

Abstract Number: **008-0618**

Abstract Title: **Managing Functional Conflicts and Response Time Delays of Customer Orders in Discrete Manufacturing Workflows.**

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POMS 19th Annual Conference

La Jolla, California, U.S.A.

May 9 to May 12, 2008

Managing Functional Conflicts and Response Time Delays of Customer Orders in Discrete Manufacturing Workflows.

Abstract: The proposed conceptual model for managing functional conflicts and response time delays is not just anecdotal, but instead the by-product of a rigorous action research study on “The Effects of Workflow Automation on Customer Synchronized Supply Chain Management in the Discrete Manufacturing Industry” (Borgman & Wilfred, 2007). This paper is an attempt to frame the problem of complexity in manufacturing sales and operations planning from a process-orientated perspective and the practice of goal setting in a discrete manufacturing enterprise

Keywords: S & OP; Complexity; Conflict.

1 INTRODUCTION

Arguably one of the most important management tasks in manufacturing is Sales & Operations planning. This is also the seat of complexity in manufacturing. We can say there are two types of complexity:

- a) Detail Complexity i.e. when there are many variables.
- b) Dynamic Complexity i.e. situations where cause and effect are subtle, and where the effects over time of interventions are not obvious. (See website below).

Both this types of complexity contribute to the functional conflict and response time delays in customer order workflows in manufacturing. The high level of details and dynamism in coordinating customer orders against the production schedule is already a complex task. This is further aggravated by the constant “change” caused by changes in delivery dates of customer orders and material receipts. Delay in response to such changes only adds to further conflicts and delays in an ever-escalating vicious cycle of complexity.

This paper is an attempt to frame the problem of complexity in manufacturing sales and operations planning from a process-orientated perspective and the practice of goal setting in a discrete manufacturing enterprise.

2. FUNCTIONAL CONFLICT

It is common practice in most manufacturing organizations to have a set of the following objectives:

- a) Reduce product cost
- b) Increase customer service
- c) Reduce inventory
- d) Increase Asset utilization

These goals are obviously valid. However this apparently innocent looking set of goals create a considerable set of conflicts within four major functional areas of the organization; manufacturing, marketing, finance and Production. Figure 1, illustrates these conflicting objectives

A closer look at the manufacturing department's performance to the objectives would reveal that it is actually the ability to make *long runs* without breaking set-ups that is the primary requirement for the department to reduce product cost and increase facilities utilization. Naturally, this will require raw material inventories in front of those long-running machines. However, as demand change for customer service, these long runs inhibit the ability of the company to provide all products to the customer when needed. Also, inventory is being built at the same time.

The marketing group has the responsibility for maximizing customer service, but in order to do so, they must have more finished inventory whenever required. This means shorter runs for manufacturing group, along with higher product costs and even lower facilities utilization.

The general accounting group in the finance department has a goal to reduce costs throughout the company. This requires an overall reduction of inventories from every department. It is easy to see what a conflict this produces. Within the same financial department is another group that is at direct odds with the general accounting group – cost accounting.

Their goals are to reduce product cost, which inevitably forces the purchasing department to buy larger lots in order to get favourable discounts, which reduce the unit purchase cost in inventory. At the same time, they want long runs from manufacturing for the same reason. Thus, if cost accounting were to have its way, product cost would drop and facilities utilization would go up, but the inventory level would increase and the customer service would go down.

Fig 1: Conflict of Objectives (only the objectives in blue are achieved)

Typical Objectives of Manufacturing – Functional orientation				
Enterprise (Goals)	Product Cost	Customer Service	Inventory	Assets Utilization
Objective (Settings)	↓	↑	↓	↑
Manufacturing	Reduction in Product Cost	Reduction in Customer service	Inventory Buildup	Improve Assets Utilization
Marketing	Product Cost Increase	Improve Customer Service	Reduction in Inventory	Under Utilization of Assets
Finance Dept.	Product Cost Increase	Reduction in Customer service	Reduction in Inventory	Under Utilization of Assets
Costing Dept.	Reduction in Product Cost	Reduction in Customer service	Inventory Buildup	Improve Assets Utilization

