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A method to avoid demand amplification in bulk paper distribution

ABSTRACT

The paper describes a detailed method for preventing unnecessary amplifications in bulk paper demand. Many mills producing standardized products in significant quantities face surges in demand, although the real market demand does not exhibit such fluctuations. It is suggested that by integrating the mill with wholesalers by a fixed cycle of information exchange and material deliveries, the amplification effect can be significantly reduced. The method is analogous to the one used for part supply in the engineering and other repetitive manufacturing industries. According to the model, the mill supplies goods at fixed intervals for the wholesaler’s predefined stock. The size of the delivery is defined by the real consumption during the previous cycle, which is filled for the next period. By applying this approach to all wholesale customers the mill obtains much more reliable demand information. The method enables the use of fixed and short production cycles with less capital invested in inventories along the supply chain. The paper also explains the necessary organizational steps needed to implement the method.

Menetelmä kuormitusheilahteluiden välttämiseksi volyymipaperin jakelulogistiikassa

Paperissa esitellään yksityiskohtaisesti menetelmä, jonka avulla voidaan välttää jakeluketjun aiheuttamat vääristyneet heilahtelut paperin kysynnässä. Useat vakio- ja standardipaperia suurin määrin tuottavat tehtaat kohtaavat merkittäviä kysyntämuutoksia, vaikka itse markkinat eivät näin todellisuudessa käyttäydy. Artikkelissa ehdotetaan, että sovittamalla tehtaan ja tukkurin väliset materiaali- ja informaatiovirrat kiinteään jaksoon, heilahtelua voidaan merkittävästi vaimentaa. Kuvattu menetelmä on analoginen metalliteollisuudessa ja monessa muussakin toistuvaistuotantoon perustuvassa toiminnassa käytettävän alihankkijoiden ohjausmenetelmän kanssa. Mallin mukaan alihankija, tässä tapauksessa paperitehdas, toimittaa tavaraa täsmällisin jaksoin kooltaan selkeästi määriteltyyn varastoon. Toimitusmäärät perustuvat edellisen jakson todelliseen kysyntään, mikä täytetään seuraavaa jaksoa varten. Soveltamalla menetelmää kaikkiin tukkureihin tehdas mahdollistaa merkittävästi luotettavamman tiedon saamisen markkinoiden todellisista muutoksista.. Samalla esitelty toimintatapa tukee siirtymistä kiinteisiin ja lyhyisiin tuotantojaksoihin, mikä on ehdoton edellytys koko jakeluketjun vaihto-omaisuuden pienentämisen kannalta. Artikkelissa kuvataan myös ne välttämättömät vaiheet, jotka edellytetään organisaatiolta uuden menetelmän käyttöönotossa.

Hameri, A.-P., “A Method to Avoid Demand Amplification in Bulk Paper Distribution”, Helsinki University of Technology, IIR-Research Centre, October, 1995.

Introduction

Most reel and sheeted bulk paper products are delivered to the end customer via myriad logistic networks. This network and its ability to serve the ultimate user of the product plays an important role in the overall productivity of the company. In a production unit based on high volumes and low profits, the overall success is determined by the interplay of the whole supply chain right from the processing of raw-material resources, through the value-adding and logistic processes to the final customer, wherever he might be located. The best way to control the whole process is to have reliable information about the true market demand along with fixed control procedures at each forwarding step of the supply chain.

High utilization of the production facilities has been, and still is, the prevailing production planning and machine investment paradigm in paper industry /6/. This approach has generated inflexibility in reacting to market fluctuations. To maintain reasonable customer service levels, companies have been forced to store products closer to the market. However, the manifold and long delivery routes, with their depots and terminals, absorb the true demand and bias the information upon which the mills act /3/. This causes huge fluctuations in the mill's order stock, which is compensated for by buffering more products in the supply chain.

Traditional and still used measures of production performance, such as low waste levels and high production volumes, have reinforced the trend towards poor capital and logistic performance /4/. To improve the latter performance indicators, action must be taken to establish collaboration between those involved in the supply chain. However, this paper focuses on ways to integrate the material and information activities between subsequent actors in the logistic network. It is claimed that partnering between mill and wholesalers will be the first inevitable step towards better logistic performance.

