SMARTLOG

Trends in Production Control

ERP Support for Pull Production

Daryl Powell,
Researcher & PhD Candidate

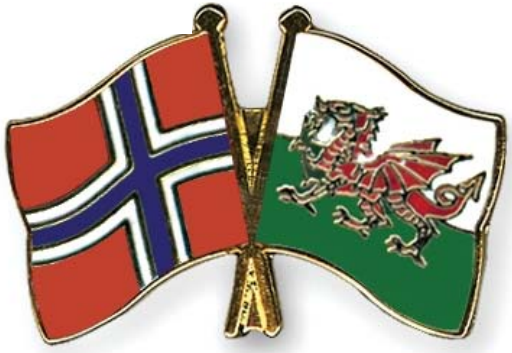
Department of Production and Quality Engineering,
Norwegian University of Science and Technology

SINTEF Operations Management

Outline

- Enterprise resource planning (ERP)
- Lean & Just-in-Time: Pull production
- The lean-ERP paradox
- A research framework for ERP in lean production
- Researching ERP support for lean production
- ERP support for pull production: A capability model
- Conclusion

LEAN i NORGE...



sfi = Senter for forskningsdrevet innovasjon norman

Daryl John Powell works for the Department of Production and Quality Engineering at Trondheim's Norwegian University of Science and Technology and for SINTEF Logistikk. He talks about the status of lean in Norway.

Norway, a lean champion

Norway is perhaps more famous for its natural wonders such as fjords, mountains, Northern lights and midnight sun than for its thriving manufacturing industry. Yet, the country boasts a variety of companies drawing on its abundance of natural resources to shape modern products from traditional materials like aluminum and wood. Giants Hydro, Aker Solutions and Norske Skog are major international players, whilst many innovative smaller companies, such as Teeness and Noca, focus on niche markets to further strengthen a robust sector which has seen consistent rises in both productivity and income.

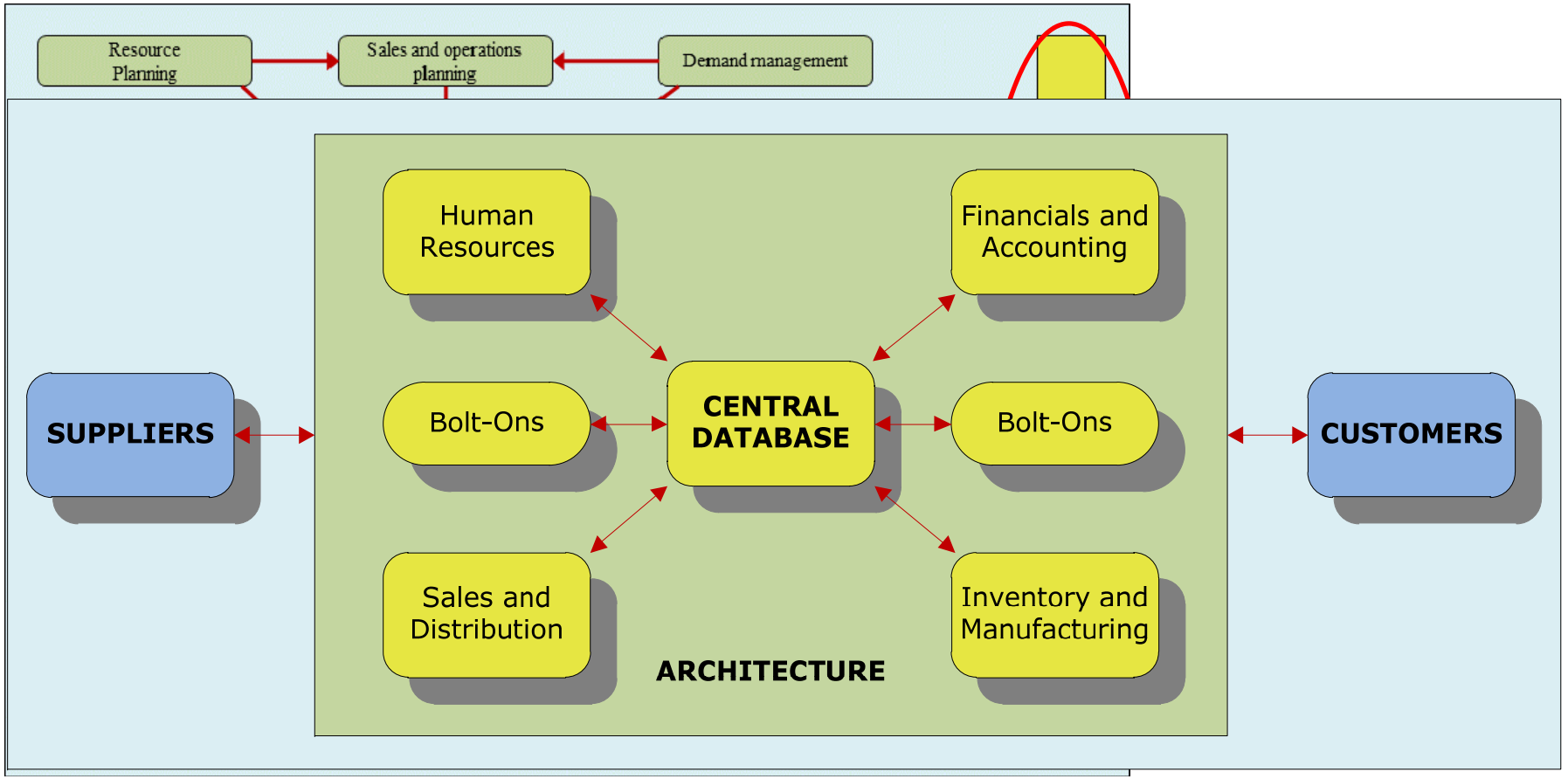
SFI NORMAN

This eight-year research programme aims to develop new and multi-disciplinary research on next-generation manufacturing, and create theories, methods, models and management tools that enable Norwegian manufacturers to thrive in the global market. Norman was established by the Research Council of Norway as a Centre for Research-based Innovation in 2007: it's the result of the collaboration between 16 leading Norwegian manufacturing companies from a wide range of industries, the Norwegian University of Science and Technology and research institution SINTEF.