This functional conflict in a manufacturing enterprise adds to the complexity and is one of the key causes for the organization to focus away from Customer Order delivery. *Why is it so important to focus on Customer Order delivery?*

3. CUSTOMER ORDER DELIVERY

Intense market competition driven by globalisation and outsourcing necessitate that we focus on customer order delivery i.e. *“make a promise and keep a promise...”* i.e. to deliver the **right quantity** at the **right time** and **right place** to remain competitive and consistently viable to our customers. In order to do this whilst ensuring survival of the enterprise, we need to revisit the way we handle customer orders and the way we respond to these orders. In the context of Manufacturing, the **“next process” is seen as a customer**. Delivery (i.e. delivery of the Right Product, at the Right time, to the Right Place, in the Right Packaging and the Right Quality) measures service levels from placing of the order to delivery at the customer. Delivery makes it imperative that management keeps a handle on demand and supply to ascertain where along the supply chain we have or have not, met our Delivery goal.

One of the most important things a manufacturing enterprise can do is to get demand and supply in balance and keep them in balance (Wallace & Stahl, 2006). This is essential to running a business well and this balancing need to occur at both the Volume and Mix.

Demand is the driver. It is what the customer want. Supply refers to the resources at ones disposal to meet the customers demand. Manufacturing has to focus on meeting the demand first and then to meet the demand in a most cost effective manner.

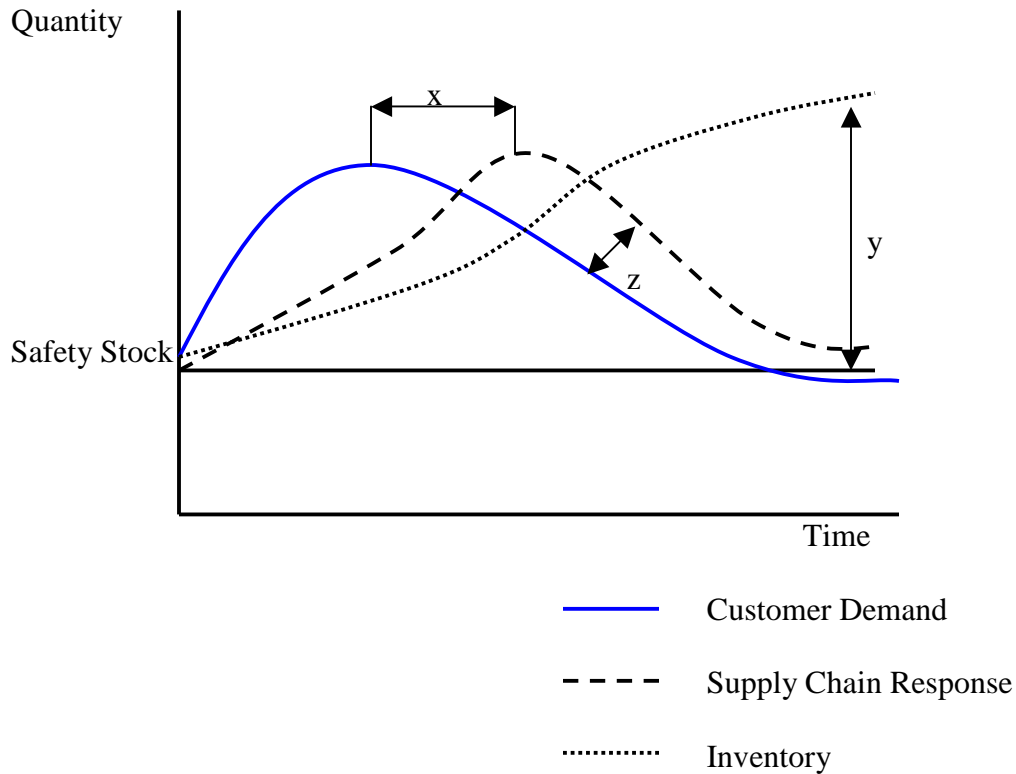
However, In the real world, Customer demand is rarely predictable. Also, Customer Order fulfillment lead times are usually less than the sum of total procurement plus production lead times. This problem is further complicated by Capacity constraints i.e. capacity cannot be increase or reduced quickly and economically.

