

Combinatorial Effects in a Supply Chain Processes

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Introduction

Definitions

- Combinatorial effect: “..is caused when a change that is imposed on a system has an impact that is not only proportional to the nature of the change, but also proportional to the size of the system on which it is imposed.” [6]
- Evolvability: “..evolvability at the business process level; the capability of a modular business process design to adapt to identified change drivers, which requires the absence of so-called combinatorial effects at the business process level.” [5]

Introduction

What is a process?

- "A business process or business method is a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers. It may often be visualized as a flowchart of a sequence of activities with interleaving decision points or as a process matrix of a sequence of activities with relevance rules based on data in the process." [2]
- We can represent an organization with a set of flowcharts that describes the activities of different areas of the company in blocks linked and interconnected together.

Introduction

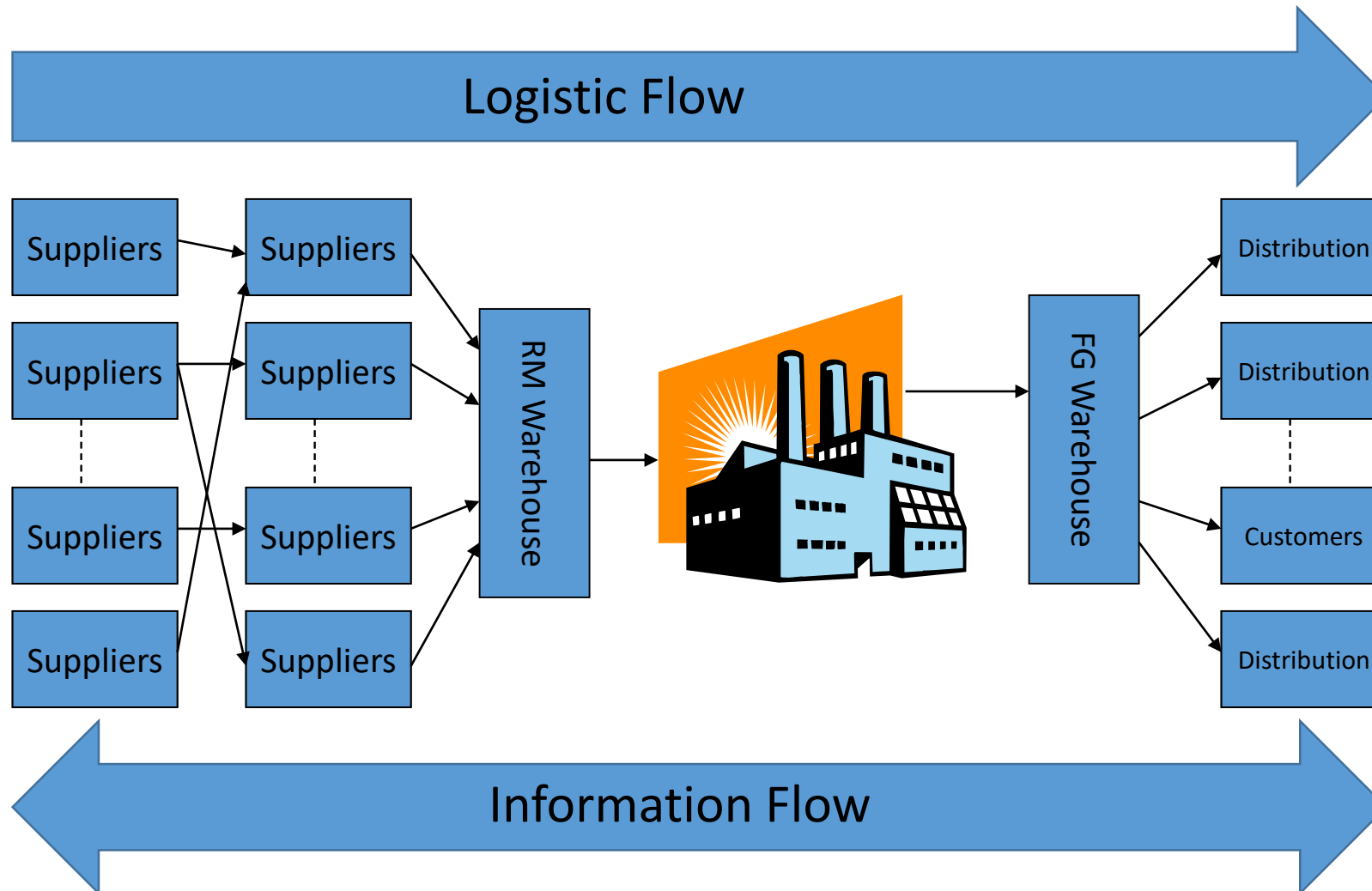
Goal

- The goal of this paper is to give some examples on:
 - Why the business processes in a supply chain may undergo changes?
 - What are the drivers behind those changes?
 - How those changes impact other processes in the chain?
 - How those changes may have a combinatorial effect on more areas of the business?



