Strategies for Engineer-to-order Supply Chains: Lessons from Manufacturing and Construction

Dr Jon Gosling

Prof Mo Naim
• Ranked 4th in the UK in the last Research Assessment

• 2600 students each year, 130 faculty staff, total 300
Logistics Systems Dynamics Group

**Purpose**

- Achieve world-class research and education excellence in the advancement of management theory and practice, specifically in the field of logistical dynamics, via business systems engineering; in so doing adding value to its members and partners.

**Group raison d'être**

- Brings together control theory, good operations management and industrial engineering practice, business process engineering and system dynamics simulation to form an integrated approach to logistics systems dynamics problem solving.
- Considers the implications of organisational, attitudinal, financial and technological factors when instigating business process change.
- Analyses, simplifies, integrates and optimises business processes via a generic modelling approach.

---

Research Group Co-ordinator:
Dr. Andrew Potter
PotterKL@Cardiff.ac.uk
Construction as a manufacturing process (?)
Personal Computer global supply chain

(Berry & Naim, 1996)
Supply Chain Focus on Total Customer Value

Meeting Customer Requirements
  Fitness for Use
  Process Integrity
  Minimum Variances
  Elimination of Waste
  Continuous Improvement

Customer Support
  Product Service
  Product Support
  Flexibility to Meet Customer Demands
  Flexibility to Meet Market Changes

Quality x Service

Value =

Cost x Lead Time

Design and Engineering
  Conversion
  Quality Assurance
  Distribution
  Administration
  Inventory
  Materials

Time to Market
  -Concept to Delivery
  -Order Entry to Delivery
Response to Market Forces
  Lead Time
    -Design, Conversion, Eng., Delivery
  Materials
  Inventory

(Johansson et al., 1990)
Some definitions

- **Agility** means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place.
- **Leanness** means developing a value stream to eliminate waste, including time, and to ensure a level schedule.
- A supply chain is a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via a feedforward flow of materials, a feedback flow of information and flows of cash and resources.
- The **decoupling point** separates the part of the supply chain oriented towards customer orders from the part of the supply chain based on planning.

(Naylor, Naim and Berry, 1999)
Supply Chain Strategies

(Roekstra & Romme, 1992)
Impact of the Supply Chain Decoupling Point

Lean supply

Push Plan
Pull Execution

The Decoupling Point

Agile response

Number of Material Flows

Demand Upstream from the Decoupling Point

Demand Downstream from the Decoupling Point

Stock Levels at the Decoupling Point

Flow Of Material

(Naylor, Naim and Berry, 1999)
The Role of Flexibility

(Purvis, Gosling and Naim, 2014)
Linking operations to marketing

<table>
<thead>
<tr>
<th>Metric</th>
<th>Agile</th>
<th>Lean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead Time</td>
<td>MQ</td>
<td>MQ</td>
</tr>
<tr>
<td>Service</td>
<td>OW</td>
<td>MQ</td>
</tr>
<tr>
<td>Costs</td>
<td>MQ</td>
<td>OW</td>
</tr>
<tr>
<td>Quality</td>
<td>MQ</td>
<td>MQ</td>
</tr>
</tbody>
</table>

(Naylor, Naim and Berry, 1999)
Uncertainty reduction in a PC supply chain

Re-engineering phases

Pre-1980
1980 - Lean
1985 - IMLS & VBI
1990 - TBM
1995 - “Leagility”

Uncertainty at chip components business

Mass customisation
Co-ordinated production (CPFR)
Lean supply chain
Traditional supply chain

(Berry & Naim, 1996)
HQ

Manufacturers A

Manufacturers B

Manufacturers C

Regional purchaser

Long term capacity requirements

Buy long term capacity

Build plan

JIT call-offs

Site manager

JIT delivery of kits & contractors

Customised needs

Options list

Sales assistant

Customer

TOTAL VALUE DELIVERED

Do the job!

