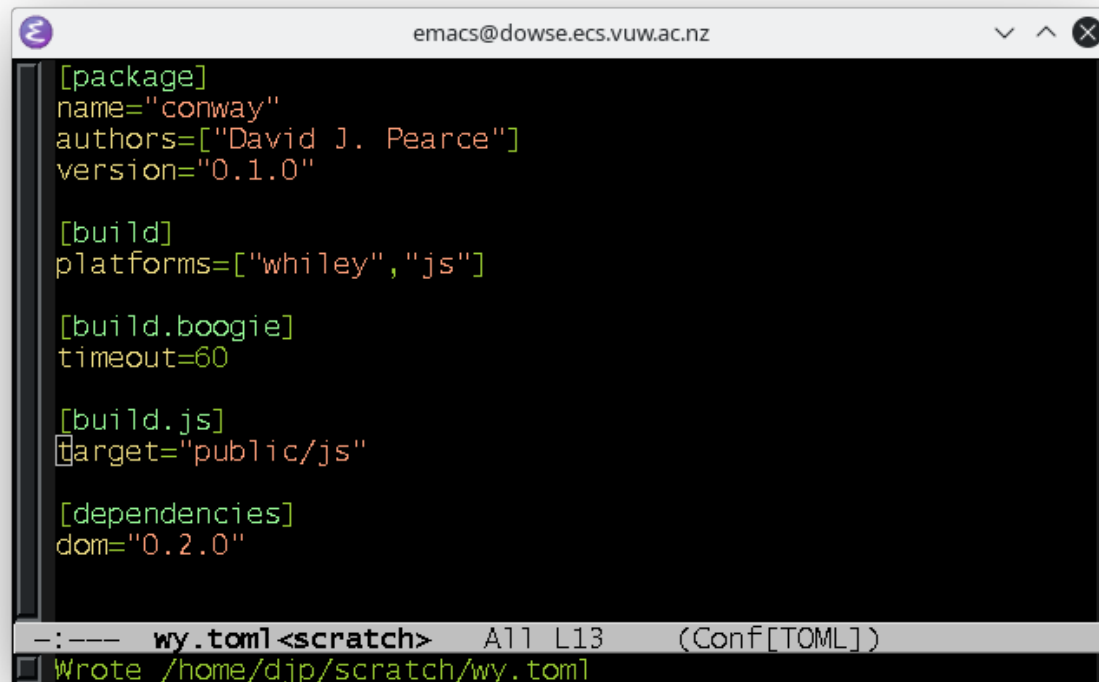


# Our “Factory Floor”



- **Whiley:** a large open source project running for 10+ years.
- *How do ideas from lean manufacturing translate?*

# Products: Command-Line Interface



```
emacs@dowse.ecs.vuw.ac.nz
[package]
name="conway"
authors=["David J. Pearce"]
version="0.1.0"

[build]
platforms=["whiley","js"]

[build.boogie]
timeout=60

[build.js]
target="public/js"

[dependencies]
dom="0.2.0"

 -:---- wy.toml <scratch> A11 L13 (Conf[TOML])
Wrote /home/djp/scratch/wy.toml
```

