Transforming mass production into Mass Customization – Understanding the operational (system design) core principles

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Abstract

Although the principles of agile manufacturing & mass customization are widely known, the actual, full implementation of these principles has only taken place in a few rare cases. Even some of well regarded MC pioneers often only provide “false” mass customization. This means, their MC businesses are mainly set up for marketing/research purposes and not to make profits. They actually loose money which is subsidized by their sales out of the “traditional” operating system.

This situation leads to a few key questions:

- **Are the core principles and necessary changes of the operating system (R&D & Manufacturing with SC) really understood and correctly implemented ?**
- What types of products / businesses are suitable for Mass Customization ?
- What is a reasonable / necessary target level of adapting MC principles to gain competitive advantage ?
- What are the key inhibitors adapting Mass Customization principles ?
- How to motivate an organization to start the journey transforming from traditional (manufacturing) operations to mass customization ?

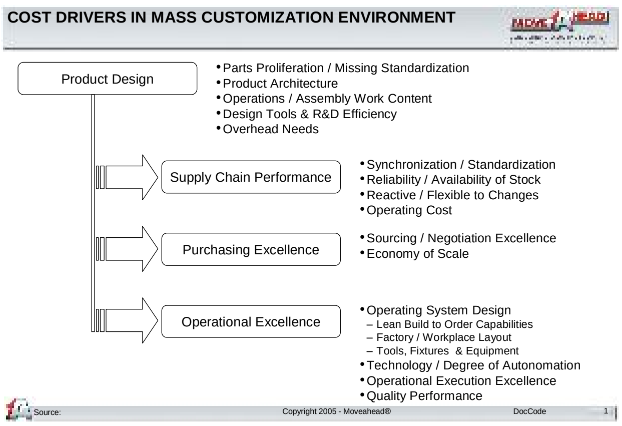
In this paper (knowledge presentation), we describe the core operating (production) system design principles that need to be implemented in order to ensure efficient manufacturing of “customized” goods at high efficiency. Being able to fulfill specific customer needs without the need for tradeoffs in cost and quality with acceptable lead time is key to success. The principles have been derived from client case studies and consulting projects implementing agile/lean production systems. A recent client case study will be used to visualize the concepts.

Keywords: Operational System Design, Lean Manufacturing, Diagnostic, Mass Customization

1 INTRODUCTION

Customizing products may unlock substantial customer value which usually leads to additional sales volume. However, the potential revenue increase generated by customized products may not be offset by increased costs (Piller, Ihl, 2002; Zipkin 2001). Thus, managing both revenues and costs are critical for success.

To manage cost, it becomes necessary to understand the drivers of cost. Costs are mainly driven by the product design, supply chain setup, purchasing excellence and operating excellence, here mainly “lean” *build-to-order* manufacturing capabilities [1]:



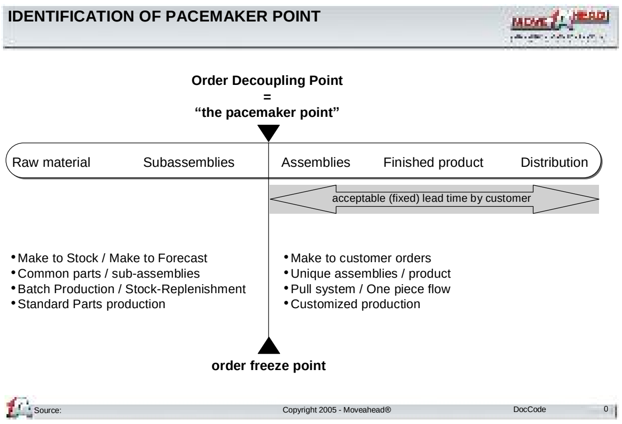
It is well known that a large portion of total operating cost is fixed by the product design and its architecture. Nevertheless, the actual design of the supply chain / value creation process (operating system design) is often the deciding factor whether enhanced offering of customization can be introduced successfully, e.g., increasing sales while maintaining or increasing profit levels per good sold.