The rest of the paper is organized in the following way. First, the problem is illustrated empirically by showing how the demand amplifies at the mill and what is the immediate cause of this. After this, the whole phenomenon of industrial dynamics is briefly discussed to provide the framework for the proposed method of reducing order fluctuations. Then the new method of controlling and monitoring demand along the supply chain is introduced, together with how it can be incorporated into the mill's business operations. Finally, conclusions are drawn.

Problem formulation

Production planning at a paper mill is based on order stock, demand estimates and constraints imposed by the production facilities. This information is used to form the content of the production cycle. The cycle is usually fixed, ranging from a rigid four weeks to advanced short cycles like one week. Mills are frequently troubled by fluctuations in demand, the result being unnecessary grade changes and buffering of products. Fig. 1 illustrates the situation at one paper mill producing sheeted, standardized and large-volume paper products, namely papers for office use.

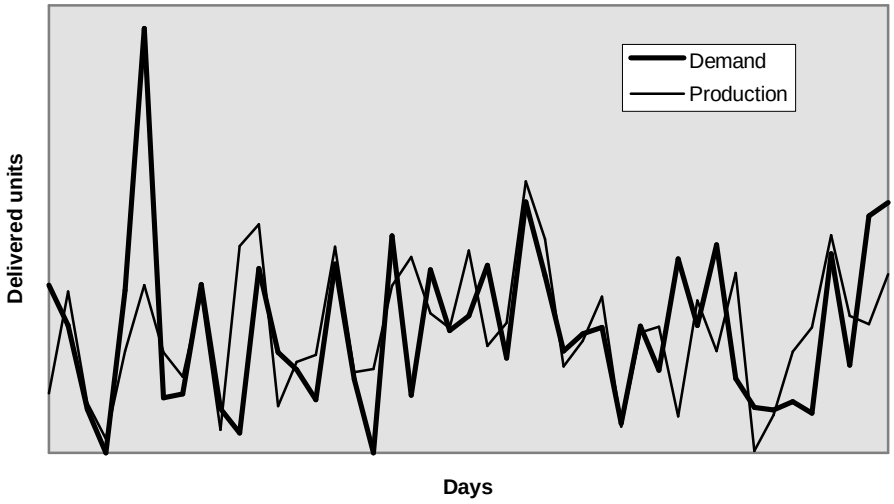

Fig. 1. Demand and production profiles at an office papers mill.

The situation is common to all three paper mills studied in this work. The same profile was found with paper roll production. The profiles indicate that mills must buffer production to react to demand fluctuations. Yet, it is unlikely that the real demand of bulk paper products alternates in such a drastic way. The analysis was further advanced to study the demand structure in more detail, i.e. where the paper was delivered and the size of the consignments. First, it was found that on average 75% of the demand originated from wholesalers and that very seldom was the paper delivered directly to the end customer. Fig. 2 illustrates how the ordering behaviour of the wholesalers correlates with the fluctuation in overall demand for the main paper grade and wrapping at the mill.