> wy build

# Products: WhileyWeb

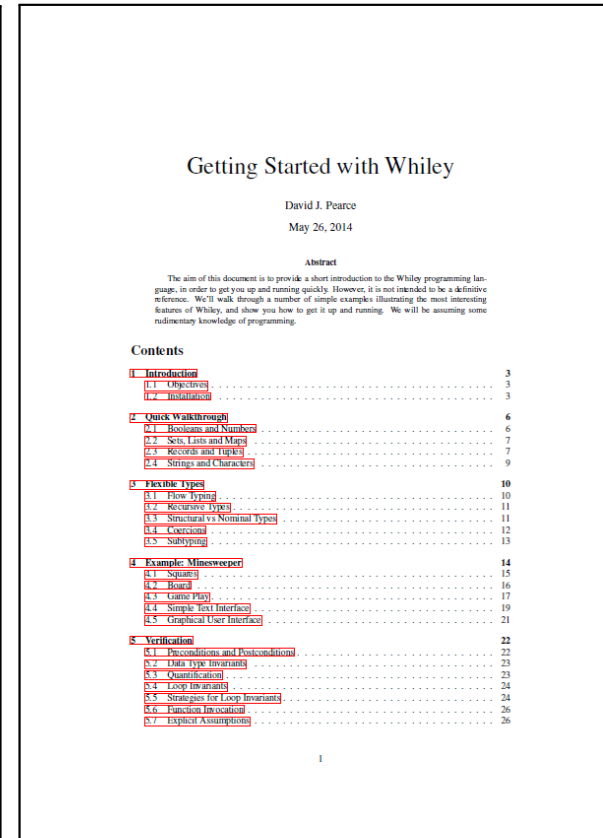
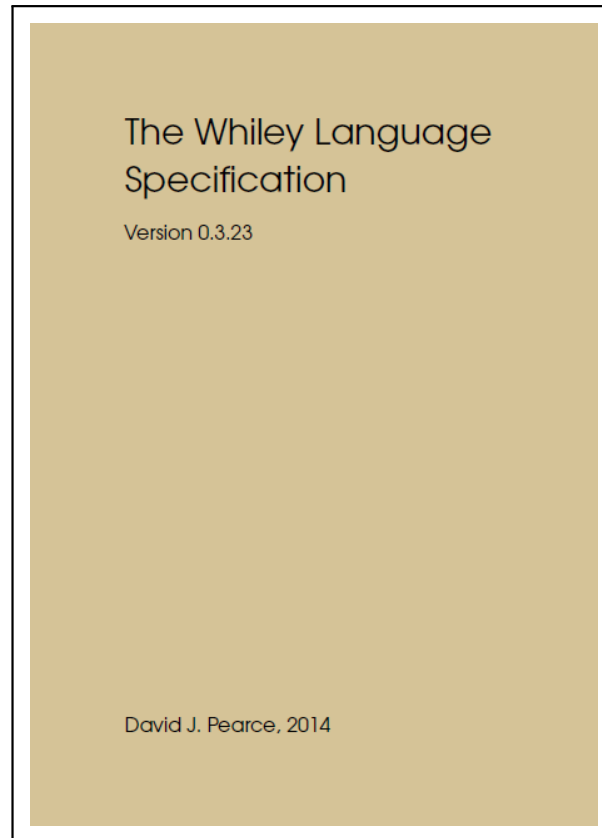
```
1 function abs(int x) -> (int r)
2 ensures r >= 0
3 ensures (r == x) || (r == -x):
4     //
5     if x >= 0:
6         return x
7     else:
8         return -x
```

Compile  Verification  Check   
Counterexamples  JavaScript

**Examples:**  
Absolute ▾

- Simple **IDE** for Whiley.
- Runs on your **local** machine.
- Currently running on **AWS EC2** ([whileylabs.com](http://whileylabs.com))