Not understanding demand means that the company may be missing out on vital information on market trends, buying patterns and factors influencing demand, etc; About 60% of the supply chain cost is based on uncertainty (Enslow, 2007). Therefore how are we to manage uncertainties in customer demand? We need to forecast to improve the customer demand predictability i.e. reduce uncertainty in customer demand. Lets say by definition, Sales Forecast is ***a projection of estimated future demand.*** Also, since no Sales forecast can be 100% accurate for the entire planning horizon due to uncertainty (of future events). Then, Forecast error is *the amount that the forecast deviates from actual sales. The forecast is at the core of our "Response time delay" problem.*

4. RESPONSE TIME

Let us start by considering the system response plot (refer to Fig. 1, below). The x-axis is time; the y-axis quantity (i.e. units of inventory or production). The demand for an item is variable over time. Our period planning processes accumulate information, causing a time delay between the actual events and when we respond to them. Because of this delay, we must adjust our response based on what happened – and what we think will happen next – typically we will ***forecast*** incorrectly and will either over-react or under-react.

Fig. 1: Response time delays



x: Time Delay (Response is delayed by the period planning cycle)

y: Inventory Oscillation (Demand is variable causing Inventory buildup)

z: Inaccuracy (Planning overreacts based on inaccurate information)

What distorts the supply chain so badly is **response time**: the lengthy delay between the **event** that creates the change (i.e. demand shift) and the time when the factory finally **responds** to this information. (Schroeder & Flynn, 2001)

Problems Created by Response Time Delays:

- a) Large inventory swings/oscillations
- b) We account for this behavior by building “protection” inventory (hedging)
- we create a lot of unnecessary inventory holding costs, if we do not, we run the risk of stock-outs
- c) Often be working on the wrong things, building inventory of some items and depleting inventory of others.
- d) Try to expedite – continuously – but that rarely works
- e) Result in poor customer service and lost sales.

This “response time” delay has been understood primarily as a planning and coordination problem. It has been variously described as “scheduling problem” by Dr Eli Goldratt (1984) from a Manufacturing/Production perspective and “Bull whip” effect by Hau. L. Lee, V. Padmanabhan, and Seungjin Whang (1997) from a Demand/Supply Chain Management point of view. The bullwhip phenomenon was first noted by Forrester (1958), and has since been observed in many diverse settings.

This “response time delay” problem can be restated as a variation from the desired output. Delivery is a key representation of an **output** of a production process or system (Keller & Ludwig, 2002). All processes and systems produce variation in output. No system is perfect. This applies to all systems, natural or manmade.

Hence the importance of Plan-Do-Check-Act cycles (Bauer, et. al., 2006). It is like an autopilot of an aircraft. Small and frequent adjustments are needed to keep the aircraft on the right path, due to influence of factors both internal and external. This means that we need an efficient synchronization to our customers’ actions. Why efficient? There is a school of thought within economics, which emphasize that the main source of an enterprise growth is constant improvement in the efficiency with which resources i.e. factors of production are utilized. Efficiency simply means making the most we can of the limited resources we have. *Where in the production process, should be the focus of this Operational efficiency?*

5. SALES & OPERATIONS FLOW

Every business has two types of flows through the supply chain (Mentzer, 2004). The first is the **Operations flow, which** consists of acquiring raw materials, manufacturing, packaging, storage, transportation, and delivery to the customer. The operations flow is also known as a Transformation (or Production) and is concerns with physical items. **Change** take place as the materials goes through the processes i.e. Routes. **Activities** are identified as work-centers or cost centers engaged in making the change. The operations flow is verb oriented describing the relationship between the activities and process i.e. Work-centers and Routes