In 2009, the Norman companies were surveyed to find out the extent to which lean practices had been adopted and applied. A questionnaire was developed that allowed each company to evaluate itself on a Likert scale for the following 10 lean practices:

1. Workplace Organisation
2. Total Productive Maintenance (TPM)
3. Kaizen
4. Total Quality Management
5. Standardised Work
6. Quick Changeovers
7. Heijunka
8. Pull Systems
9. Supplier Relationship Management
10. Customer Relationship Management

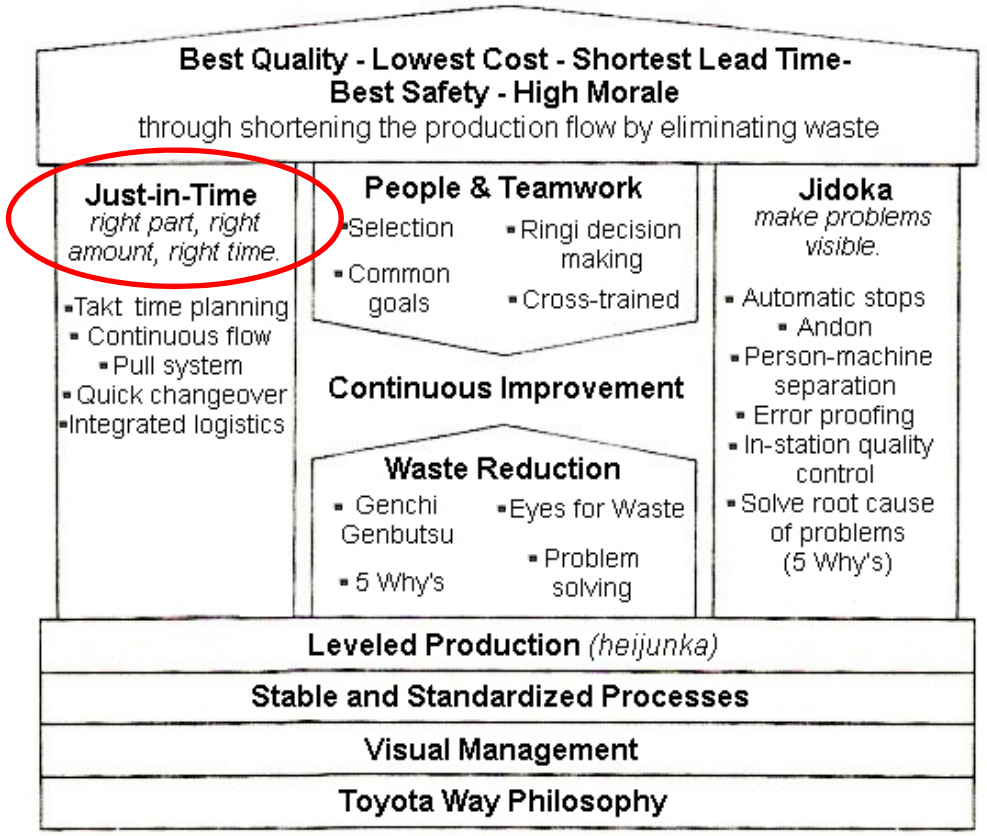
Enterprise resource planning (ERP)



Vollmann et al. (2005) Mabert et al. (2001)

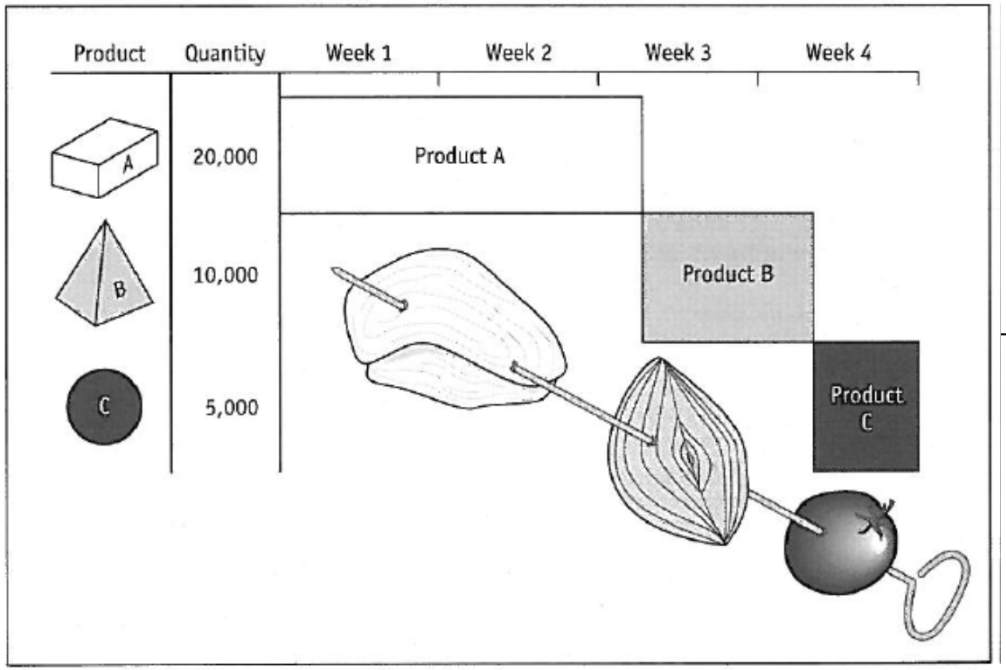
Lean & Just-in-Time: Pull Production

- 3 fundamental principles of JIT (Sugimori, 1977):
  - Levelling of production (Heijunka)
  - One piece production and conveyance (Single piece flow)
  - Withdrawal by subsequent process (Kanban)



Liker (2004)

Levelling of production: Heijunka



Estimated production output (monthly)

