Roles and Responsibilities of Manufacturing Engineering in Japan and Europe

Is M.E. the lynchpin of a lean productive enterprise?

Daniel Arturo Heller
(daheller@ynu.ac.jp)
Yokohama National University

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Agenda

1. Introduction: What is M.E.?

2. System Integration: Necessary & Difficult

3. Int’l Comparison of System Integration
   “Japan” = Key role played by M.E.
   “Europe” = Key role played by development (i.e., product engineering)

4. Overseas expansion of Japanese companies: Doing Japanese-style M.E. abroad (or not?)

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What is M.E.?

• Manufacturing Engineering sits between product development and manufacturing in the value chain

• Roles of M.E.
  – Set plant layout & production process flow
  – Establish standard operating procedures
  – Design production equipment
Manufacturing Engineering

D \leftarrow \text{M.E.} \rightarrow \text{M}
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System Integration Example

In Japanese: 「扇 (おおぎ) の要 (かなめ)」

(Lynchpin (＝System Integrator))

© D.A. Heller, 2013 (Photo Source: http://japan.osu.edu/culture_box_program.html)
Integration is often Difficult

• Integration is made difficult by:
  – Uncertainty in user needs
  – Trade-offs among a product’s functions
  – High complexity of structural component interactions

• Automakers faced with great challenges in all three of these areas
Difficult System Integration

Examples…

• Piston and Piston Ring
• Car Door
• Car
Piston and Piston Ring

3-ring set for gasoline engines

3-ring set for diesel engines

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（出所: Riken Corporation, 2008 Corporate Outline）
Car Door

出所: Aisin Seiki, 2009 Company Profile
RX-8 (2003)
(Source: Mazda Motor)
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System Integration in Automotive Product Development

(Clark & Fujimoto, 1991; Higashi & Heller, 2012)

- Integrate movement of information
- Maximize the time spent on value adding activities
- Two Types of Integration
  - External integration (achieving fit w/ customer needs)
  - Internal integration (coordinating divisions & suppliers)
- Key complicating issues: Uncertainty in...
  - User needs, user interface
  - Product’s *structural* interactions
  - Product’s *functional* interactions
- Principal system integrator (the lynchpin):
  **HWPM** (Heavy-Weight Product Manager)
Integrative Role of HWPM

• Heavy-Weight Product Manager (HWPM) is the cornerstone of lean development for products:
  – With high complexity, and
  – Equivocal user needs

• HWPM leads both external and internal system integration (i.e., plays the role of both a planner and an engineer)
Automotive Lean Manufacturing
(Womack et al., 1990; Koike, 2008)

• Whole plant optimization to minimize waste
  – Integrating the movement of...
    Material  Work Activity  Information
  …to get smooth flow from input to output.

• Key complicating issues: Uncertainty in...
  – Market demand
  – Manufacturability of product design
  – Parts/component delivery

• Principal system integrator (the lynchpin):
  Shop-floor worker
But, who integrates Product Development (D) and Manufacturing (M)?

• For complex assembly products, there is often a vast chasm between D and M
Role of M.E. in (Toyota-style) Japan

• Strong capability in Manufacturing Engineering can be the bridge between product development and manufacturing

• M.E. can be the principal system integrator for the whole productive endeavor
Development

M.E.

Manufacturing
Why give M.E. this role?

• An unlikely candidate to be key player
  – M.E. neither develops nor manufactures the product

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Why M.E.?

• M.E. can occupy a neutral position
  – Because it neither develops nor manufactures the product
• M.E. is positioned to “look both ways”
  – For problem solving M.E. is independent of the local interests of D and M
  – M.E.’s neutrality frees it to be the guarantor of the customer’s interest
• M.E. can translate, mediate and adjudicate:
  – Between product development and manufacturing
  – Across development and manufacturing functions
  – Within development and manufacturing functions
Tend to see…

D  M  

Customer!

or

But with PE as mediator/adjudicator…
Two-way System Integration

• This role for M.E. is typical of Japanese management: A focus on the key role played by the middle

• “System thinking” needed
  – Systems knowledge = systems thinking
  – “Connection knowledge” (Sobek’s term)
  – System-level design (Sobek, 2006)

• The aim is full-system optimization
  – Products that are complex systems require organizations that efficiently manage complex management systems

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M.E. in (Toyota-style) Japan

- Role = System Integrator of Productive Enterprise
- Responsibility = 1\textsuperscript{st} be customer’s guarantor
  2\textsuperscript{nd} be active internal mediator
M.E. as Lynchpin

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Impact of M.E. as Lynchpin

On Product Development…
• Less “designing”
• More “choosing”
…driver of strategically focused design work?

