Paper Track4: Lean Systems Engineering
Monday, 20 June 2011 in Room 403

13:30 – 14:55

Combining Lean and Sustainable Concepts with Systems Engineering for Manufacturing Enterprises
Prof. Masaru Nakano (Keio University, Japan)

A Framework for Supporting the Transition to Lean Systems Engineering
Mr. Steffen Gruenwaldt (Siemens Corporate Technology, Germany)

- 30 minutes talk + 10 minutes for discussion
- required to attend the Speakers/Sessions Chair's breakfast
- a written short introduction of yourself, which the Session Chair

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Combining Lean and Sustainable Concepts with Systems Engineering for Manufacturing Enterprises

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INCOSE, Denver
20-23, June, 2011

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Introduction

- Lean systems engineering (LSE) has recently emerged in INCOSE.
- There are a lot of lean related concepts such as LPS, TPS, JPS, and TPDS.
- Propose yet another LSE (a concept of lean and sustainable enterprise) by combining TPS, JPS and TPDS with SE.

Contents

- Lean systems engineering (LSE) concept
- Lean related concepts for manufacturing and product development
- A lean and sustainable concept for manufacturing enterprises

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Lean Systems Engineering (LSE)

- Definition (INCOSE 2009): the application of lean principles, practices, and tools into SE to enhance the delivery of value to the system's stakeholders.
- LSE is considered to be a way of solving the problems of schedule delay, cost overrun, and mission failure in SE applications by adding it to conventional SE methods.
- The idea is to apply the lean concept (e.g., Womack, 1990; Morgan and Liker, 2006) to project management, where systems engineering techniques are used.

Questions for LSE

1) What is the relationship between lean and SE?

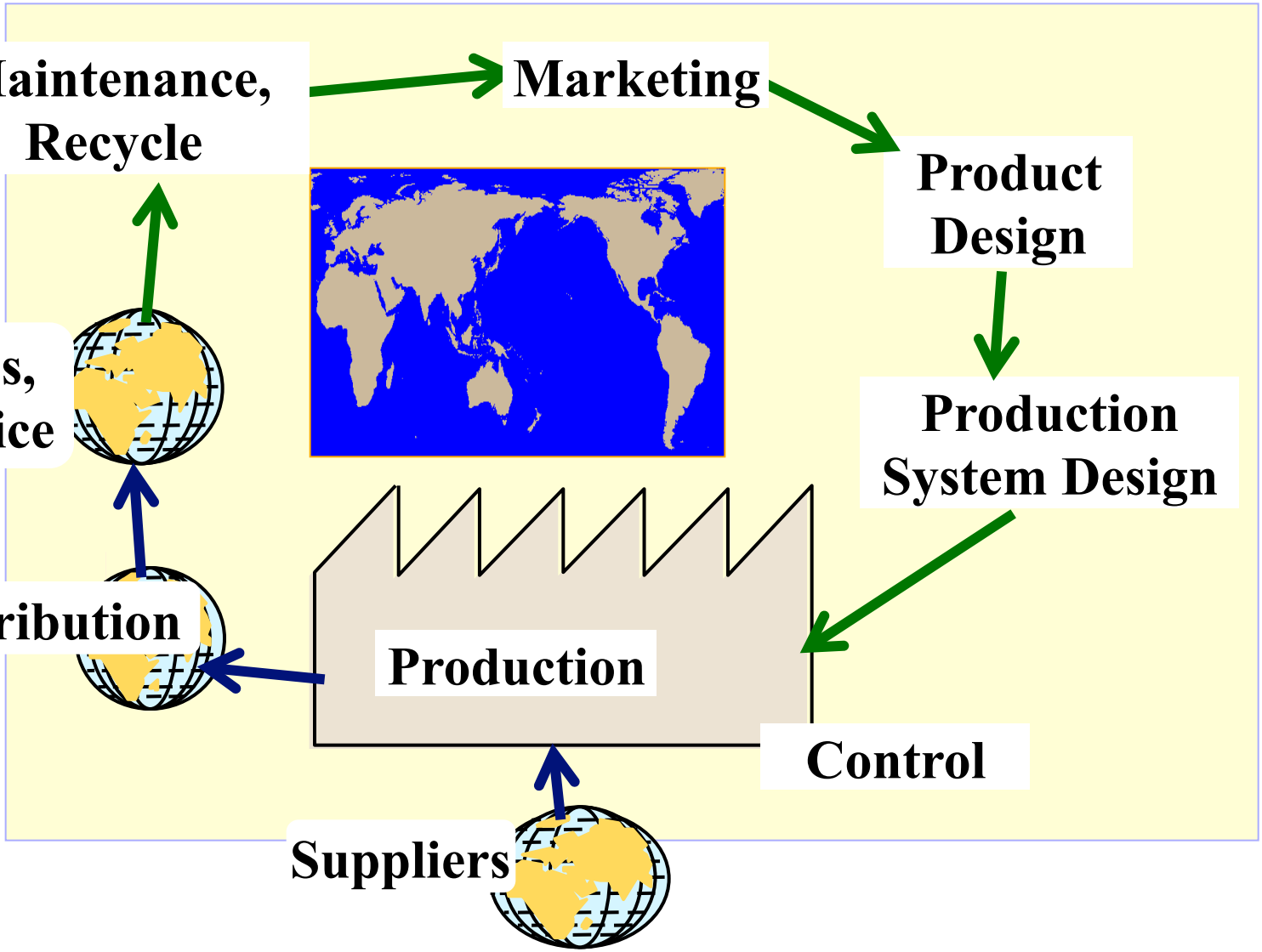
   SE with lean concepts, lean and SE, or lean with SE

2) How to create synergy between lean concepts and SE?