Number of working days: 20

	Month	Day
X	1,000 units	50
Y	600 units	30
Z	400 units	20

Daily production schedule

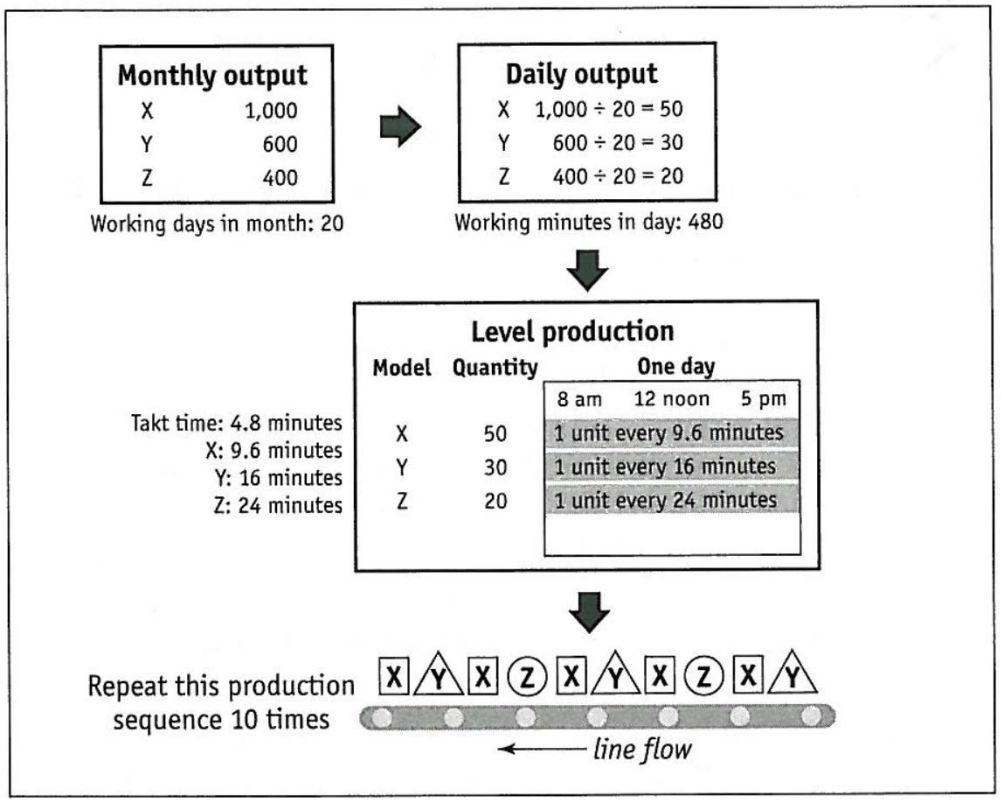
Model	Quantity	One month 1 2 3 4
X	1,000	50 units per day
Y	600	30 units per day
Z	400	20 units per day

Assembly schedule for one day

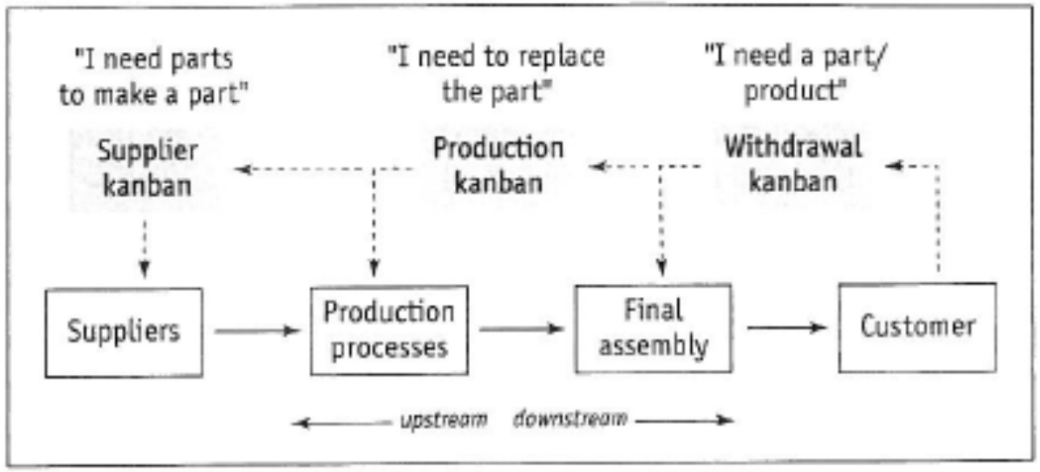
Model	Quantity	One day 8am	12 noon	5 pm
X	50	50 units		
Y	30		30	
Z	20			20