Therefore the ideal state for a mass customization operational system must be a full make-to-order process independent of forecasts and the need to produce to stock. A superior synchronizing and standardizing of the supply chain is essential to cut overall lead times. This includes, among others, the simplification of complex material and information flows, and the synchronization of order management, logistics and production between an OEM and its critical suppliers [2].

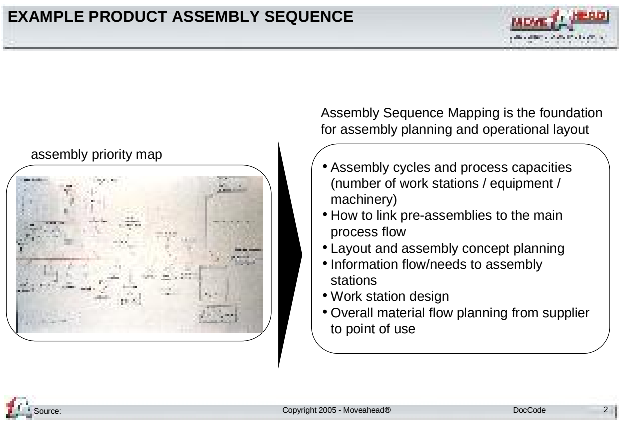
2 OPERATING SYSTEM DESIGN

2.1 Identification of “pacemaker point”

The critical point and also the starting point in designing the operating system is to identify the "pacemaker-point" (also known as order decoupling point). This is the transition point from make-to-order to make-to-stock (forecast) when the customer's accepted lead-time exceeds the (minimal possible) internal order throughput time [2].



Before designing the operating system it is therefore necessary to identify the current and potential minimum of the internal order throughput time. The given product main assembly sequence as well as sub assembly flows need to be documented, analyzed and if possibly improved.

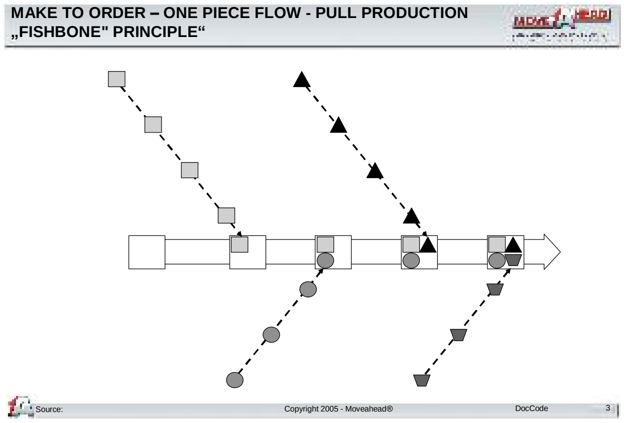


This clear picture helps to identify the pacemaker point and allows the beginning of the design of operating system.

2.2 Fishbone Principle (Information & material flow design)

The basic overall layout of an assembly operation has to match the assembly sequence diagram. Achieving a short internal order lead time (assembly throughput time) requires to limit the assembly steps of the main assembly process (e.g. assembly stations in row) while the work content has been moved to sub-assemblies that produced in parallel and are attached to the main flow.

With sub-assemblies process flows attached to the main flow from both sides the ideal layout without space restrictions would looks like a “fishbone”.



The start of subassemblies can be easily triggered by the main-assembly flow (signal point) while the information on what sub-assembly type to produce needs to be given by an information system (paper print or display).