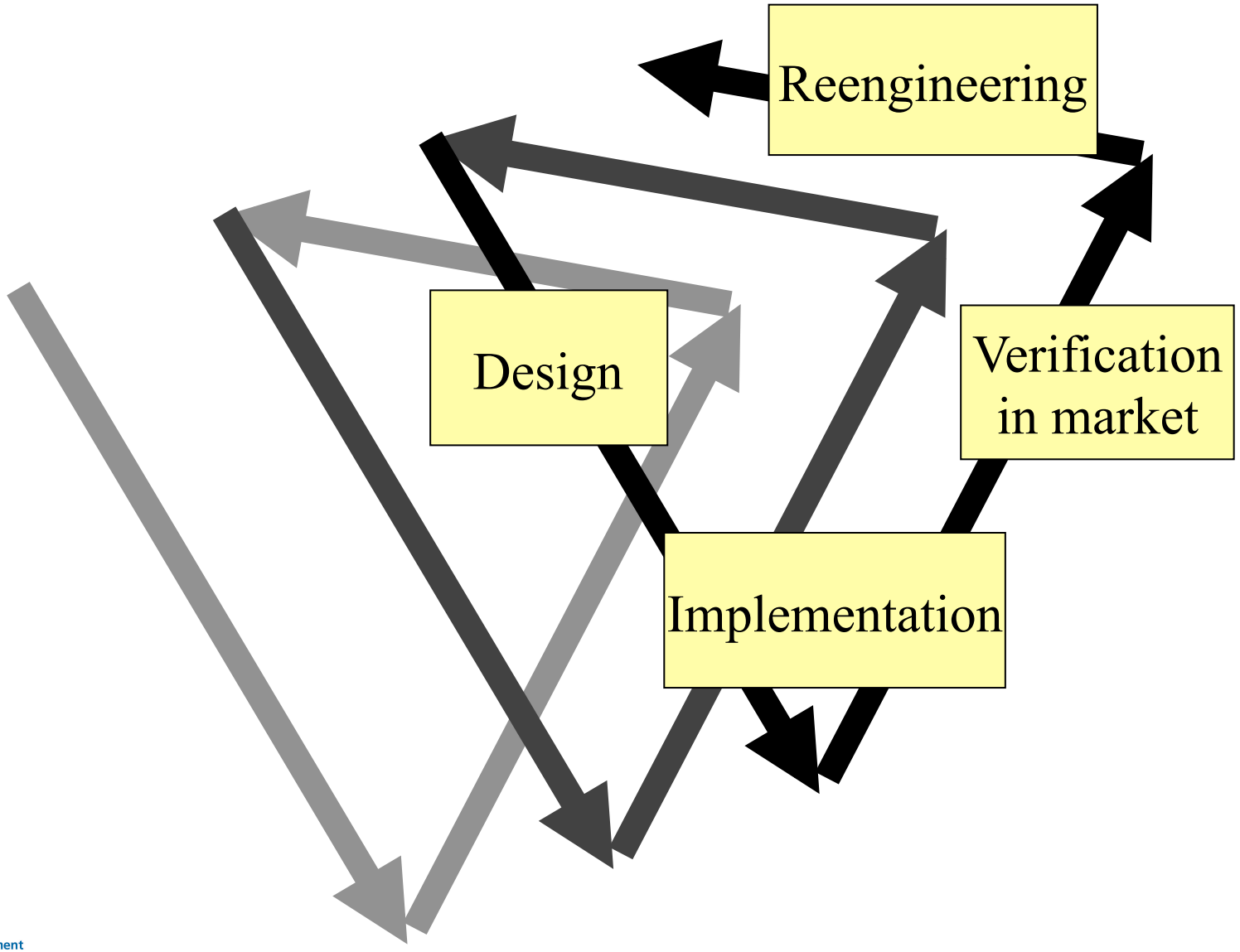
3) What is the relationship between lean and the Toyota production system (TPS)?

4) Is LSE applicable to both repeatable manufacturing and one-off applications?

BtoC manufacturing enterprises



Main process of repeatable manufacturing



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Lean related concepts:

Lean production system (LPS)
Toyota production system (TPS)
Japan production system (JPS)
Toyota product development system (TPDS)

LPS

TPS like concept made in the USA:
a philosophy of eliminating waste

(1) JIT

(2) QC or TQC

(3) Pull system,

(4) Small storage, small lots, and quick set-up

(5) Cells and U-shaped lines

etc.

Efficiency

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TPS

Toyota Motor Co. website:
http://www2.toyota.co.jp/en/vision/production_system/

Just-In-Time (JIT): Just what is needed, Only when needed, Only in the quantity needed.
There are many methods such as Kanban, the standard process, leveling or smoothing, or a worker with many opportunities to enhance Just-In-Time.
Eliminating three types of waste: *Muri*: unreasonableness or overburden, *Mura*: inconsistency or unevenness, and *Muda*: waste or uselessness.

Jidouka: the equipment stops automatically and immediately, preventing defective products from being produced.

TPS concept aims to not only improve efficiency (time related cost) but also to visualize bottlenecks, and foster the employees' ability to correct their systems.