This is still shish-kabob production

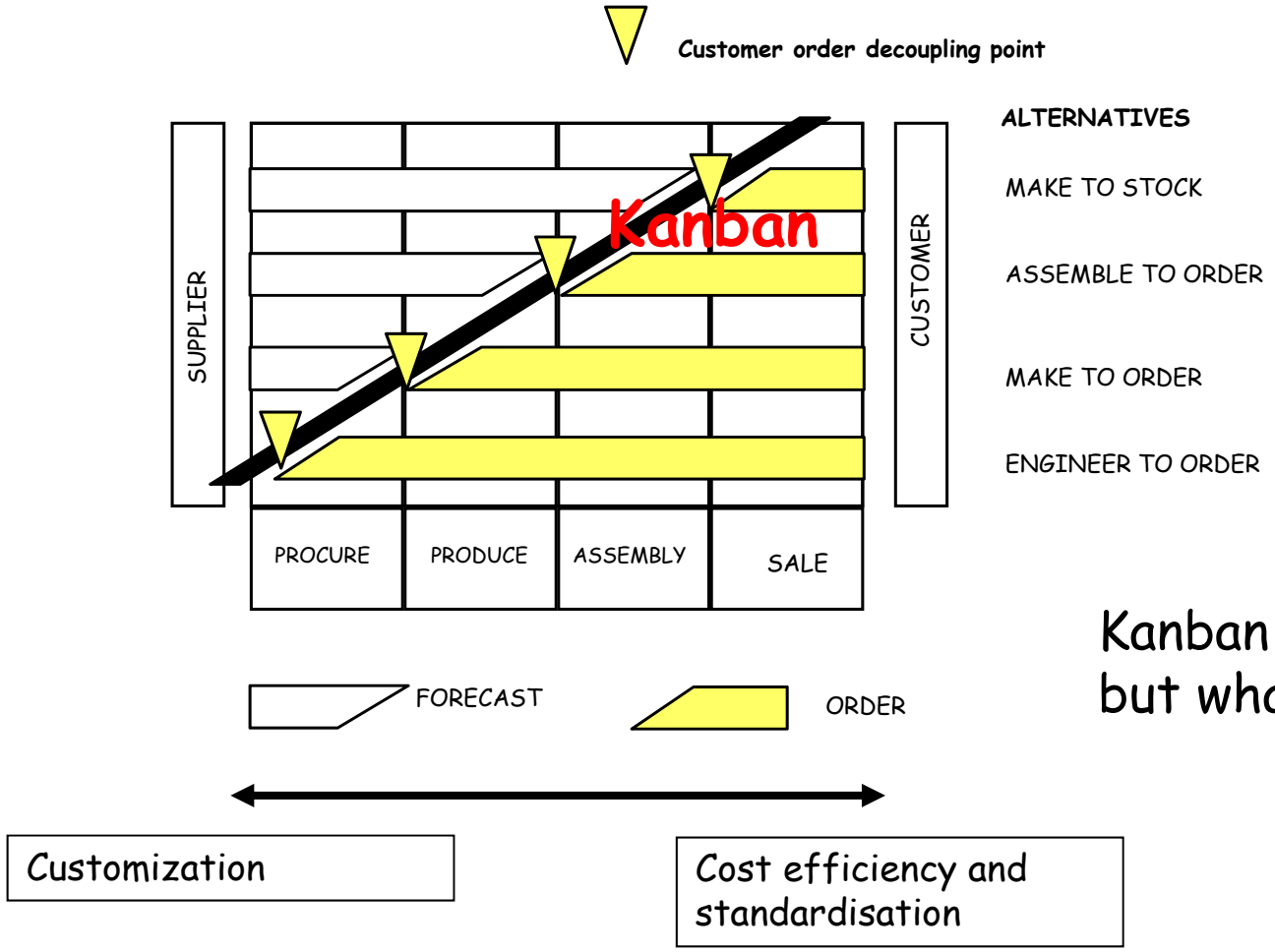
One piece production and conveyance: Single piece flow



Withdrawal by subsequent process: Kanban



Customer order decoupling point



Kanban for MTS / ATO,
but what about MTO / ETO?!

Paired-cell Overlapping Loops of Cards with Authorisation: *POLCA*

Why POLCA?

- Kanban requires a minimum amount of inventory to be held between each workstation – LARGE NUMBER OF PRODUCT SPECIFICATIONS?

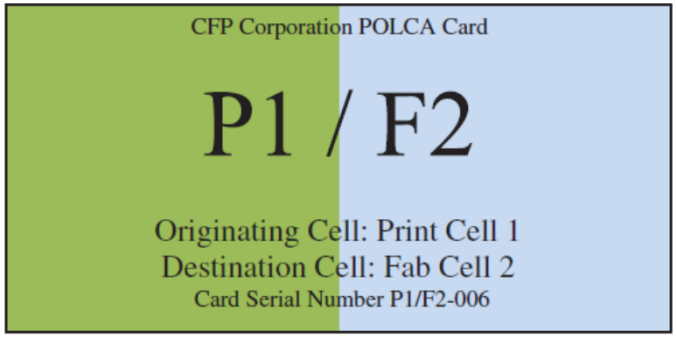
- Custom designed products? – NO PREDIFINED FINISHED GOODS.

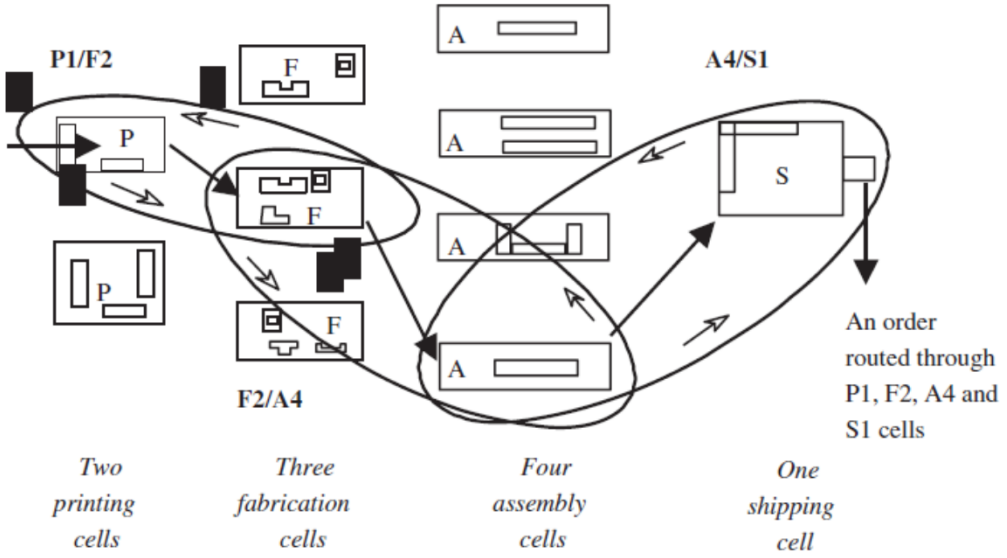
- POLCA for material control in manufacturing environments with *high variety* or *custom-engineered* products

What is POLCA?

- Paired-cell Overlapping Loops of Cards with Authorisation (POLCA)
- A Hybrid "Card-based" Push-Pull Strategy
- Controls material flow through the factory (for minimal WIP)

Order release
(from HL/MRP)





How is POLCA different from Kanban?

- POLCA cards are paired-cell specific, kanban cards are product specific
- POLCA cards are used to control material movements between cells, not within cells
- POLCA cards are a **capacity signal**, kanban cards are an **inventory signal**
  - POLCA cards signal production can start ***if*** there are orders waiting, kanban cards signal that production must start regardless.