# Products: Documentation



# Value Flow

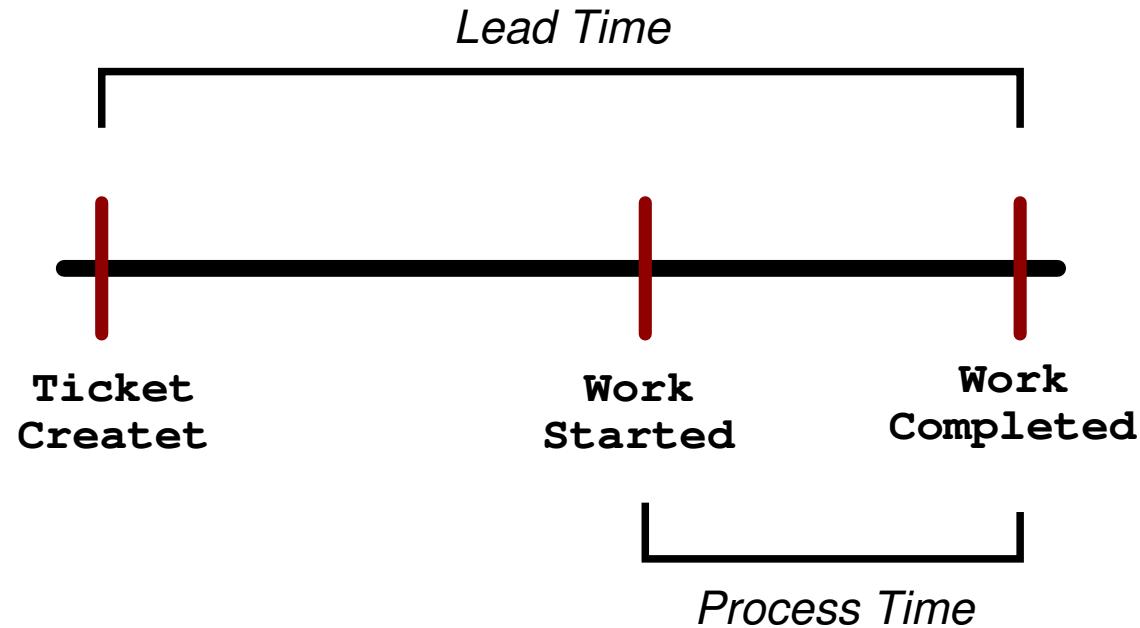
*“You know, this reminds me of something that I’ve seen the **plant floor guys** use all the time. If one of them walked in, I’m guessing that they’d think we’re building a **value stream map**.”*

*– The Phoenix Project*

*“In our value stream, **work** likely begins with the product owner in the form of a customer request or the formulation of a business hypothesis. Some time later, this work is accepted by Development, where **features are implemented** in code and checked in to a our version control repository. Builds are then integrated, tested in a production-like environment, and finally deployed into production where they (ideally) **create value** for our customer.”*

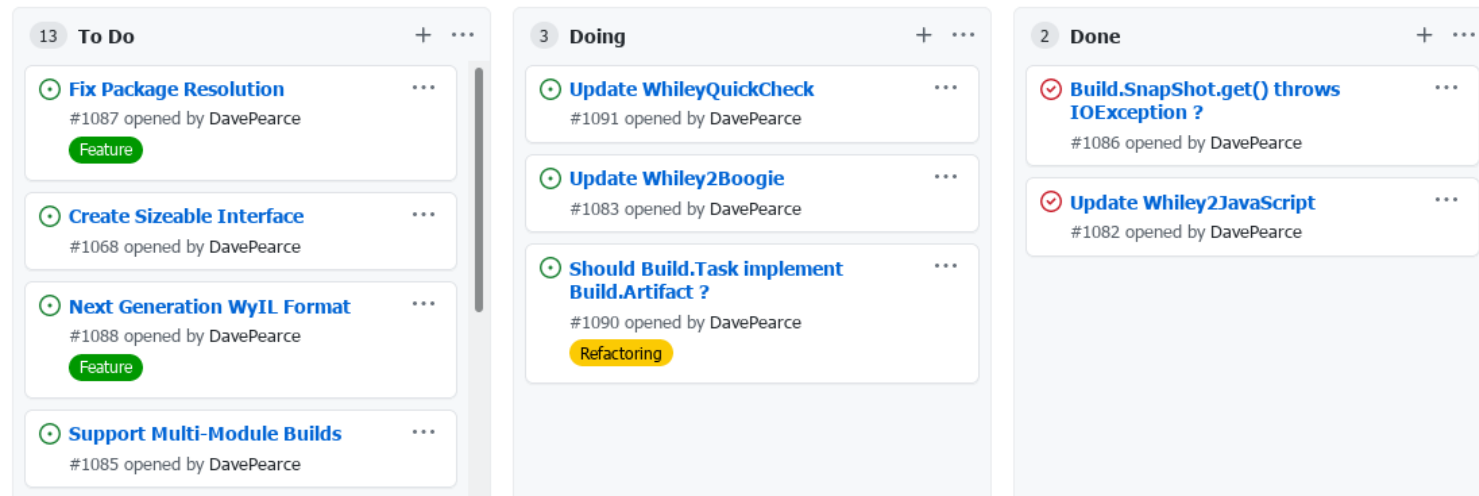
*– The DevOps Handbook*

# Lead Time



- In many organisations, lead time measured in **months**
- Long lead times can lead to **waste** — *Why?*
- Short lead times improve **customer experience**