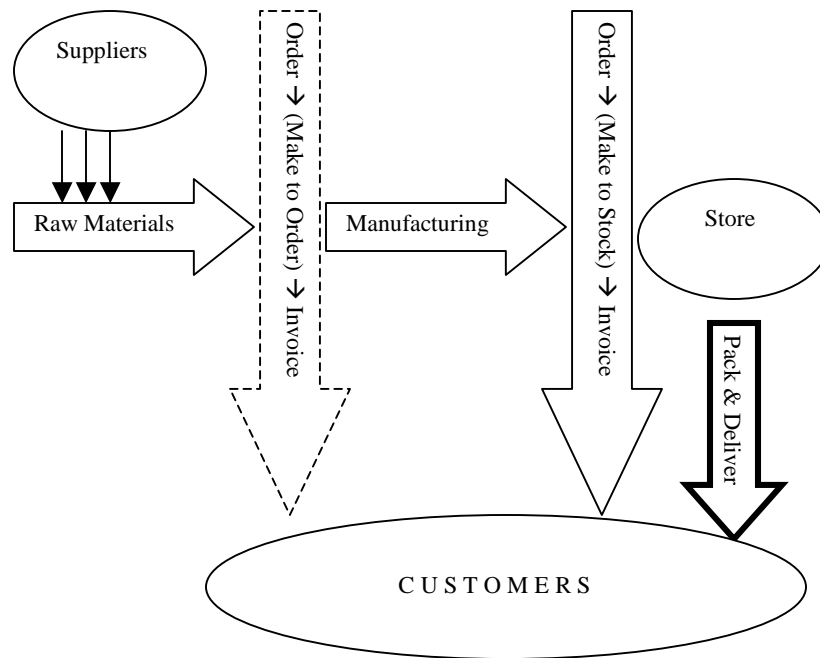
The second flow is the **Sales flow, which** determines when certain activities of the operations flow can be executed (Wallace & Stahl, 2006). This flow consists of the activities initiated when a sales order is received (refer to Fig. 2, below). The sales flow is also known as an Interaction (or Transaction) and is concern with communication. Entities are networked together, given the orders and opportunities from customer to supplier enterprises. Interactions progress through various organizational and functional structures from order to deliver. The sales flow is noun oriented describing the relationship of the Entities in the Group i.e. Customers and Suppliers

If the sales flow intersects the operations flow at the finished goods level, then the manufacturing is for a *make-to-stock* type because the production has to be completed and available for delivery. The only activities initiated by the order are packing the items, transportation and delivering to the customer.

On the other hand, if the sales flow intersects the operations flow before manufacturing, it is a *make-to-order* type because the product can be manufactured with the Order in hand. (*Note: Make-to-order includes Engineer-to-Order, Design-to-Order, Assemble-to-Order*)

Hybrid manufacturing (in a supply chain context), is a mixture of MTS and MTO scenarios

Fig. 2: Type of Manufacturing Environment



The place where the sales flow crosses the operations flow is also known as the *control point* (also, *order penetration point*). In general, supply chain activities that are to the right of the control point, are initiated in response to customer orders (front-end). Those to the left are initiated in response to a demand projection, or a forecast (back-end).

The activities on the left of the control point are generally sourcing; procurement and manufacturing activities that are to a large extent constrained by lead-time. This side of activities is performed in *anticipation* of orders i.e. driven by forecast. However, on the right of the control point are generally customer orders processing activities (i.e. obtaining material, manufacturing, packaging, storage and delivery to customer). This side of the activities is performed based on actual orders from customers. The lead time (i.e. production time) for the operations flow activities that are initiated in response to a customer orders, must be less than the customer order fulfillment lead-time i.e. Sales flow.