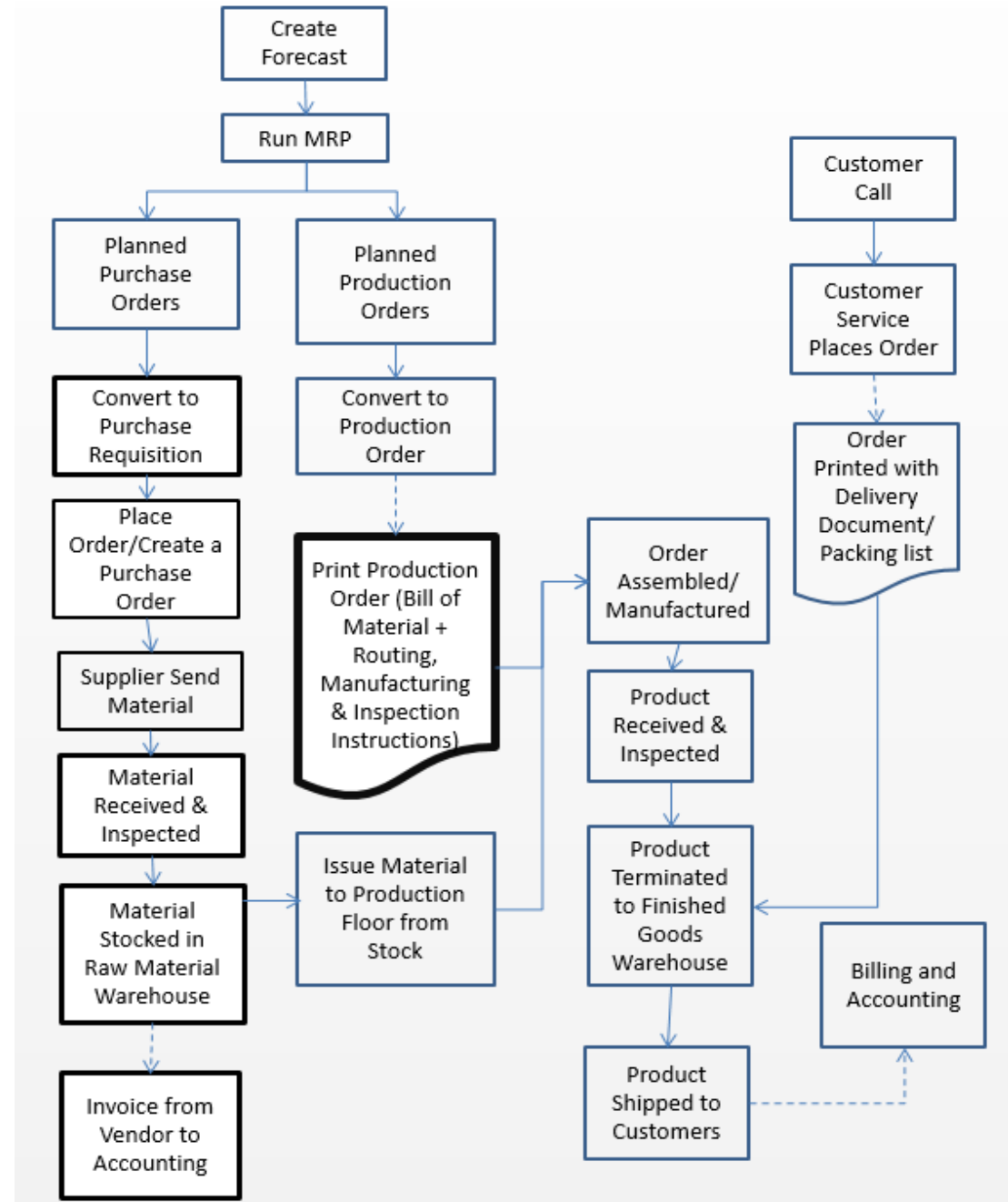
Supply Chain Management

High Level Model



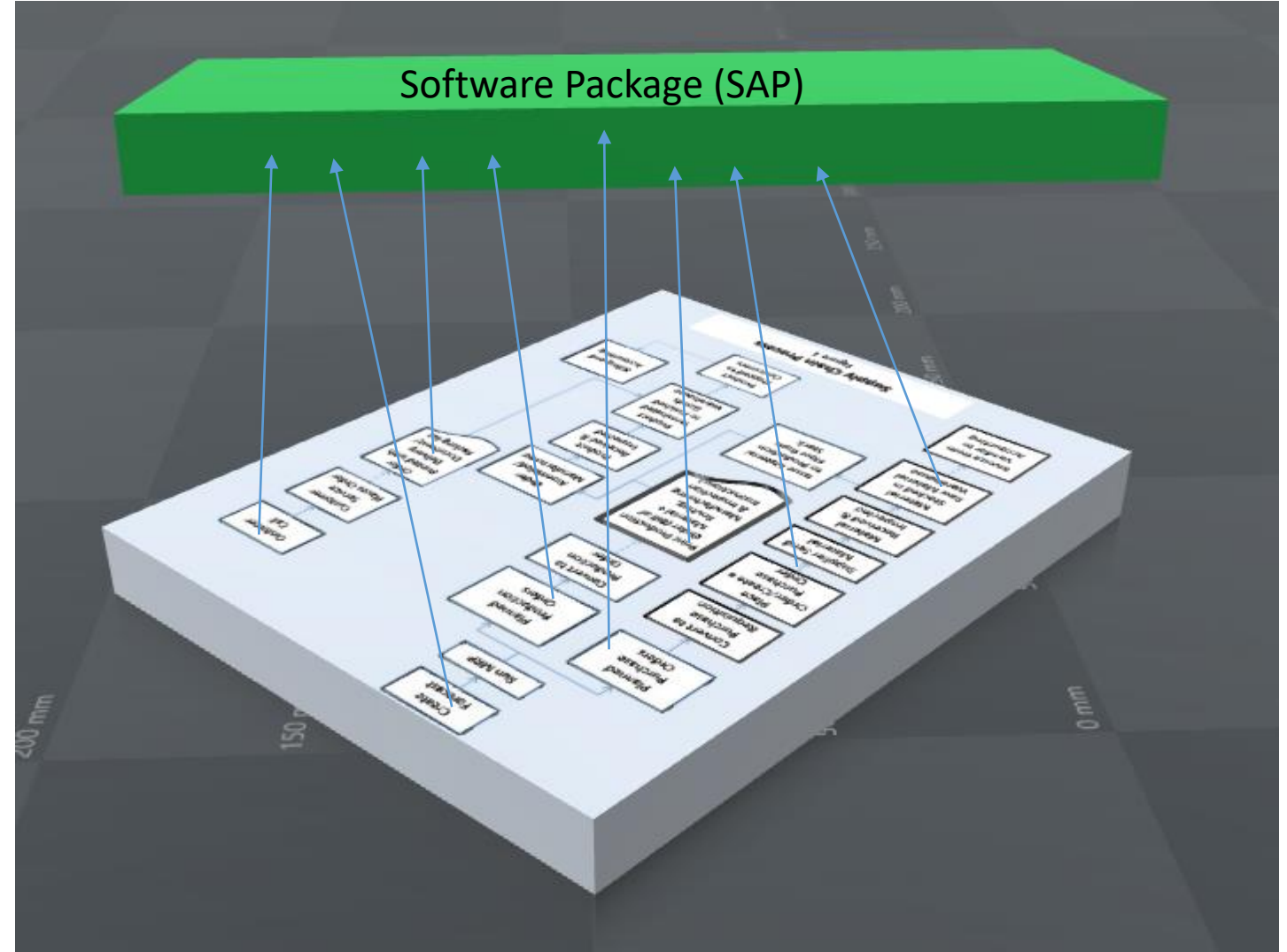
Supply Chain Management

A Lower level



Mapping Process

- Those processes are mapped into a software information system
“..those information systems capture, store, process and distribute information regarding an increasing range of aspects of organizations on the operational, tactical and strategic levels.” [1]



Drivers Behind Evolving Processes in a Supply Chain

- **Improvements** Manufacturing firms change their processes to improve their gross margins, by reducing the cost of their products or to better the quality of their products for competitive reasons.
 - Manufacturers try to improve their tooling, automate the manufacturing processes and minimize scrap by using more precise equipment or adding online Statistical Process Control (SPC) machines to monitor the consistency of production and captures inconsistencies as early as possible.
 - Sometimes manufacturers modify their products to introduce a better new version because of either a market requirement to stay competitive and/or due to customers' feedback.

Drivers Behind Evolving Processes in a Supply Chain (cont'd)