Leveling

Production leveling or Smoothing

- Leveling loads in production lines and keeping a constant production speed.
- Eliminating bottlenecks is required to keep the production speed constant. Production leveling results in fewer inventories.
- Low-quality production prevents leveling by returning poorly produced parts to the production lines and causing unnecessary work.
- Activities to prevent the leveling often cause waste of time, material, or effort. Conversely, constant production is efficient and lean.

JPS

- Life-long employment
- Visualize real obstacles prior to consideration at desk
- Enhance team value
- Do before asking
- Continuous or endless improvement
- Admire customer value

Sustainability

Applicable for not only manufacturing but also entire enterprise

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TPDS

Morgan and Liker (2006) identified 13 principles of the lean product development system (LPDS)

(1) **Mapping the value stream** from customer-defined values to the product development process

(2) **Project management** with chief engineer system to lead development from start to finish and cross-functional team to balance functional expertise and cross-functional integration in order to **integrate all activities in a holistic way**

(3) **Standardization to reduce variations**

(4) Integration with suppliers in product development

(5) **Simultaneous engineering** between product design and production design, and between Toyota and suppliers

Communication with holistic approach (SE)

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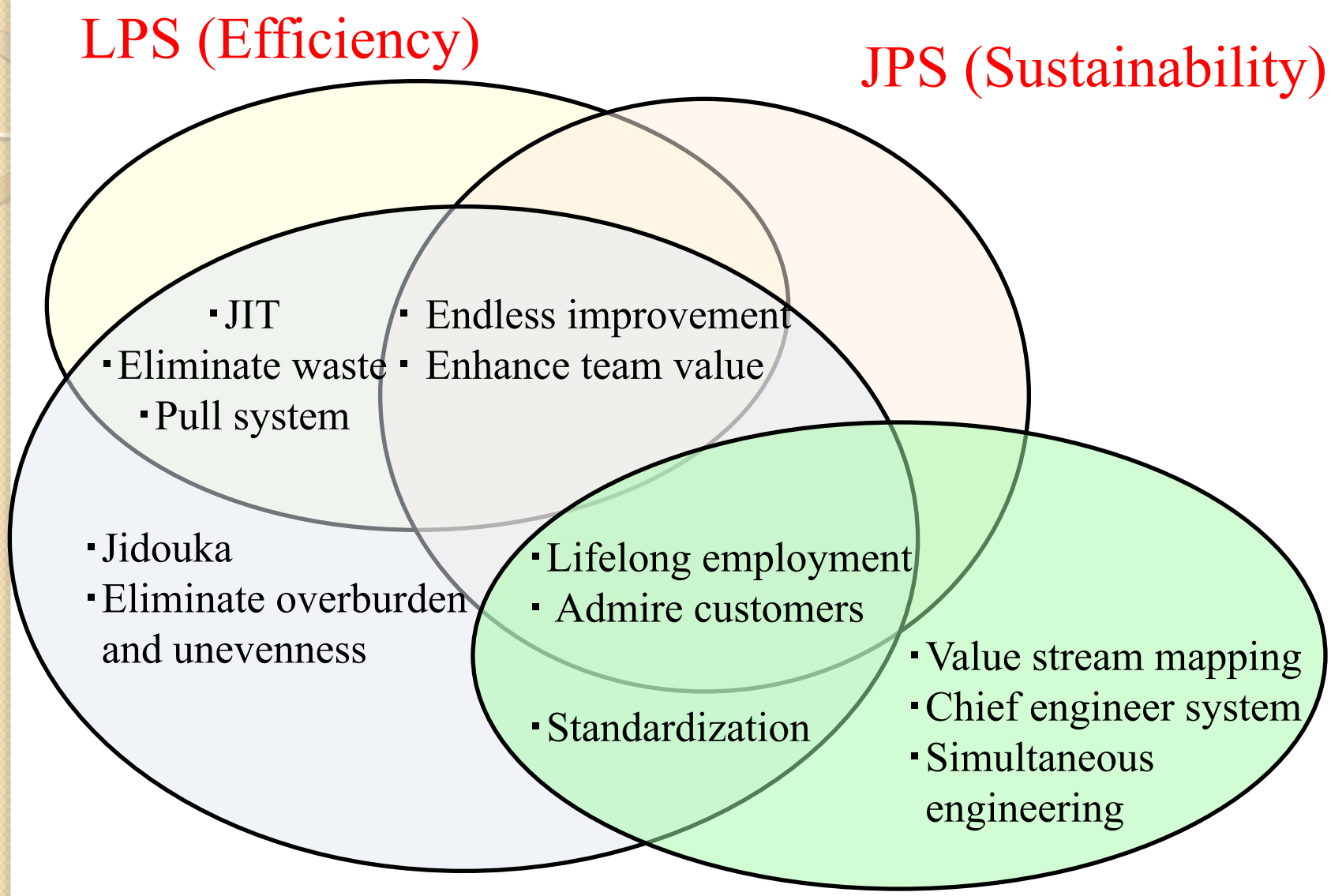
Relationship among the lean related concepts



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Extension of leveling to the enterprise level