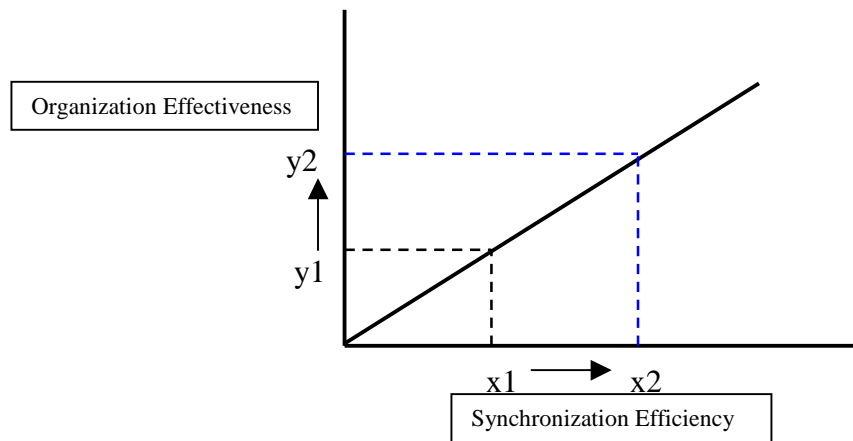
Most of the inventory to support *response time delay* (i.e. demand uncertainty) and *throughput* (i.e. production variability) should be concentrated at the intersection of the sales and operations flows i.e. *control point*. The production lead-times tend to be quite long in relation to the delivery lead-times imposed by the market e.g. consumer durables. For instance, before the control point stock will be held intentionally to buffer against fluctuations in demand and the build schedule reflecting a make-to-stock (Forecast) environment. Conversely, after the control point the focus is on the *responsiveness to the marketplace* and the ability to meet needs i.e. a make-to-order environment. *But how are the sales and operations flow to be coordinated?*

6. MASTER PRODUCTION SCHEDULE (MPS)

A system is a network of components, linked together by a relation of interdependence and interaction, to achieve the goal of the system. The core idea of systems thinking is that a complex whole may have properties which refer to the whole and are meaningless in terms of parts which make up the whole. These are called the *emergent properties*. The vehicular potential of an aircraft is an emergent property of the combined parts of an aircraft when it is assembled in a particular way to make the *structured whole* (Checkland & Scholes, 1996).

The structured whole, having emergent properties, may in principle be able to survive in a changing environment if it has processes of **communication** and **control** which could enable it to adapt in response to shocks from the environment. Such a process is called a Meta Process i.e. process about other processes. Meta-processes (Afsarmanesh et al., 2004) are for ongoing alignment of the basic business processes that are common to most organizations e.g. Sales flow and operations flow. The objective of any organization is to implement an effective and sustainable process of ongoing improvement e.g. Plan-Do-Check-Act cycles. A strategy for sustainable “ongoing” improvement involves managing the interactions between these basic business processes. Workflow efficiency i.e. communication & control can also be applied to production through the meta-process. MPS can be seen as such a meta-process i.e. a process, which the production manager carries out to improve order promising and deliver performance i.e. organizational effectiveness.