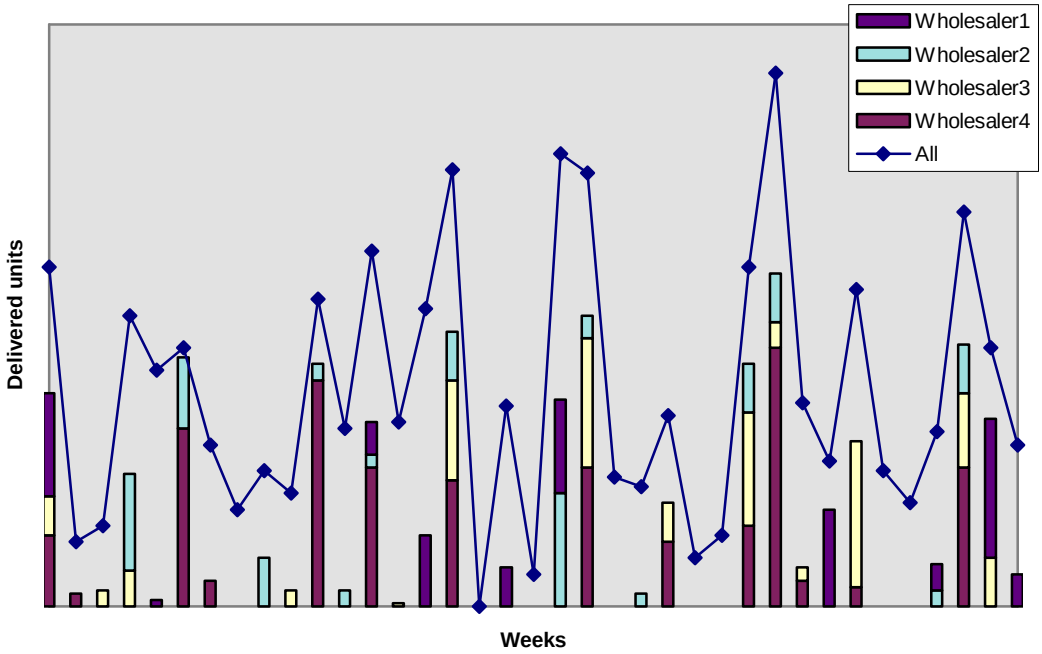

Fig. 2. The main wholesaler customers and their correlation with the fluctuation in overall demand for the main paper grade and wrapping at the mill.

According to the analysis, it is obvious that the voluminous deliveries from the main wholesalers make the situation at the mill difficult. It was even discovered that double

storage took place, i.e. the same paper with the same wrappings was stored in significant quantities both at the mill and by the wholesaler. The main reason for the problems seems to originate from the random way in which paper is ordered. The mills try to meet the orders as they arrive. Surprisingly, there were some long-term delivery contracts up to one year between the mill and the wholesalers, with no other instructions that paper will be delivered on request. True partnering on the level of material and information flow was completely missing between the production unit and the next step in the chain.

The problem to be tackled is related to information on true market demand and how to obtain it for use in production cycle planning. Along with this fundamental problem the following facts concerning the daily operations at the mill emerge from the analysis:

- The true demand of bulk paper, such as the A4 paper, does not fluctuate as much as perceived at the mill.
- The true logistic interplay between successive partners in the supply chain is non-existent.
- Uncontrolled and random large-volume deliveries confuse the production schedule and generate unnecessary grade changes and inventories.
- No technological means or managing procedures where found in the case companies to better integrate wholesalers with production.
- Orders from the wholesalers were usually received well in advance, thus providing planning time for production people. Despite this, the long production cycles comprise several large orders and, thus, levelling the order stock by smaller deliveries becomes impossible.

As it is the very first stage in a long supply chain, the cooperation between mill and wholesalers is vital and the very first compulsory step towards better logistic performance. Before going into ways of establishing fruitful cooperation between mill and wholesaler, the phenomenon behind the problem, called industrial dynamics, will be studied.

Industrial dynamics

The underlying problem of achieving better logistic performance in many cases lies in the quality of the demand information. If the whole chain from mill and wholesaler to sales office and end-user acts on estimates and, in general, does not have fixed procedures to deal with the data, the demand information will amplify and be strongly biased. This phenomenon has been much studied by industrial economists, but is poorly understood in practice. Significant analyses were carried out on demand amplification and its correlation between general economic performance as early as the 1950s /2/. The analogy has since been extended to individual supply chains /1/. The simple and plain outcome of these studies indicates that, if demand for products is transmitted along a series of inventories using stock control ordering and estimates, then the demand variation will increase with each transfer (see Fig. 3).