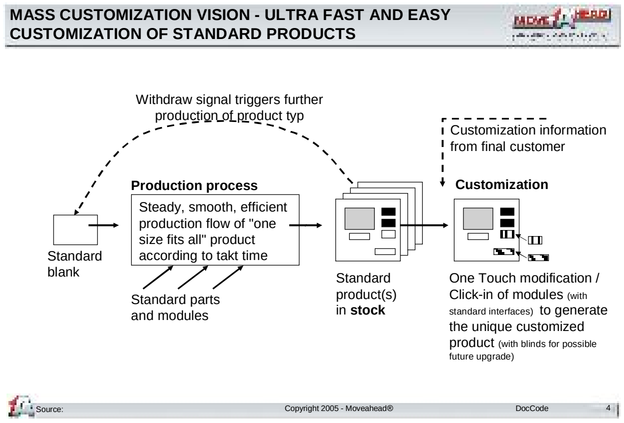
With a “smart” product design / architecture, sub-assemblies can be even produced without individual information. Here, final customization (of sub-assemblies) is either not needed or these “standard” sub-assembly can be used in all product options and are customized either automatically by design (car harness) or thru a soft customization by final customer (power inlet).

Ideally assembly times along the main flow are similar and match the anticipated production rhythm (takt time).

Peaks and lows in the assembly content of the product are ideally not present or moved into sub-assemblies.

This avoids work-in-progress in the main product flow. All flows are synchronized by a fixed production rate (takt time) and material is virtually pulled through the whole value creation process (“fishbone”).

Ideally would be a ultra-fast and easy customization at the very end of a standard value creation process.



It becomes clear that outsourcing decisions (sub-assemblies) as well as the product design (part numbers to handle / complexity of sub-assemblies) are extremely critical to overall business success. Both have major implications on the overall order throughput time and cost accepted by the customer. Combined with the product design (form, fit, function) they create the potential customer perceived product value that is in competition with products from other market players.

2.3 Benchmark Example

One of the most convincing examples of make-to-order production is a pre-fabricated home manufacturer belonging to the Toyota Group. Their entire operations are thoroughly streamlined by adapting “Lean Principles”. They achieve a plant throughput time of only one day while being able to manage an extremely high degree of customization in a cost-effective, high quality manner.

The example serves as a role model for Mass Customization. It shows that with a superior product design / architecture combined with a lean operational system design and professional execution, mass customization can be offered at no tradeoffs between quality, delivery time and costs. Once the operating system is set up, the production cost of a customized pre-fabricated house does not differ from making only standard versions

Mass customization therefore drives the adoption of Just-in-Time / Lean Manufacturing Philosophy as well as a *proactive operating mode* within the R&D department.

3 IMPLEMENTATION OF A NEW OPERATING SYSTEM

The first step should be a diagnostic of current material and information flows with the help of proven standard assessment tools performed by own employees but guided by an independent expert. This exercise quickly makes operational problems apparent but it is important not to stop there (and apply lean manufacturing gimmicks from a tool box) but to invest in further analysis and interviewing rounds of key players to identify true root causes.

With this clear picture of required operational change needed, it is possible to estimate what it takes to transform production and supply chain towards a successful make-to-order model. Since the transformation towards mass customization is not a continuous improvement process (e.g., small improvement steps of the current situation) but a step change process, it is strongly recommended to design an ideal "greenfield" operating system (vision) as a design guidance and for benchmark discussion (performance target setting). Although it will probably not be implemented as such, it has proven to be more successful to start with a "perfect production and supply chain picture" that is then adapted to reality (required target levels, given space & product design restriction) [2].

This design phase is the not the most difficult but most important phase in transforming the production and supply chain system as it sets the aspiration / performance targets. It is followed by the design of a detailed implementation roadmap that synchronizes all improvement activities.

The full implementation can take anytime between a few months and several years, depending on the starting point, size and complexity of operations.

4 SUMMARY

Mass Customization, maybe not directly named this way, has already found its way into a sustainable, mature business models as it unlocks substantial customer value. Besides product design & architecture, purchasing and supply chain excellence the design of the operating system (value creation process) is often the deciding factor whether mass enhanced offering of product variations can be introduced successfully. It requires a rigid adoption of lean manufacturing principles that are the foundation for a new operation system design. A key design principle is the make-to-order / pull-flow principle that. A typical “virtual” layout has the shape of a fishbone as sub-assemblies feed the main assembly process. Besides operational system design it is required to have up-to-date production technology, and, last not least, the right operational organization to manage a necessary step-change.

5 REFERENCES

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