Fig. 3: Meta Process – Master Scheduling

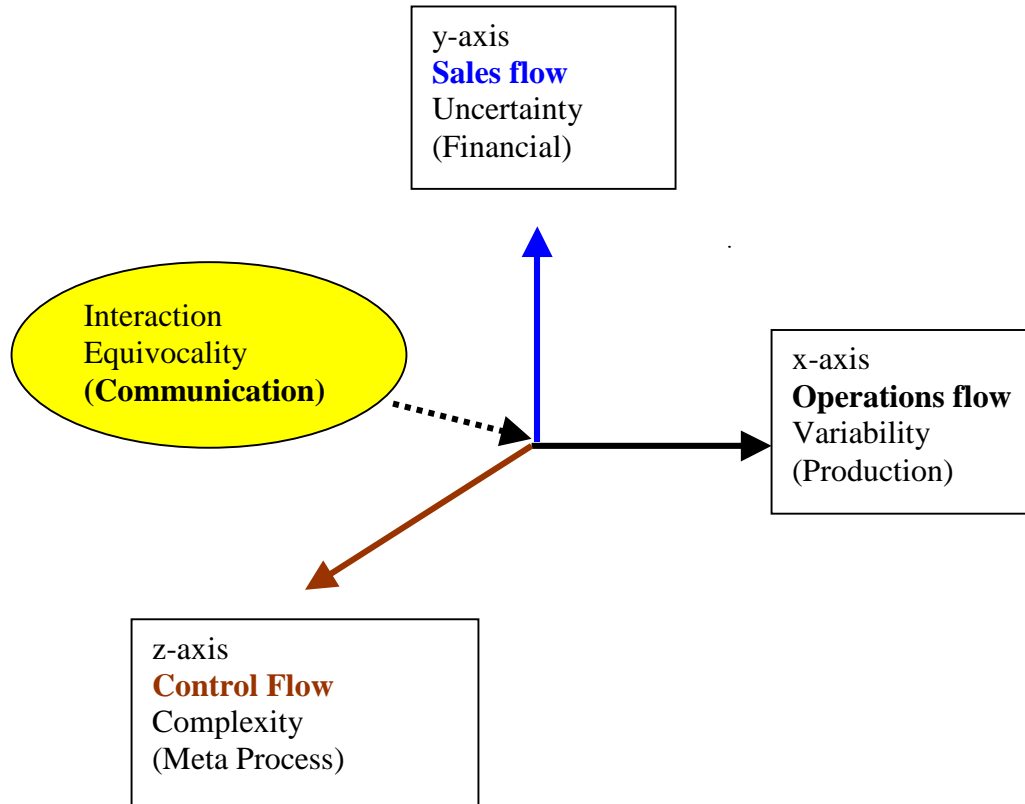


7. WORKFLOW ORTHOGONAL MODEL

The Workflow Orthogonal model (WOM) provides a convenient and useful conceptual framework for discussion of manufacturing workflow grounded in systems thinking. The WOM uses the x, y, and z-axis of a three-dimensional model to show the *dependencies* of Sales Flow (Financial), Operations Flow (Production), and Meta Process (Coordination), the three primary aspects of any production process. As one aspect of an event occurs or is acted upon in the course of business, there is a corresponding *reaction* by one or both of the other two aspects. *Do something to the x-axis and there is a corresponding response by the y or z-axis.*

The vertical or y-axis represents the financial aspects of a business event i.e. cost of the event, the revenue resulting from the event and the capital investment. The horizontal or x-axis represents the product or service produced or delivered by a business i.e. what it takes to source the materials and resources for each event, What it takes to make the final product or service delivered by that event, What it takes to deliver the product or service to the next step in the process; and the inventory involved in the event. The oblique or z-axis represents Meta process for coordination and control of the y and z-axes. The Workflow automation i.e. the underlying interaction technology infrastructure represents the communication channel.

Fig .4: Workflow Orthogonal Model (WOM)



Importantly, WOM illustrates that the sales flow, operations flow, control flow and workflow i.e. the underlying technology infrastructure, are part of the structured whole i.e. organization. Systemic is the adjective (of the noun: system) referring to "affecting an entire system". Efforts for managing functional conflicts and response time delays need to be driven through an integrated improvement of both the sales and operational flows supported by workflow efficiency. *So what is the common denominator?* Once again based on WOM, the cost of operations in production can be summarized to Sales flow and Operations flow i.e. two flows of *time*.

In Sales flow, it is the cost of communication involving different people over diverse geography. People are paid based on the amount of time spent on the job i.e. the more time, the more money. Expediting due to equivocality (i.e. response time delays coupled with inaccurate messages and responses) becomes necessary. Expediting is a waste of people's time.