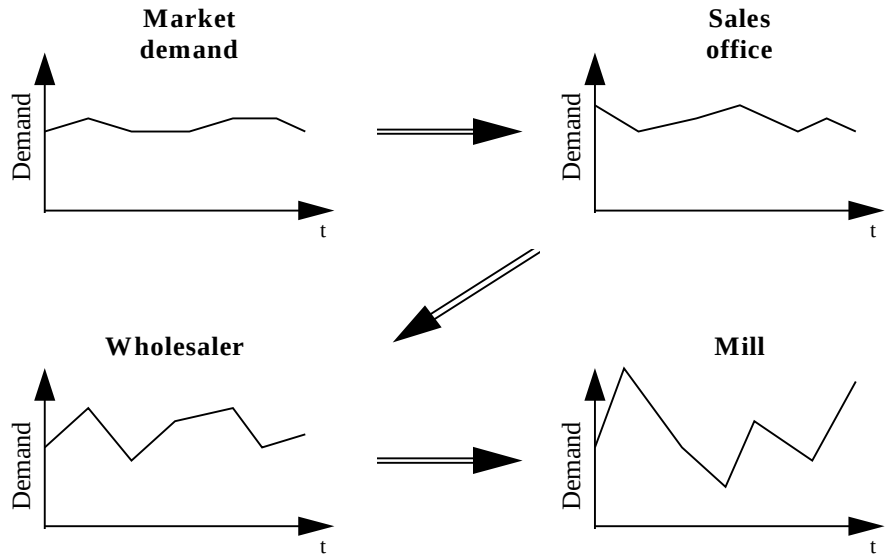

Fig. 3. Industrial dynamics and demand amplification along the supply chain.

Models depicting the peculiar dynamics of a supply chain has been studied extensively /8/. Together with empirical observations and implementations of managerial principles, these studies indicate that the whole chain must adapt the same phase, i.e. cycle time, according to which information is passed to the next player. The very first applications of fixed cycle time go back to the birth of mass production. An assembly line can be balanced only when each step of the chain uses the same amount of time to complete the signed task. A mismatch in cycle times between subsequent operations create automatically creates delays, waiting and buffering, that is non-value adding activities. The same fact applies to any chain of activities depending on each other's inputs and outputs.

In a sequence of suppliers, retailers and sails offices, each link embeds a certain amount of instability in its operation. When transmitted along the chain, this minor distortion creates biased demand information. This in turn creates the so called "flywheel" effect /5, 8/. This effect establishes a cycle of poor performance, as indicated in Fig. 4. In short, this means that demand distortion cause problems with the production capacity, which results in delivery shortages. This triggers over-ordering, causing some demand amplification, but also indicates poor delivery performance which leads to an increase in safety stock. This again gives a boost to the flywheel and the circle is complete.

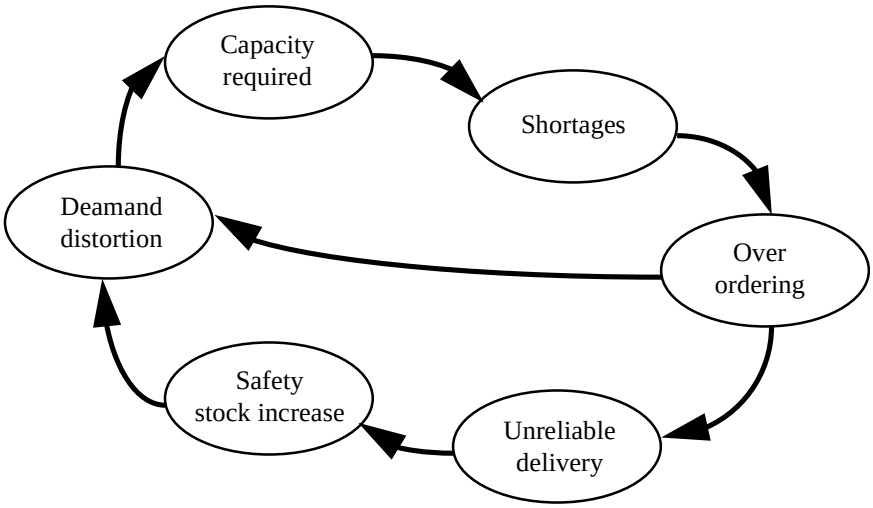

Fig. 4. The flywheel effect that feeds demand amplification /5, 8/.

The consequences of industrial dynamics in demand amplification cannot be exaggerated /7/. It has even been reported in fast-growing industries that component factories have been established to cater for the biased demand. It has become one of the key competitive advantages to have reliable and up-to-date information on the real market situation. For example, grocery stores and other consumer product retailers are implementing sophisticated technological means to transmit online information on frontline consumption, e.g. by linking cash registers direct to the inventory system, which in turn is connected to the wholesaler's information system.

In general, paper industry exploits the latest technological advances in production control, order handling and even intra-company communication. Yet, many cases imply that the huge amount of data produced by the various information systems is not used to analyse the true situation at the mill. Most of the systems are used to operate with the infrastructure, not to develop it. Industrial dynamics, and especially demand amplification, are largely existing phenomena in the paper industry's logistic networks linking the mills with their customers.