- Beyond manufacturing and product development

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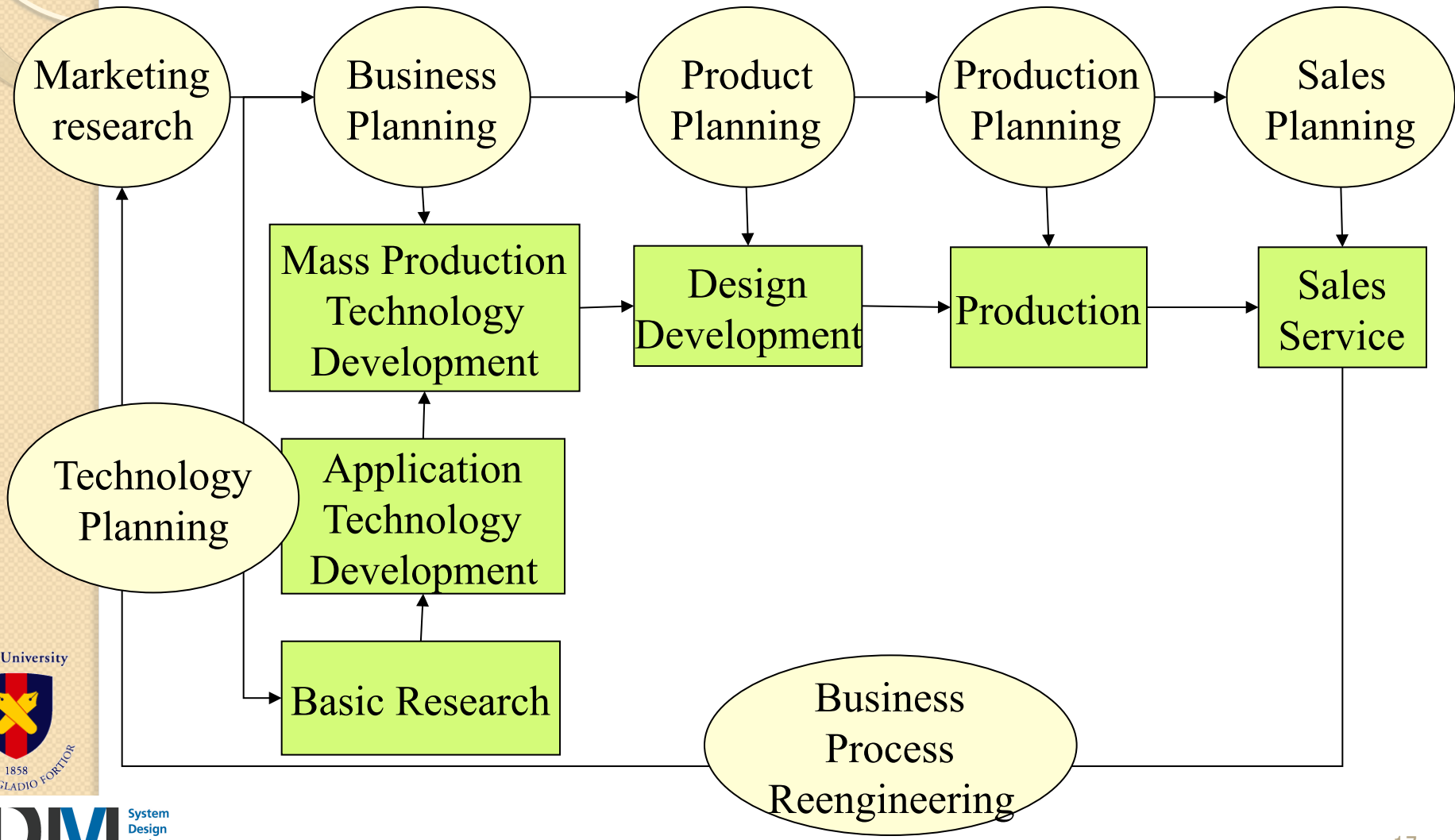
Business process in BtoC manufacturing enterprises



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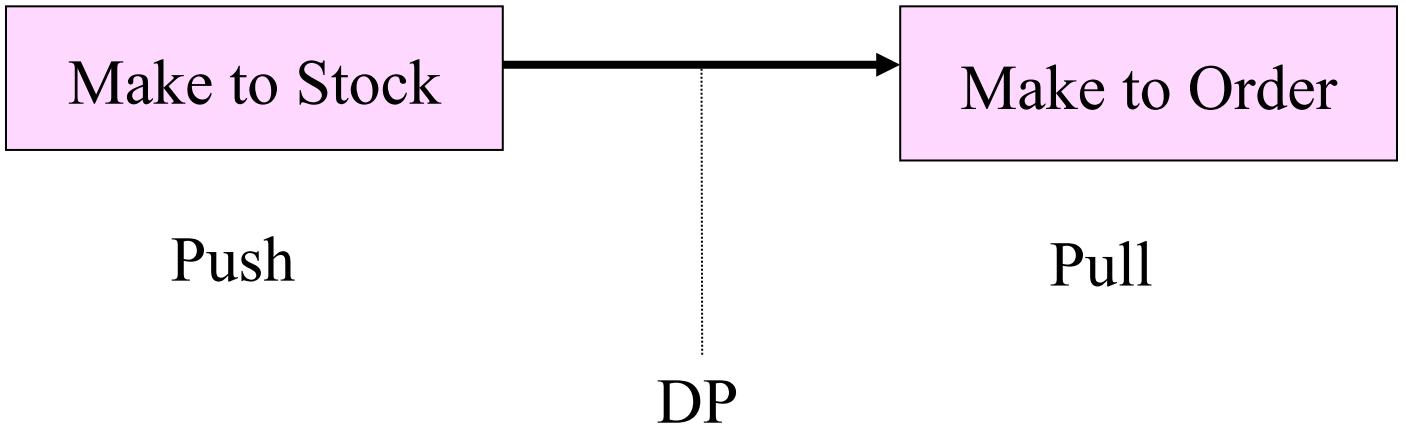
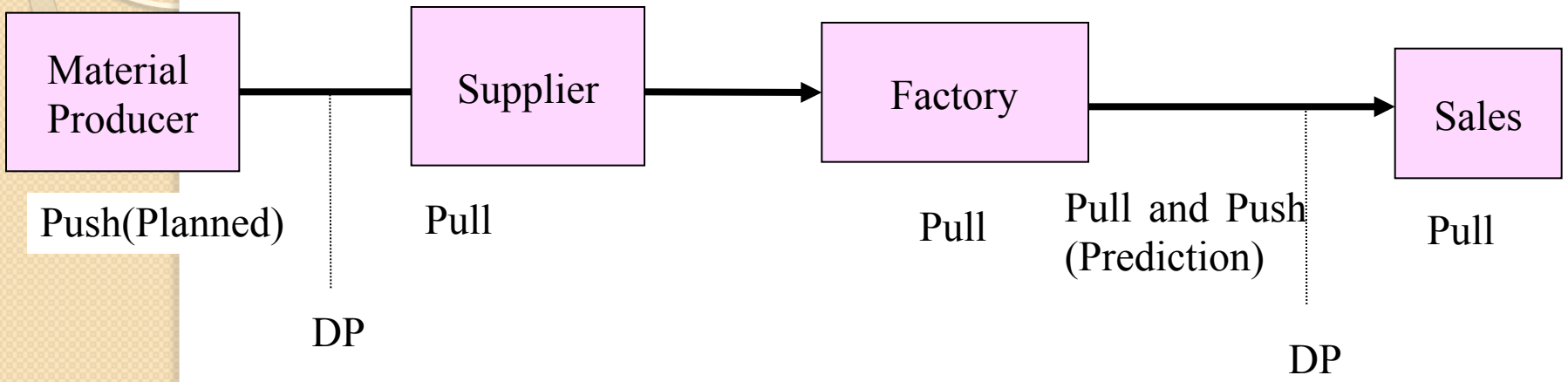
Decoupling points