In Operations flow, Inventory is placed in the system, to protect throughput against variability. The cost of Inventory measured by the time to make it, time to store it, the time to move it, and the time to pay for it. Inventory also represents the “*time value*” of money. As long as you own it, you are paying for it. Inventory is everywhere. It is on the shop floor, in the warehouse and in the distribution channel. It is raw material, supplies, parts and finished goods. No matter where or what, inventory is costing time (i.e. money). Time, therefore is the common denominator of the production process (also, supply chain). *So what do we know about time? We know that time is money. Waste time and you waste money. How do we then setup" ongoing improvement cycles" to eliminate such waste?*

8. A MODEL FOR MANAGING FUNCTIONAL CONFLICTS AND RESPONSE TIME DELAYS OF CUSTOMER ORDERS

The sales and operational flows are interdependent and cannot be individually targeted for improvement. Local optimization models will not yield the desired result of “*making a promise and keeping a promise*” i.e. *Delivery*. Current literature gives evidence that Operations flow (production centric) has been the single focus of much attention for improvement initiatives e.g. Zero Inventory, JIT, SMED, TQM, etc; This very “Shop floor centric” approach may not produce the desired results (see Table 2, below) due to the difference in Product cost distribution.

Our research findings (Borgman & Wilfred, 2007) guided us to a hierarchical relations i.e. *Delivery* focus at the Sales flow and *Efficiency* focus at the Operations flow in the Supply Chain. Further, this relationship is complementary and interdependent. Focusing on *Delivery* alone will not guarantee survival of an enterprise in current conditions of intense market competition. An enterprise cannot be achieving *Delivery* for all customers’ orders and still be cost effective without being efficient. For an enterprise, being “synchronize” with the customer primarily, means that the enterprise is focused on meeting the demand first (i.e. *Delivery*) and then to meet the demand in a most cost effective manner (i.e. efficient).

Table 2: Product Cost Distribution

Type of Supply Chain	Procurement (%)	Manufacturing (%)	Distribution (%)
Sourcing Centric (e.g. Consumer Durables)	50	15	35
Manufacturing Centric (e.g. Industrial Equipment & Components)	35	50	15
Distribution Centric (e.g. FMCG)	35	15	50

With reference to Table 3, below. We start the explanation building with the constraints row. There are 2 main *constraints* at the Sales flow (i.e. Volume) i.e. “Uncertainty of future events” and “Equivocality of interactions”. The objective is to reduce Uncertainty in Sales Flow and Equivocality in workflow. Improvements at the Sales flow results in feed forward to Operations flow (i.e. Mix) in terms of “Effectiveness”. The remaining 2 *constraints* apply to the Operations Flow i.e. “Complexity of Planning & Scheduling” and “Variability of Production and delivery”. The objective is to reduce Complexity and Variability. These objectives are influenced and subordinate to the Sales flow objectives (due to the hierarchical relationship). Improvements at the Operations Flow level feeds back into the Sales flow in terms of improved efficiency. Thus, the interplay between the 2 levels feeding each other over time, comes to form iterations or continuous improvement cycles (Dalcher, 2003).

Table 3: Process Orientation – Goal Setting

Model for Managing Functional Conflicts				
S & OP	Volume (Demand & Supply Balancing)		Mix (SKU level, Options, etc;)	
Process (Improvement)	Forecasting & Demand Management	Interaction & Communication	Planning & Scheduling	Production & Delivery
Constraint (ref: WOM)	Uncertainty (Sales)	Equivocality (Workflow)	Complexity (Control)	Operations (Variability)
Objective (Minimize)	↓	↓	↓	↓
Goals (Enterprise)	Replace Inventory with Information		Delivery of the Right Product, at the Right Time, Right Place, Right Packaging and Right Quality, Cost Effectively	

This “improvement cycles” enable the enterprise to pursue PDCA iterations on an “on-going” basis without having to revisit the set goals, team members are clear of the objectives and no “conflicts” are created as a result of achieving the objectives. Having defined the constraints and having framed the objective as a consistent “minimization” problem, the process improvement can be continuous i.e.

At the Sales Flow:

- a) Forecasting & Demand Planning for minimization of uncertainty.
- b) Communication & Collaboration for minimization of equivocality.