The method

From the wholesaler's point of view, the paper mill is a *supplier*. A good, reliable supplier provides products of the agreed quality on time, and has the flexibility to adjust to change. Most customers are willing to pay for reliability and to establish long-term development projects to fully exploit cooperation. No actor in the paper business or in any field of trade is an isolated entity. Partnering and collaboration bring benefits and extra competitive advantage for the players. The method presented here to reduce demand amplification focus on exploiting the supplier analogy to paper distribution.

The simplest and most widely used procedure for tackling the amplification problem by obtaining reliable information on true market demand is called visual control. This method is often used in part supply management. The idea is to have two "baskets" or "bins", so that while one is being used the other is being filled, i.e. manufactured by the supplier. An empty basket signals that more material needs to be ordered and usually the supplier guarantees that enough material is always available. In advanced cases, as in automobile industry, full responsibility for deliveries is given to the supplier. Parts are delivered to the factory in "waves", i.e. at pre-determined, fixed intervals. The process is

fine-tuned by reducing the size of the basket and the length of the replenishing intervals, i.e. capital invested in material stocks, as the procedure becomes a routine. When the material and the related information processes between factory and supplier are under control, attention may be directed to product and process development at both ends of the collaboration.

In the present case, the basket is located at the wholesaler, and it is the mill's job fill it at certain intervals. The basket has a safety level to buffer sudden fluctuations and correspondingly it has limited capacity upon which it cannot be filled. The length of the replenishing cycle defines the size of the basket, in order to ensure the necessary safety level. This cycle is entirely linked with the production cycle time at the mill. The longer the production cycle the more capital is tied up in inventories, and vice versa. The paper is sold from the basket. The true consumption of the paper is obtained by subtracting from the whole capacity of the basket the amount of material in the basket at the end of the cycle. This amount is then produced during and delivered by the end of the next cycle. The deficits of the baskets from all major wholesalers are collected at the same time, i.e. on a certain day of the week, to establish the overall consumption of paper. This information forms the basic demand for the paper grade. The final production lot is defined by taking into account other possible deliveries and, perhaps, by adding an extra 2-5% to the safety margin. Fig. 5 illustrates the method.

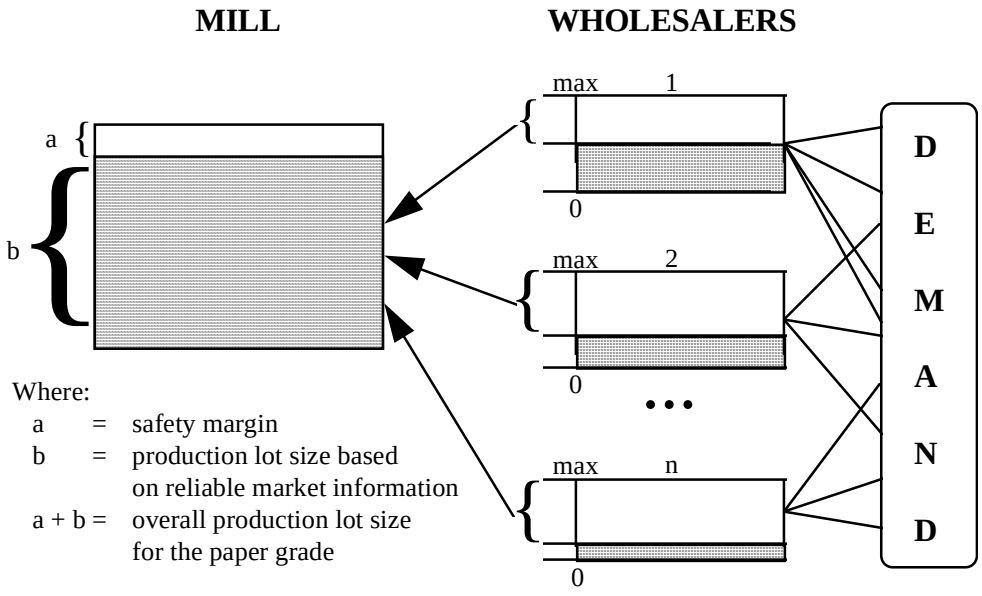

Fig. 5. The method of avoiding demand amplification by applying the supplier control analogy to paper distribution.