Decoupling Point (DP):

decouples operations into two parts, namely, planned production (Push production) and ordered production (Pull production)



Decoupling points in automotive industry



- DP: anywhere between factories and dealers
- The invisible DP is established by the constant level of production, which is achieved by constant sales.

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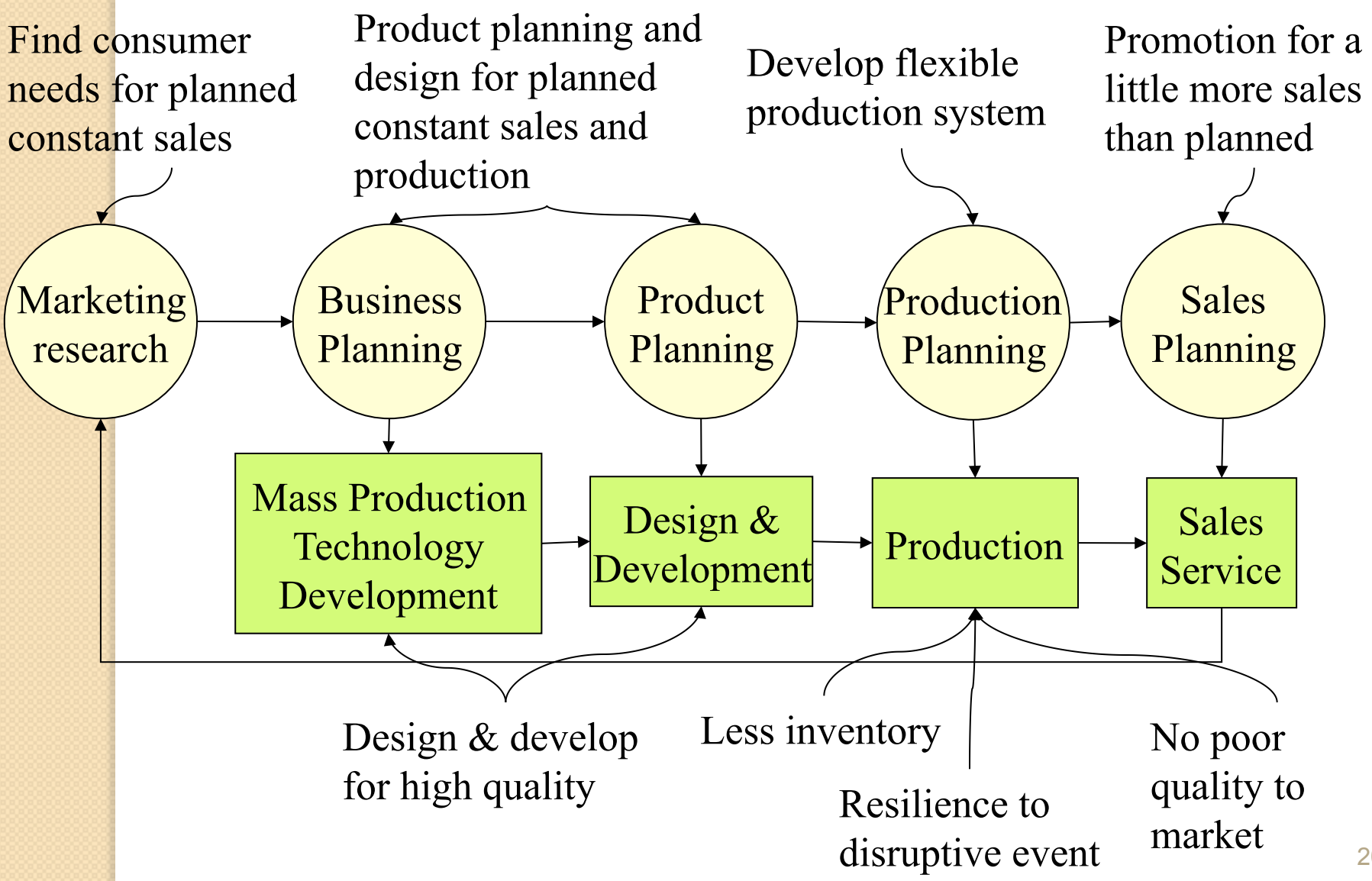
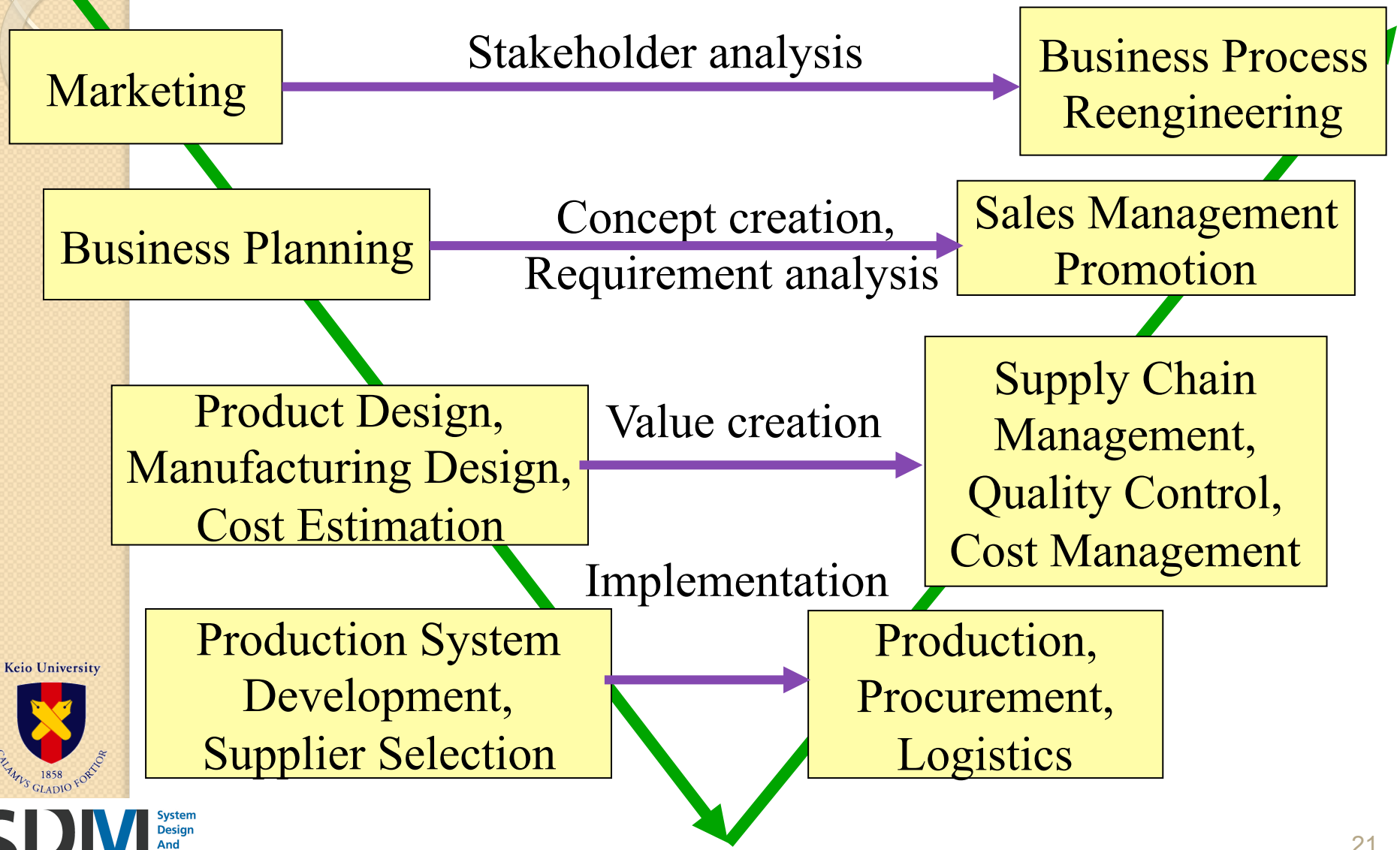
E-TPS

Extension of TPS (leveling) to the enterprise level



An Entity Vee to realize a lean enterprise

E-TPS is consistent with SE.