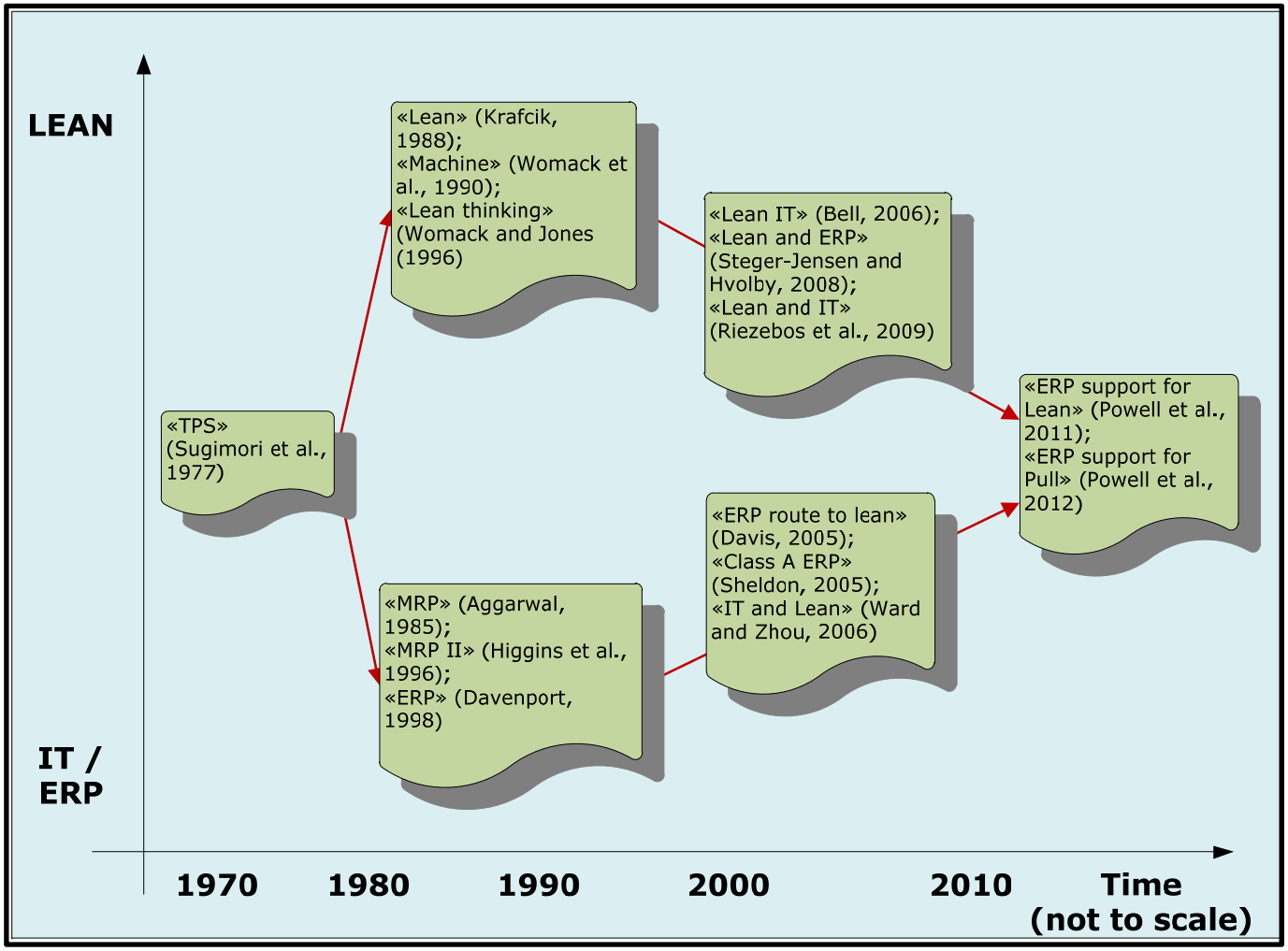
Back to Lean & ERP…

- Lean and ERP consistently rated as the most important strategies for achieving competitive advantage in manufacturing operations (Carroll, 2007)

- In lean, information technology (IT) has often been viewed as non-value adding activity (Sugimori et al., 1977)

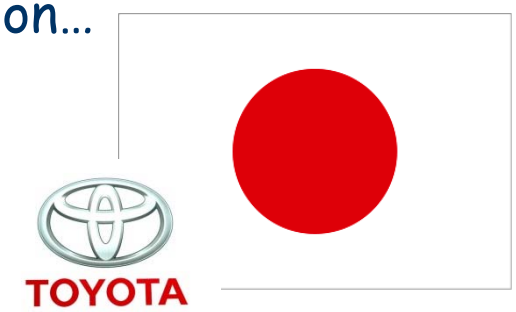
- Modern IT can be tailored to support lean production (Riezebos et al., 2009)

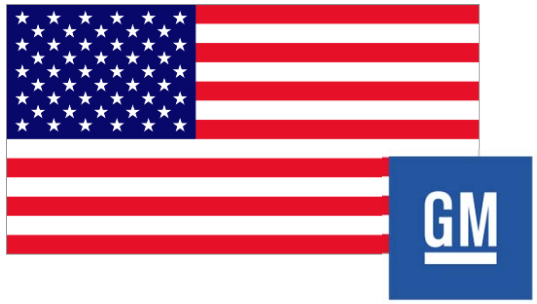
Lean Vs. ERP Systems?



Pull vs. Push: The Lean-ERP Paradox

- Lean and ERP have emerged from fundamentally different approaches to production…





Lean	ERP
Production based on consumption (pull)	Production based on forecasts and machine utilisation (push)
Decentralised control and empowerment (bottom-up approach)	Centralised planning and control (top-down approach)
Rate-based, mixed model production	Time-phased, batch production
Focus on maintaining flow	Focus on tracking material movements

Summary of the lean–ERP paradox

Table I

Powell and Strandhagen (2011)

- …Potential synergy in combining the two?

(Perceived) Benefits?