At the Operations Flow:

- a) Planning & scheduling for minimization of complexity.
- b) Production & Deliver for minimization of variability.

These goals can now be the focus of our monthly Sales & Operations Planning (S & OP) meeting i.e. At the Sales flow, “it is all about demand and supply balancing i.e. **Volume**”, it is all about being effective i.e. “the right product at the right time”. At the Operations flow, “it is all about SKU’s, options, lead times i.e. **Mix**”, it is all about being efficient i.e. shorter set-up, shorter lead-times, flexible changeover etc.

Now going back to Fig. 1, the only goal that each functional team has to set is: ***“Meeting the demand first and then to meet the demand in the most cost effective manner”***.

In this way all the functional teams are integrated as opposed to “operating in silos”. Although from an organizational perspective, the functions remain quite “functional oriented”. It is important to note that the individual goals from Fig. 1, i.e. (a)-(d) above, are no longer the main focus of the functional units; in fact individually the functions operate at a sub-optimal level. The key goal is “Meeting customer demand and then meeting the demand in the most cost effective manner”. All functions of the enterprise are united in the pursuit of this one goal.

9. CONCLUSION

To ensure the survival of a business is to ensure its future. To ensure its future is to ensure an effective S & OP process (Wallace & Stahl, 2006). Functional conflicts and Response time delays contribute to complexity in Sales & Operations planning process. Customer order workflows are the key driver of the S & OP process. Therefore, it is pertinent to minimize functional conflicts and response time delays in customer order workflows.

The proposed conceptual model for managing functional conflicts and response time delays is not just anecdotal, but instead the by-product of a rigorous action research study on “The Effects of Workflow Automation on Customer Synchronized Supply Chain Management in the Discrete Manufacturing Industry” (Borgman & Wilfred, 2007).

By changing the way we set goals, all functions of the enterprise can be united in the pursuit of one key goal i.e. Delivery of the Right Product, at the Right Time, Right Place, Right Packaging and Right Quality, cost effectively to the customer.

ACKNOWLEDGEMENT: WILFRED

First of all, I would like to thank SMaF (Singapore Manufacturing Federation) for their invaluable support in allowing us open access to their database on Manufacturing Sales & Operations Planning.

Also, a deep sense of gratitude to my colleagues at Electra (S) Pte. Ltd. and Jebsen & Jessen Group of Companies South East Asia, for their useful and direct comments that enable me to sharpen my thinking in many areas of Sales & Operations Planning.

Finally and most importantly, thanks to my dear wife, Roslyn Ng for the support and encouragement without which, I most certainly would have stop trying.

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Biographical notes:

Prof.dr. H.P. Borgman (Hans): Rapid changes in information and communication technology (ICT) and its application over recent years have caused major changes for individuals, organizations and industries. The Internet, and information systems and communication technology in general, have radically impacted our personal and professional lives and challenged our thinking on physical, geographical and industry boundaries, on distance, speed and communication. My research aims at providing a deeper understanding of the issues, challenges and opportunities in this area, with a specific focus on the adoption and use of new technologies such as data warehouses, e-commerce systems and knowledge management systems.

Wilfred Rachan domain of interest is in Supply Chain Synchronization i.e. getting the right item, in the right quantity, to the right place. Having worked in IT since 1984, Wilfred is keen to seek opportunities to harness ICT (Information & Communication Technology) to drive Supply Chain Synchronization. Wilfred has more than 5 years of experience in Container Handling Equipment sales in Asia-Pac and 18 years of experience in Software application consulting and sales in the South East Asia region. Wilfred has also taught part-time at German-Singapore institute (now part of Temasek Polytechnic) on MRP (Material requirement planning) and MPS (Master Production Scheduling) and SIPMM (Singapore Institute of Purchasing & Materials Management) on ERP (Enterprise Resources Planning). Wilfred is also listed in the Singapore “Who's Who - Industry Professionals Directory”. Wilfred is currently a PhD student at LUSM (Leiden University School of Management).