# Work-In-Progress (WIP)

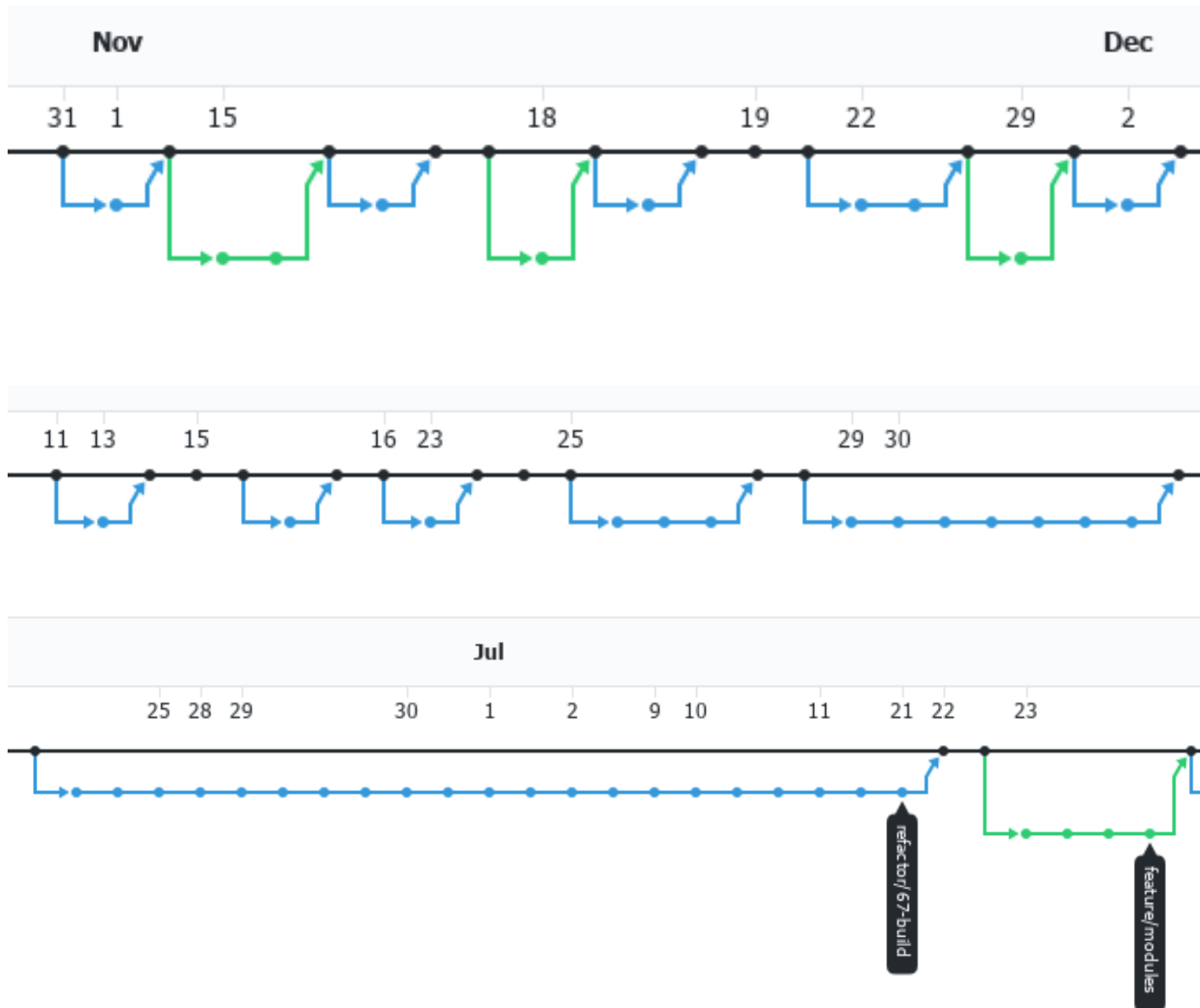


*“For example, we may set a WIP limit of **three cards** for testing. When there are already three cards in the test lane, **no new cards** can be added to the lane unless a card is completed or removed ...”*