To implement the model information, production and delivery flows must be synchronised. This means that information has to be collected on a fixed date from all wholesalers. The date should just precede the beginning of the production cycle. Deliveries take place according to logistic constraints, which depend on each wholesaler's geographical location and the availability of transport vehicles. For example, depots abroad receive products according to ship or train arrivals and trucks may be scheduled to follow fixed routes. The idea is that each wholesaler receives the products on fixed date. Fig. 6 shows schematically how planning, production and delivery cycles are interrelated.

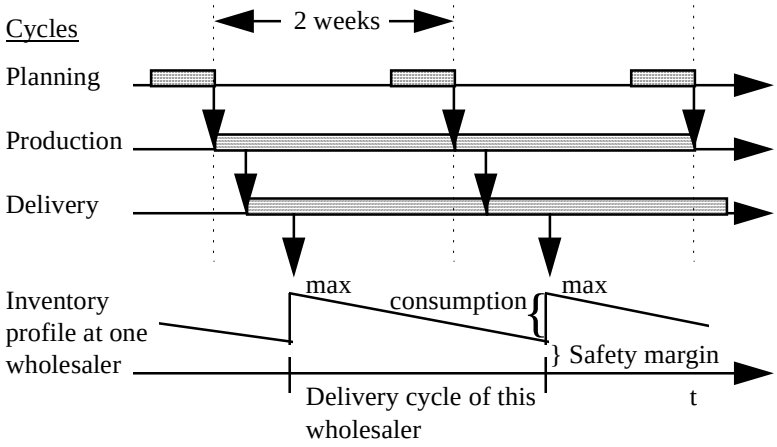

Fig. 6. Synchronizing the planning, production and delivery cycles, together with a view of the inventory profile at one wholesaler (production cycle time two weeks).

The fixed cycle approach between mill and wholesalers has been implemented in a few cases. The results have been reassuring, but there has so far been no full-scale application of the method. However, the use of similar methods in other industries similar to papermaking indicates that the method works. The following steps are needed to put the method into practice:

1. Define and fix the production cycle.
2. Select the bulk products and the main wholesaler customers.
3. Calculate the average cycle consumption by dividing the annual sales to selected wholesalers by the number of production cycles in a year.
4. Define the basket size for each wholesaler using the same calculation.
5. Study the frequency of deliveries to each wholesaler.
6. Adjust the results according to the sales budget.
7. Introduce the method to the wholesalers and if necessary start a pilot project with a few wholesalers.
8. While the method is being used, fine tune the cycle times and basket sizes.

Starting small but thinking big is certainly rewarded. Tuning the process into fluent daily routines takes time and effort from both parties. Pilot projects have shown that organizational resistance to the introduction of new methods is the main problem and that top management involvement and backing is needed. Yet, the method has proven to be intuitively and easily understandable and that if the will exists results may be obtained rapidly. There are many reasons for motivating the organizations to apply the method:

- The mill benefits from a levelling of demand and reduction in inventories with better turnover.
- The wholesaler takes an advantage of smaller capital invested in inventories and greater reliability of deliveries.
- Both benefit from well-defined and simple ordering and operational routines.
- The true fluctuations in market demand are also levelled through the many baskets in diverse market areas.
- A fixed and simple operating model gives the mill credibility in the customers' eyes and prepares the way for stepping up collaboration.

- The art of forecasting as an information source for decision-making loses its significance.
- The metrics of the mill's operating efficiency, i.e. cycle time and size of the baskets, are easily quantified and correlate direct with the overall production performance.

Conclusions

By applying the supplier control analogy from the engineering industry, paper mills gain more reliable information on market fluctuations. This enables them to avoid demand amplification, which disrupts bulk paper production schedules. The model presented here for integrating a paper mill with its main wholesaler customers establishes a well-defined protocol for controlling material and information flows. This way the mills get rid of the fallacy of demand prediction and in general reduce the workload related to conventional ordering routines. The method can easily be applied to other than bulk products, and mills can use it for their own purchasing procedures, e.g. with packing and wrapping suppliers. The simplicity of the method means it can be automated with state-of-the-art communication technology. Collaboration between mill and wholesalers is a decisive step towards full-scale control of the logistic network. It is certainly one of the keys for future competence and success.

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