On Manufacturing…
• Less capital investment
• More skill development of workers
…driver of improved market responsiveness?
The result...

Photo Source: wikipedia
The result...

Photo Source: wikipedia
The result...

Photo Source: wikipedia
The result...
Does M.E. play such a system integrating role in European Companies?

No Way!

In most cases

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M.E. in Europe

By closely linking M.E. with Development, M.E.’s Output can be clearly defined.
In Europe, rather than Japanese (Toyota) style two-way, one-way (upstream to downstream) integration seen.
M.E. in Europe (typically?)

• Role = Designer of new production equipment

• Responsibility = Make high-spec equipment
  (but *not* responsible for actually achieving the high specs on a day-to-day basis)
The result...
The result...
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Empowerment of M.E. in Overseas Subsidiaries

• To get global optimization, become truly lean, must strengthen M.E. in the overseas subsidiaries of Japanese automotive companies

• But M.E. is not a natural repository of power and influence. This is especially true outside of Japan.

• Special organizational initiatives needed.

• For example in Toyota, Japan:
  – High % of top management w/ M.E. background
  – As of 2007, in Toyota City there were more than 8,000 Manufacturing Engineers (called “production engineers”)
  (not including plant-based manufacturing technicians)
Capabilities needed for Japanese-style M.E. to work

- “Systems thinkers” w/ connection knowledge
  - Deep understanding of development
  - Deep understanding of manufacturing
  - Strong working knowledge of CAD/CAM
- Interpersonal skills (negotiation)
- Organizational memory
- Understanding of customer’s interest

Not easy to find (develop) such manufacturing engineers outside of Japan.
A Long-Term Challenge

• More standardization of development needed
• Shared priorities facilitate standardization
  – Getting agreement on what are the right priorities takes time and effort
  – Everyone must buy-in to these priorities
• Cultural transformation needed
  – Empowering overseas M.E. function
  – Career path management; top-level people into M.E.
  – Only possible when the whole enterprise values and rewards “systems thinking”
• Recruiting & retaining appropriate persons
(Keeping them in M.E. is even harder...)

(Cover of Harvard Business Review, May 2010に筆者加筆)
A concluding word on doing Japanese-style M.E. overseas

• Japanese-style M.E. all begins with understanding one’s neighbors (the upstream & downstream processes you interact with)
• Best way to diffuse it = just do it (yourself)!
  – Do your own job considering your neighbor
• Value “connection knowledge” (Sobek) and reward it

…and the lean results will naturally follow.

The problem is such diffusion takes time. (Can it be accelerated?)
For the foreseeable future, expensive & supply-constrained Japanese expats and short-term assignments must continue to shoulder the burden of doing Japanese-style M.E. overseas. (Is there enough time?)

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Selected References


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Thank you!

Q&A
Appendix
Tasks of Manufacturing Engineering

(1) Line design - designing production lines or production processes;
(2) Method development - developing production methods, and/or equipment;
(3) Production preparation - setting up new production machinery or equipment, making jigs, tools and dies;
(4) Production improvement - improving existing production lines and processes, with the aim of getting productivity increase.

Shibata (2009)
Micro-level Summary: Distribution of Manufacturing Engineering Tasks

Focus on analytical tasks in the phase

Key: Blue indicates holder of overall responsibility; “Lead role” means coordinate, strongly influence decision making, and execute the majority of the tasks in the phase; “Informational support” means focus on providing feedback from the point of view of the line operators; At both Supplier E and Supplier J, ME provides various forms of technical and informational assistance to MT in the production preparation phase.

Figure Source: Marinov & Heller (2013), p. 18; see also, Shibata (2009)
Types of work organization in manufacturing engineering – JAPAN

In assembly and part-processing shops – automobiles, car components, electronics

- Line design
- Method development
- Production preparation
- Production improvement

ME - manufacturing engineers
MT - manufacturing technicians

Shibata (2009)
Types of work organization in manufacturing engineering – the U.S.