- **Regulatory requirement:** A good example will be the Food and Drug Administration (FDA) or European Food Safety Authority (EFSA). Those organizations monitor most products in USA and Europe and accordingly come up with rules that may force manufacturing companies to change their processes, for example:
- New rules: New regulations can be added when a loop hole in the system is found
- Tighter processes and inspection: For instance, when there is a failure in a product or a label issue that caused damage or life loss, organizations need to demonstrate that they took the right measurements to forbid this from happening again. An example of those measurements can be a recall of the faulty products from the market and/or changing the processes for the issue never to happen again.

Case Study

Case 1: Changes to the Production Order Packets

- **A Production Order Packet** consists of:
 - A bill of material (BOM)
 - A production order flow signoff sheet, to be approved by production supervisors
 - Routing: for costing purposes

Production Order Packet

Bill of Material

Item Number	Description	Qty	UOM	Location
10123A	Adhesive Loctite	20	ML	RM
20013B	Cap Small	10	EA	RM
22019A	Tube 12 mm	12	M	SFG

Actual Production Order Flow for Regulatory :
It needs to be signed by Work Area Supervisors

10	Issue Material	MI _____	Supervisor Signature: _____	Date _____
20	Set Printing Machine	MI _____	Supervisor Signature: _____	Date _____

Routing for Cost Calculation

30				
40				
10	Assemble Parts Using 10123A 20013B	Work Center ASSY1	Operation Qty 20,000 EA	Standard Labor Time: 74 Hours
20	Print Parts	Work Center PRT1	Operation Qty 20,000 EA	Standard Machine Time: 4.2 Hours
30	Package and Label and Inspect	Work Center PACK1	Operation Qty 20,000 EA	Standard Labor Time: 14 Hours
40	Terminate to Finished Goods	Work Center HANDL	Operation Qty 20,000 EA	Standard Labor Time: 1 Hours

Production Order Packet

Changes to Routings and Sign off Sheets

- If a manufacturing process changes because a new machine is bought to print and pack products at the same time, instead of two steps. A new work-center is created PRPACK to replace the two work-centers PRT1 and PACK1, where PRT1 was used to print labels and PACK1 was used to package products.
- Hence the routing needs to change by replacing the two operations 20 and 30 by one operation as shown in figure. This work-centers change will also trigger the sign-off sheets, the manufacturing instruction and the quality inspection to change. This may affect thousands of routings to be changed for the different values of the new machine for similar products.