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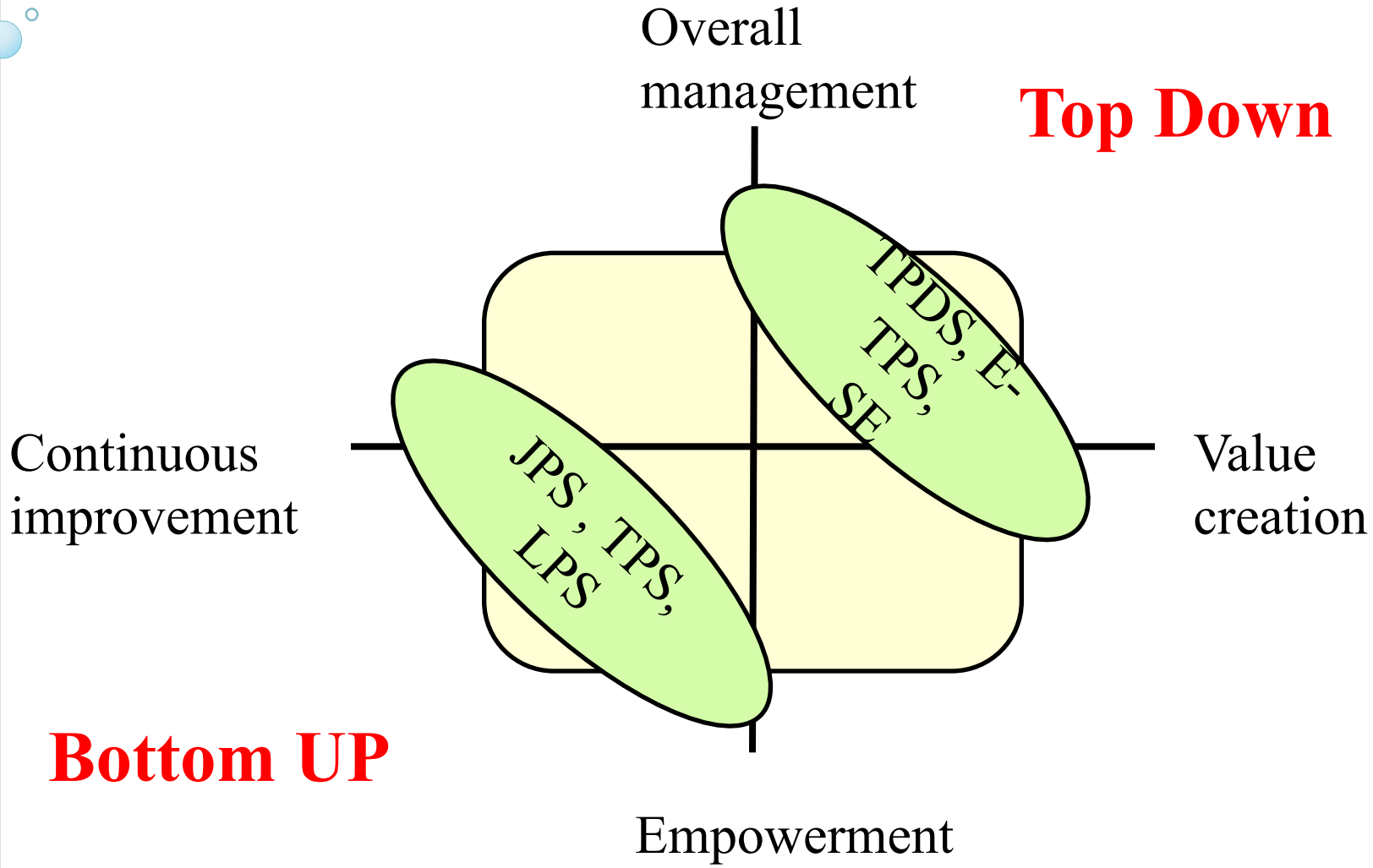
Top Down and Bottom Up Approaches



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Lean and sustainable concepts for manufacturing enterprises

A concept for sustainable enterprises

JPS: business abilities can be enhanced and maintained by continuous improvement and life-long employment.

Safety is essential in the automotive industry; repeatable manufacturing with low speed of technical innovation.

It tends to bring too high quality and too many functions with high cost for customers to accept. (ex. a sarcastic remark of "Galapagos mobile phone")

SE: proactive management, which predicts future risks, sets goals to mitigate them, and manages the system; one-off application with large-scale complexity (ex. Fukushima nuclear plant)