A

B

C

Merchant

JIT Kitting

Consolidate kits

JIT delivery of kits & contractors

Contractors

Lean (push plan / pull execute)

Agile (pull execute)

DP

(Naim & Barlow, 2003)
Customisation vs. standardisation

Lampel & Mintzberg, 1996
House building supply chain strategies

(Barlow et al., 2003)
Construction as a manufacturing process? or Manufacturing as a construction process?
Why we think ‘engineering-to-order’ is a useful term?
CODP Basic Concept

- Logic of Aggregation
  Typically Means
  - Standard Work Processes / Products
  - Resources Easy to Forecast

- Logic of the Specific
  Typically Means
  - Variety in Work Processes / Products
  - Flexible Resources May Be Required

Demand Upstream from the Decoupling Point
Decoupling Point
Demand Downstream from the Decoupling Point

Co-creation of products - need to manage design system

Purchasing has an element of uniqueness – partnerships difficult

Production process is variable – much more like a job shop

Increasing customization, lead times and cost
What do we already know about ETO?
A system with levels

Adapted from Gosling, Towill Naim and Dainty (2014) 'Principles for the design and operation of engineer-to-order supply chains in the construction sector
ETO Project

- Windows (MTO)
- Lifts (MTO)
- Bricks (MTS)
- Roof System (MTO)
- Bathrooms (ATO)
- Concrete (MTO)
- Doors (BTO)
- Timber Frame (MTO)
- Metalwork (BTO)
Characterising Uncertainty and Risk from Project Team Perspective?

Gosling, Naim and Towill (2013) Identifying and Categorizing the Sources of Uncertainty in Construction Supply Chains
Typical Problems from a Manufacturer’s Perspective?

Incorrect Specification Received
Demand Uncertainty from Project Environment
Labour Shortages
Supply Problems
Unable to Establish Site Readiness
Access Issues
Integration of trades
Lack of up to date information

Adapted from Gosling, Towill Naim and Dainty (2014) ‘Principles for the design and operation of engineer-to-order supply chains in the construction sector’
Are there sufficient similarities across ETO sectors?

Do you recognize these challenges and problems?
Transfer of Best Practice

Adapted from Gosling, Towill, Naim, and Dainty (2014) ‘Principles for the design and operation of engineer-to-order supply chains in the construction sector’
Adopting, adapting, and implementing improvement initiatives from MTS
Principles for the design and operation of engineer-to-order supply chains in the construction sector

Jonathan Gosling*, Denis R. Towillb, Mohamed M. Naimc and Andrew R. J. Daintyc

*Logistics Systems Dynamics Group, Logistics and Operations Management Section, Cardiff University, Abercomway Building, Cardiff, CF10 3EU, UK; bSchool of Civil and Building Engineering, Loughborough University, Leicestershire, LE11 3TU, UK

(Received 19 March 2012; accepted 14 December 2013)
Individual Cycle Times

Time Compression Principle

Information Transparency

Adapted from Gosling, Towill Naim and Dainty (2014) ‘Principles for the design and operation of engineer-to-order supply chains in the construction sector’
Echelon Elimination Principle

Control System Principle

Adapted from Gosling, Towill Naim and Dainty (2014) ‘Principles for the design and operation of engineer-to-order supply chains in the construction sector"
Synchronization Principle

Decisions, information and orders are co-ordinated and related to discrete points in time

Adapted from Gosling, Towill Naim and Dainty (2014) ‘Principles for the design and operation of engineer-to-order supply chains in the construction sector"
Adapted from Gosling, Towill Naim and Dainty (2014) ‘Principles for the design and operation of engineer-to-order supply chains in the construction sector.”
We concluded that initiatives need appropriate ‘interpretation’ & additional extras.
Closing thoughts

• ETO is an important model – maintain ETO identify while translating best practice initiatives

• Manufacturing as a construction process (?)
  – Shipbuilding, aerospace

• Sustainability and Resilience

• Complex adaptive systems

• Risk and Reward


Many thanks for listening