LEAN PRODUCTION

- *Lead time reduction*
- *Inventory reduction*
- *Productivity improvement*
- *Quality improvement*
- *Customer service improvement*
- ***Performance improvement!***

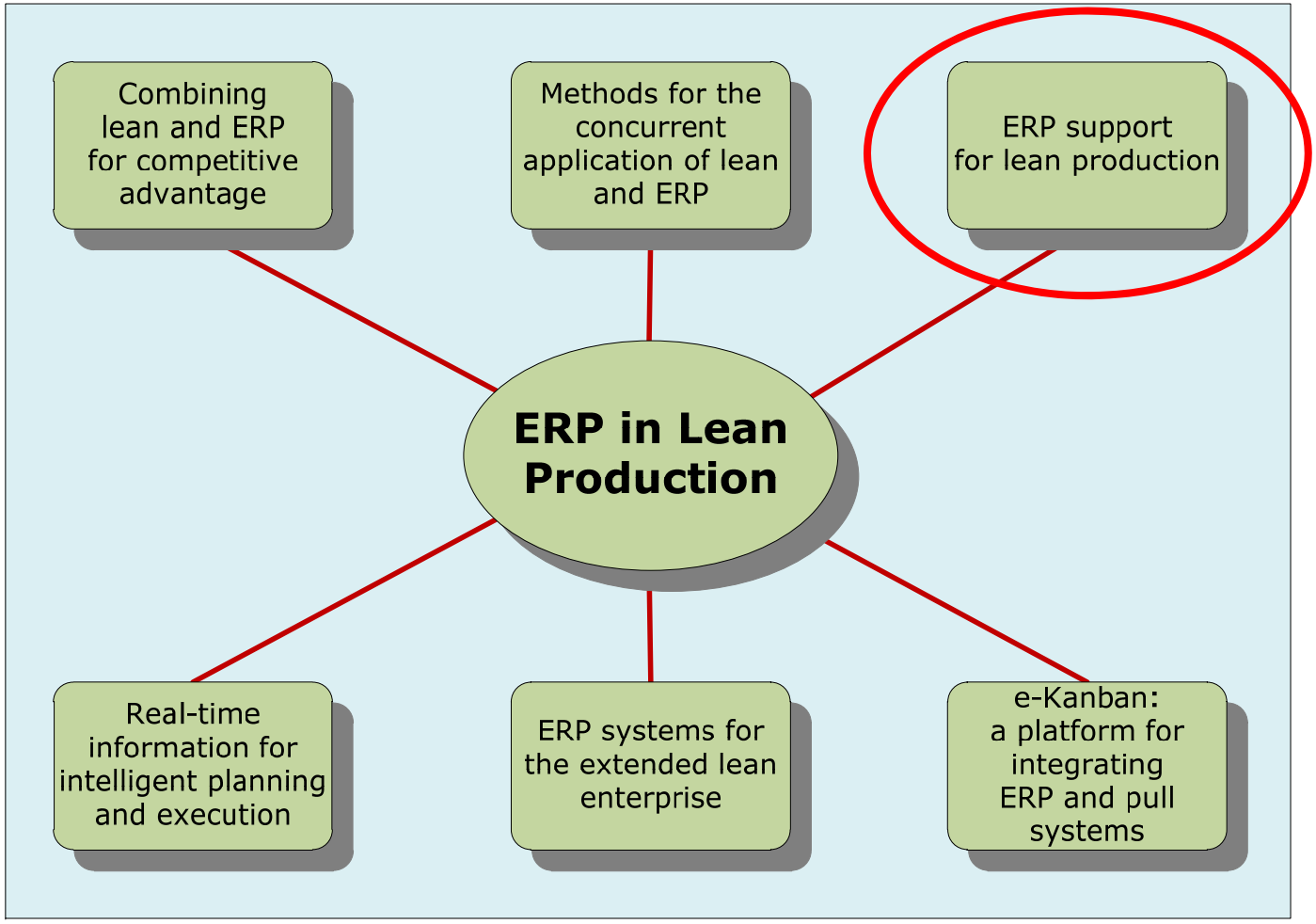
ERP SYSTEMS

- *Lead time reduction*
- *Inventory reduction*
- *Productivity improvement*
- *Quality improvement*
- *Customer service improvement*
- ***Performance improvement!***

But ERP systems used with "traditional" operating practices:

- *Excessive planned lead times = Increased inventory*
- *Large lot sizes = MORE inventory*
- *Just-in-case safety stocks = EVEN MORE INVENTORY!!!*