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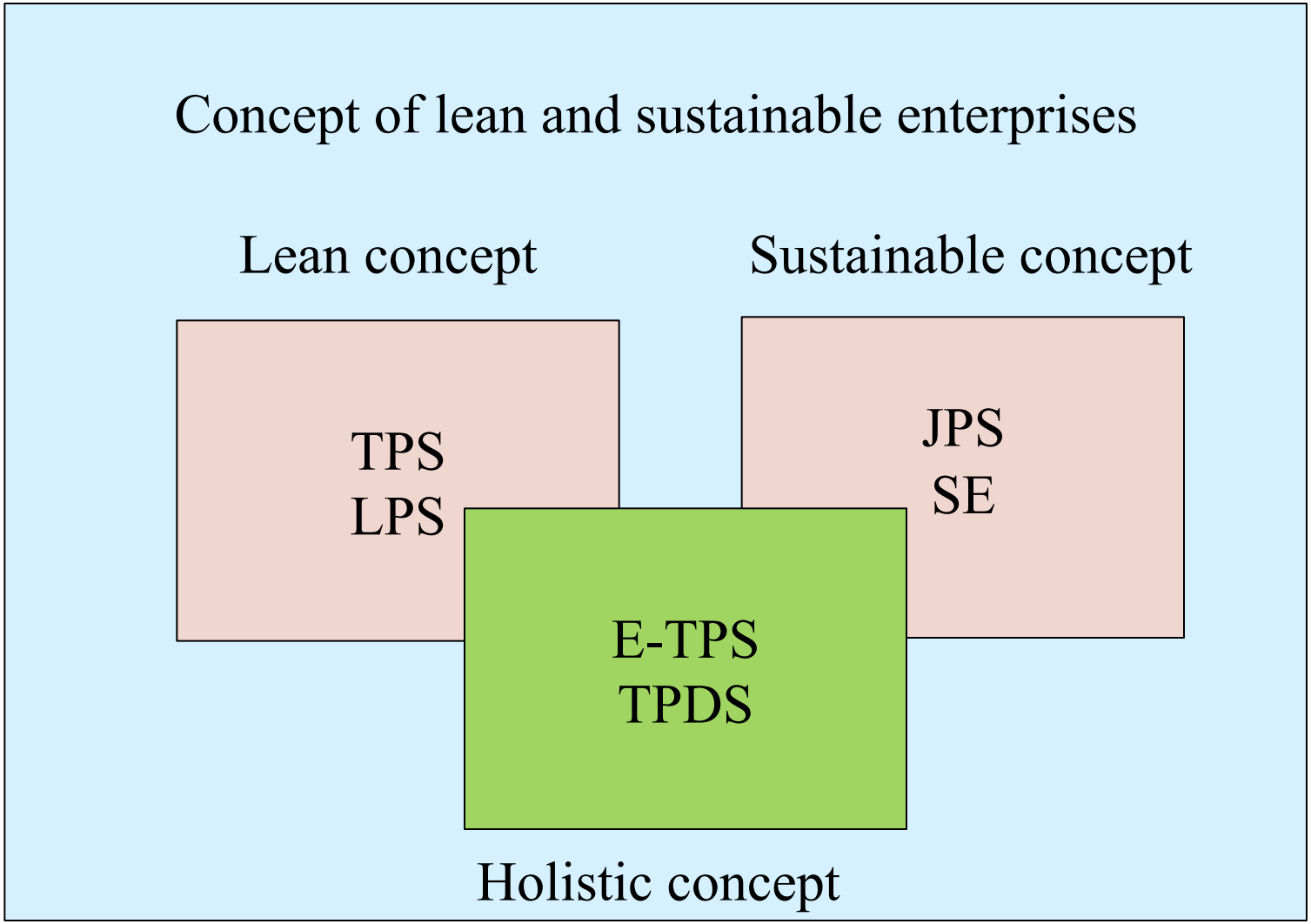
Combination!

A concept for creating lean and sustainable enterprises



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Conclusions

- Redefines lean production system (LPS), Toyota production system (TPS), Japan production system (JPS), and Toyota product development system (TPDS).
- Extends TPS to the entire level (E-TPS), based on the leveling concept. The E-TPS is interpreted as a systematic concept by applying it to an Entity Vee.
- Proposes a concept for lean and sustainable enterprises (yet another interpretation of LSE), integrating lean concept of TPS or LPS and sustainable concept of JPS or SE by focusing on sustainability more.
- The concept is expected to be useful for both repeatable manufacturing and one-off applications.

Thank you for your attention!

Toyota recent recalls

1. Floor mat interference with the accelerator pedal

The acceleration pedal can be interfered by unfixed or very thick floor mats. → Lack of brake overriding function. Too much confidence in quality. → Issue of sustainable enterprise.

2. Sticking accelerator pedal

Accelerator pedal made by CTS Co. may mechanically stick in a partially depressed position or return slowly to the idle position when the pedal mechanism becomes worn. → Issue of lean enterprise.

3. Prius brake control

An inconsistent brake feel during slow and steady braking on certain road conditions, such as potholes and bumpy or slippery road surfaces when the ABS is activated. Integration method of regeneration braking and ABS was badly changed. → Less experience of brake by wire. Little explanation before and after. → Issue of sustainable enterprise.

Rehman shock

- Car inventories in US West Coast
- Big deficit in FY2009.
- Stop Texas factory

Table. Consolidated financial results (billions of yen)

	FY2008	FY2009	FY2010
Net revenues	**26,289.2**	**20,529.5**	**18,950.9**
Income before tax etc.	**2,437.2**	**-560.4**	**291.4**
Forex rates($)	**114 yen**	**101 yen**	**93 yen**

My opinion

Risks to worsen the leveling of design, production and sales processes.

- Global procurement
  (Big recalls due to CTS brakes used in NA, CH and EU)
- Component standardization due to cutting cost
  (More efforts to evaluate quality)
- Implementing overseas factory inflexible for volume reduction
  (Flexible production lines in Japan, however…)

Localization is better but takes a long time to implement flexible production lines, keeping the leanness of the enterprise.

Cause: The expansion speed was too high, and may have caused an unbalance and less collaboration among activities throughout the business process.

Earthquakes & Production

If there is insufficient stock when an earthquake strikes, production will stall temporarily.

1995: Hanshin Awaji earthquake

2007: Chuetu Oki earthquake

2011: Great East Japan earthquake（Tsunami, Nuclear crisis)

Toyota announced in May that perfect recovery will be made in November.

Earthquakes & Production (Discussion)

1) Risk: It is extremely inefficient to save up stocks in ordinary times in case of an earthquake which only occurs very rarely.

In most cases, the long-term damage is not so large for it is possible to respond by increasing production.

To counter this, it is effective to use multiple suppliers to divide orders (multiple places). However, for international dispersal, caution is required as the necessity for supply chain risk management (risk visualization) will increase.

2) Human psychology: Those suppliers effected by the earthquake may hide their stocks even if they have some (as otherwise their wastefulness will be discovered)

3) Humanity: Restoration should be prioritized over economic activity. For staff retention and the alleviation of road congestion, the cessation of manufacturing is desirable. The brand supersedes the cost.

4) Efficiency: There are many suppliers involved in the automobile production and the hierarchy is complex. Stopping completely means faster recovery.