Routing for Cost Calculation				
10	Assemble Parts Using 10123A 20013B	Work Center ASSY1	Operation Qty 20,000 EA	Standard Labor Time: 74 Hours
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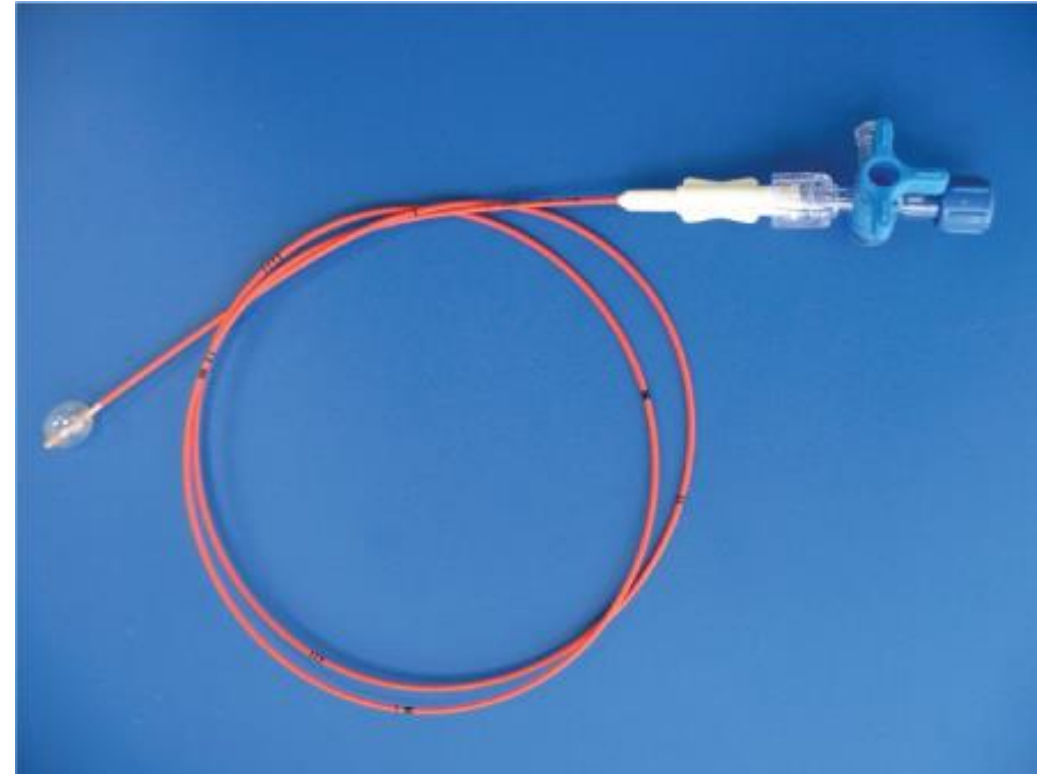
30	Print and Pack	Work Center PRPACK	Operation Qty 20,000	Standard Labor Time 14 Hours
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Replacing Two Operations with one