A research framework for ERP systems in lean production

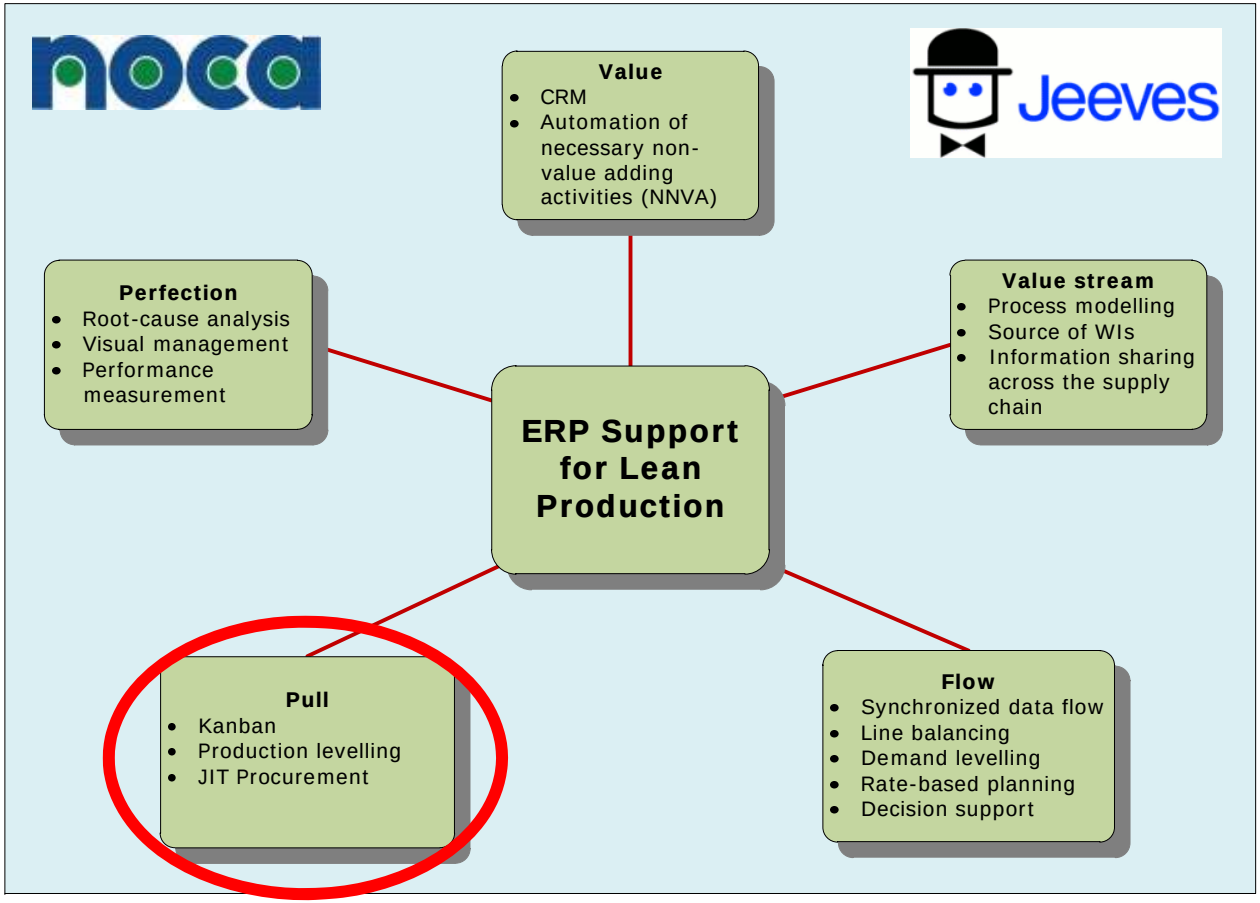


Researching ERP Support for lean Production

- Action Research (Norway)
  - Simultaneous implementation of ERP and lean practices