*– The DevOps Handbook*

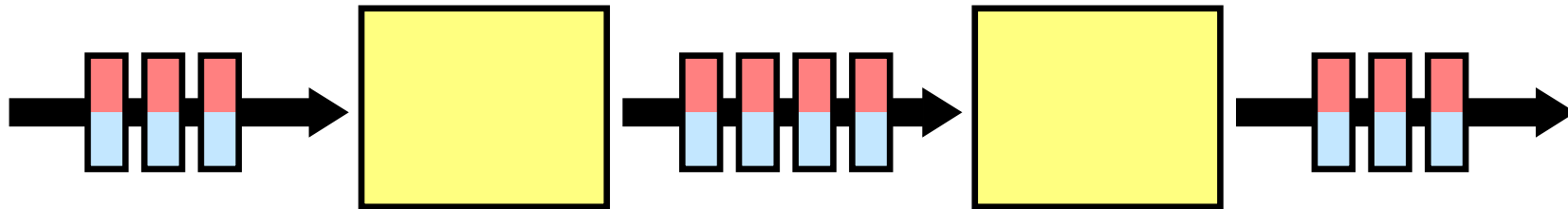
**Q)** *What WIP currently on our factory floor?*

# Examples!





# Reducing Batch Size

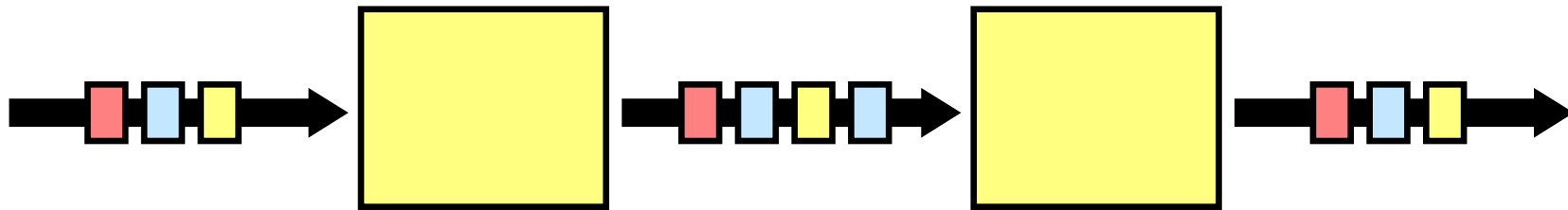


*“If we cut our **batch sizes** in half, then I guess that at any one time we’d have half the work-in-process on the floor.”*

*– The Goal*

- In manufacturing, *batch size* is the number of items processed at the same time (e.g. in an oven)
- *What is does batch size mean on our factory floor?*

# Reducing Batch Size



*“But if we go to **smaller** batch sizes”, she says “doesn’t that mean we’ll have to have **more** setups on equipment?”*

*– The Goal*

- *What does this mean for our factory floor?*

# References

- Mary Poppendieck; Tom Poppendieck (2003). *Lean Software Development: An Agile Toolkit*. Addison-Wesley Professional
- Eliyahu M. Goldratt (2009). *Standing on the Shoulders of Giants – Production concepts versus production applications The Hitachi Tool Engineering example*.
- Gene Kim, Kevin Behr and George Spafford. *The Phoenix Project*, IT Revolution Press.
- Gene Kim, Jez Humble, Patrick Debois and John Willis. *The DevOps Handbook*, IT Revolution Press.
- Eliyahu M. Goldratt. *The Goal: A Process of Ongoing Improvement*, North River Press, 1992.