Case Study

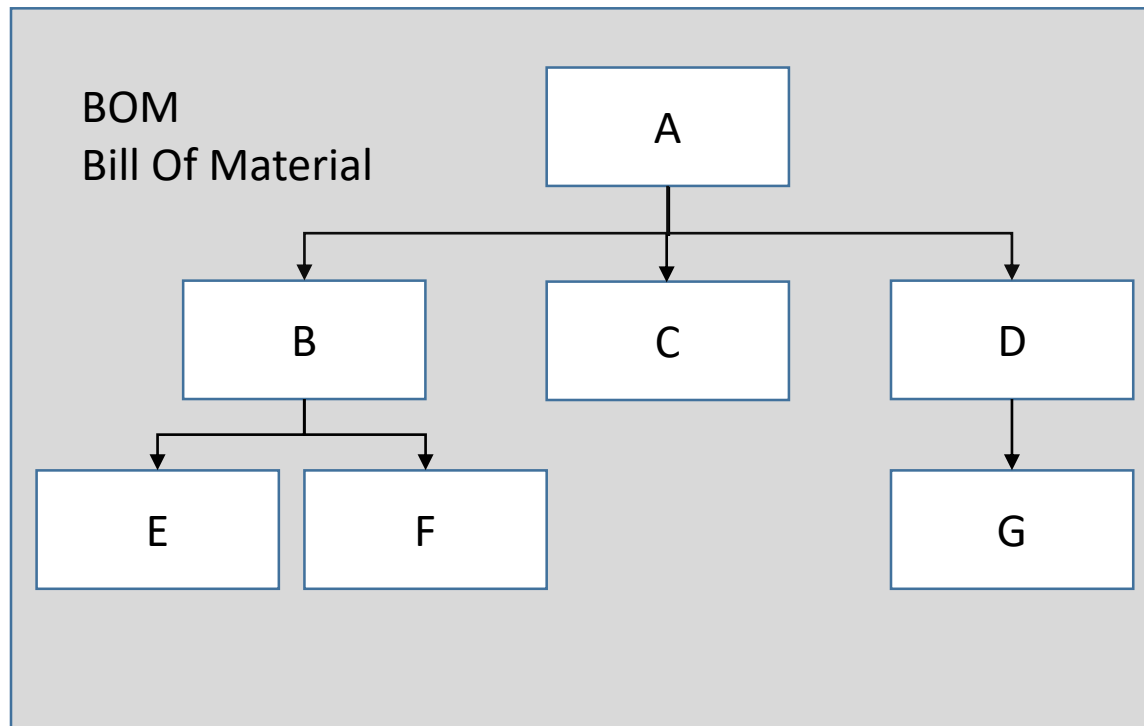
Case 2: Changes to the FDA Regulations

- Case 2 involves a warning from the FDA about some allergic effect of latex material on some humans.
- This was an alert to industries dealing with Latex products, like catheters, gloves etc. Some industries started proactively searching for alternative material to latex because they realized that a can of worms just had been opened. A race had just started. This will not stop here, especially when the market knows about it, so the sooner dealing with that issue the better.



Substituting Latex means: Changes to Bill of Material

- Any changes to the Bill of Material of a component: means a combinatorial effect on every BOM that uses this component



Bill of Material				
Item Number	Description	Qty	UOM	Location
10123A	Adhesive Loctite	20	ML	RM
20013B	Cap Small	10	EA	RM
22019A	Tube 12 mm	12	M	SFG
23654C	Container	12	EA	SFG
22245C	Wire 15 mm	12	M	RM
23651F	Label	1	EA	RM

Conclusion

- In this paper we showed a couple of examples on how a supply chain processes go under continuous changes.
 - Some are for improvement in order to reduce cost and/or to be competitive in an evolving market, and some are to be in compliance with a continuously changing regulatory rules.
 - These changes may drive the system with time to be more complex and rigid that only a major costly overhaul implementation can rescue the business.

References

- [1] Normalized Systems Theory, From Foundations for Evolvable Software Toward a General Theory for Evolvable Design, Herwig Mannaert Jan Verelst Peter De Bruyn.
- [2] <https://en.wikipedia.org>
- [3] <https://www.fda.gov/Safety/SafetyofSpecificProducts/ucm180604.htm> FDA U.S. Drugs and Food Administration
- [4] <https://www.fda.gov/downloads/forconsumers/consumerupdates/ucm342742.pdf>
- [5] Towards Designing Modular and Evolvable Business Processes by Dieter Van Nuffel
- [6] Evolvable Accounting Information Systems: Applying Design Science Methodology and Normalized Systems Theory to Tackle Combinatorial Effects of Multiple GAAP by Els Vanhoof Thesis University of Antwerp



Questions & Answers

(Answering is not Guaranteed)