- Multiple Case Study (Netherlands)
  - ERP support for pull production in SMEs

ERP support for lean production



ERP Support for Pull Production:
Case Study Research, NL

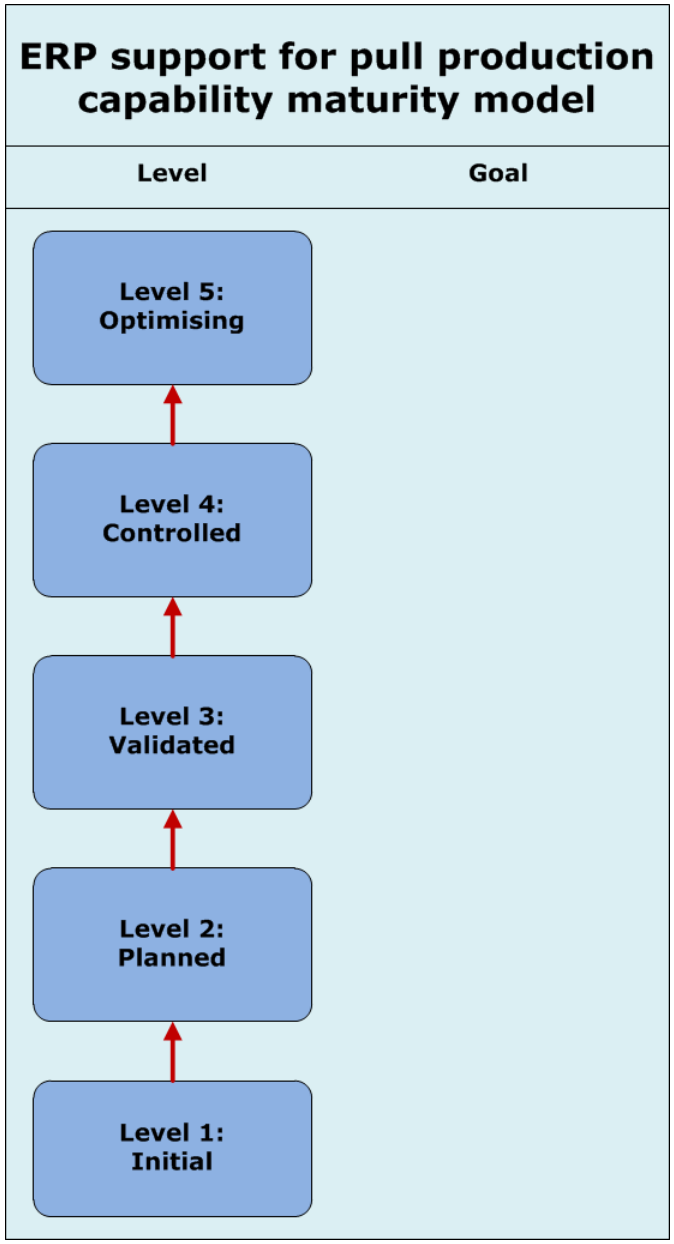
Overview of Case Studies

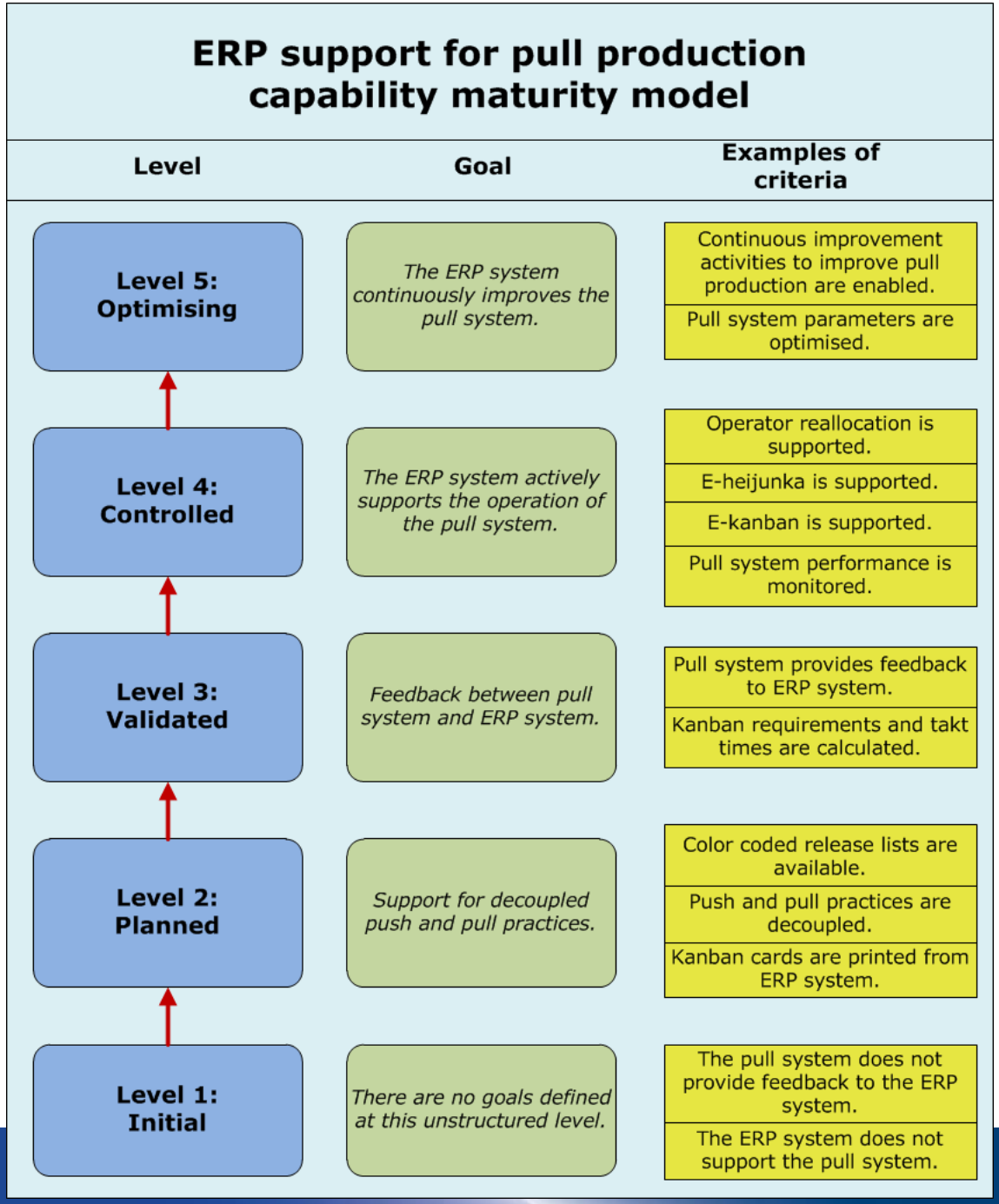
Company	AgriCo	BOSCH Scharnieren	VARIASS ELECTRONICS	altrex
Industry	Machinery	Mechanical	Electronics	Mechanical
Product	Potato Harvesters	Bespoke Hinges	PCBs	Step Ladders
Employees	100	30	120	150
Turnover	€20M	€4M	€20M	€42M
ERP System	Microsoft Navision	Exact Globe	SAP	Infor
Pull System	Kanban	Polca	Polca	Kanban
CODP	ATO	ETO/MTO	ATO	MTS

Development of a capability maturity model for ERP support for pull production

- aims to aid companies in benchmarking the maturity of their operations relative to industry best practice

- Used to compare the findings from each of the cases




ERP support for pull production capability maturity model
Level
Goal
Examples of criteria
Level 5: Optimising
The ERP system continuously improves the pull system.
Continuous improvement activities to improve pull production are enabled.
Pull system parameters are optimised.
Level 4: Controlled
The ERP system actively supports the operation of the pull system.
Operator reallocation is supported.
E-heijunka is supported.
E-kanban is supported.
Pull system performance is monitored.
Level 3: Validated
Feedback between pull system and ERP system.
Pull system provides feedback to ERP system.
Kanban requirements and takt times are calculated.
Level 2: Planned
Support for decoupled push and pull practices.
Color coded release lists are available.
Push and pull practices are decoupled.
Kanban cards are printed from ERP system.
Level 1: Initial
There are no goals defined at this unstructured level.
The pull system does not provide feedback to the ERP system.
The ERP system does not support the pull system.

Challenges and solutions

C: No kanban functionality in the ERP system.
S: Functionality added to the ERP system for printing of kanban cards.

BOSCH Scharnieren

C: Basic ERP System is "only an accounting system".
S: Bolt-on "PROPOS" system developed to visualise real-time requirements on the shopfloor.

VARIASS ELECTRONICS

C: The ERP system is too static, and proposes to build batches based on historical batch sizes.
S: Modification made to SAP with regard to parameterization and logic used for the calculation of batch sizes.

altrex

C: ERP system is unable to effectively level the demand.
S: Periods of free capacity are utilised to build up stock for promotions by using temporary (green) kanbans.

ERP support for pull production capability maturity model

Level	Goal	Examples of criteria
Level 5: Optimising	*The ERP system continuously improves the pull system.*	Continuous improvement activities to improve pull production are enabled. Pull system parameters are optimised.
Level 4: Controlled	*The ERP system actively supports the operation of the pull system.*	Operator reallocation is supported. E-heijunka is supported. E-kanban is supported. Pull system performance is monitored.
Level 3: Validated	*Feedback between pull system and ERP system.*	Pull system provides feedback to ERP system. Kanban requirements and takt times are calculated.
Level 2: Planned	*Support for decoupled push and pull practices.*	Color coded release lists are available. Push and pull practices are decoupled. Kanban cards are printed from ERP system.
Level 1: Initial	*There are no goals defined at this unstructured level.*	The pull system does not provide feedback to the ERP system. The ERP system does not support the pull system.

noca ?????

BOSCH Scharnieren altrex

VARIASS ELECTRONICS

Conclusion & Further Work

- Findings suggest a range of potential ERP support functionality for lean production principles
- Our CMM highlights examples of ERP support functionality for pull production
- Further work should apply the CMM to demonstrate capability in deploying ERP-enabled pull production in Norwegian industry.

Thank You

Questions?

email: daryl.j.powell@ntnu.no