In assembly and part-processing shops – automobiles, car components, electronics

Line design
Method development
Production preparation
Production improvement

ME

ME - manufacturing engineers

Shibata (2009)
Key Differences between Japan and the US

Shibata (2009, p. 1907)

1. Overlapping or not
Compared to the U.S. companies, the Japanese companies exhibited downstream personnel who are much more heavily involved in upstream processes

2. Hierarchical or not
Japan: Horizontal relationship between ME and MT
US: Vertical relationship between ME and MT

3. Localized or not
US: MT localized to plant
Japan: Inter-divisional tasks and functions of MT
Why is ME in Japan and the US different?

(1) **Integration (suriawase) orientation** - higher integral capabilities in Japan.

(2) **Production workplace orientation** - employees are heavily oriented to:

- production
- production workplaces
- on-site problem solving

Shibata (2009)
Segregation of work in U.S Companies

- In the U.S., Engineering drawings are not “tangible objects”, separating the engineers, and to a lesser degree the technicians, from the assemblers.
  
  Bechky (2003a, 2003b)

- In Japan, engineering drawings are “tangible objects” and serve as common ground that can reconcile differences among groups.

  Shibata (2009)
図5-1 ミドル・アップダウンによる知識創造

壮大な理論（あるべき理想）

（Source: Nonaka & Takeuchi, 1996, Knowledge Creating Company）

出所：野中・竹内（1996）『知識創造企業』、191ページ
表5-1 3つのマネジメント・スタイルの特性比較

<table>
<thead>
<tr>
<th>だれが</th>
<th>トップダウン</th>
<th>ボトムアップ</th>
<th>ミドル・アップダウン</th>
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<td>知識創造の主体</td>
<td>トップ・マネジメント</td>
<td>企業家精神旺盛な個人</td>
<td>ナレッジ・エンジニアであるミドル・マネジャーが率いるグループ</td>
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<td>司令官</td>
<td>後援者／庇護者</td>
<td>触媒者</td>
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<td>ミドルの役割</td>
<td>情報処理者</td>
<td>自律的な個人</td>
<td>チーム・リーダー</td>
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<td>蓄積される知識</td>
<td>形式知</td>
<td>暗黙知</td>
<td>形式知と暗黙知</td>
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<td>知識変換モード</td>
<td>部分的：連結化と内面化に焦点</td>
<td>部分的：共同化と表現化に焦点</td>
<td>全面的：共同化・表現化・連結化・内面化のスパイラル</td>
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<td>知識の貯蔵</td>
<td>コンピュータ・データベースとマニュアル</td>
<td>個人に封じ込められている</td>
<td>組織の知識ベース</td>
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<td>組織</td>
<td>階層組織（ヒエラルキー）</td>
<td>プロジェクト・チームと非公式なネットワーク</td>
<td>階層組織とタスクフォース（ハイパーテキスト）</td>
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<td>コミュニケーション</td>
<td>命令／指令</td>
<td>自己組織化</td>
<td>対話とメタファー／アナロジーの使用</td>
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<td>カオスとゆらぎの許容度</td>
<td>カオスとゆらぎは許されない</td>
<td>カオスとゆらぎを前提とする</td>
<td>カオスとゆらぎを創造し、増幅する</td>
</tr>
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<td>弱点</td>
<td>トップへの過度の依存</td>
<td>調整に時間とコストがかかる</td>
<td>冗長性のコストと人的疲弊</td>
</tr>
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</table>

出所：野中・竹内（1996）『知識創造企業』、192ページ

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西洋/West

日/Japan

top
middle
bottom

top
middle
bottom

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西洋 / West

日 / Japan

boss

worker  worker

boss

worker  worker  worker
西洋/West 日/Japan

出所Source: 成沢俊子氏（Lean Enterprise Instituteの月刊ニューレター）より
成沢（2008）『英語でkaizen!トヨタ生産方式』日刊工業新聞社を参照。
応（受）援無し

Production Line Example
[Ou-ju-en Line]

Before Mutual Assistance

Just waiting
応(受)援有り

Mutual Assistance Line
[Ou-ju-en Line]

With Mutual Assistance
Mutual Assistance Line
[Ou-ju-en Line]

With Mutual Assistance

However, we have a dilemma.

When defects occur at a mutual assistance gemba, it can become very hard to immediately identify who made them! Also, it can be difficult to see and improve imbalance.

So, some TPS sensei dislike mutual assistance operations. Others love it. How about you?
What’s a lynchpin?

Pin inserted through an axletree to hold a wheel on

(Source: http://www.thefreedictionary.com/lynchpin)
A lynchpin

- pin inserted through an axletree to hold a wheel on
- a central cohesive source of support and stability

(Source: http://www.thefreedictionary.com/lynchpin)