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using web technology:
the experience of Aprilia in Asia V-Chain Project

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SUPPLIER CAPACITY REQUIREMENT PLANNING USING WEB TECHNOLOGY: THE EXPERIENCE OF APRILIA IN ASIA V-CHAIN PROJECT

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ABSTRACT

The paper describes the production planning model of the whole supply chain and the ICT (Information and Communication Technology) pilot implementation in the experience of Aprilia, the famous Italian motorcycle firm. The management model is based on a master production plan with increasing details and on a capacity requirements planning of the critical suppliers. An innovative ICT solution, based on open source WEB technology, is presented. Finally the application of the methodology for pilot Chinese companies is discussed: this test is carried out within the European Asi@ITC Programme, which aims at the technology transfer between Europe and Asia.

Keywords: ICT, Supply Chain Management, Capacity Requirement Planning

INTRODUCTION

Aprilia Group adopts a model of “network company” in which the production-distribution process is co-ordinated with a group of suppliers-dealers. The factory is not engaged in manufacturing but only in assembling final products. Aprilia decided to manage by itself the design and final assembly of vehicles as a mean to ensure flexible dispatch and control of finished product, leaving the manufacturing of all components to outsourcers.

Aprilia is aware that competitive advantage can be achieved outside the company through the adoption of increasingly fast and flexible organization and business models and the latest communication technologies to dialogue with partners, suppliers, third parties and customers. In particular, e-business strategies has to become an essential part of development model in order to govern efficiently the performance of the enterprise through global link-ups, integration of operating processes, total communication and information. This type of model increases the importance of decisions regarding flows of information between the company and outside world, stepping beyond the traditional activities of managing purchases and sales with ERP systems which integrate only internal processes; the company is considered as a combination of many independent enterprises that have to

meet the demands of their individual customers, internal or external, with a constant look on the market.

DEFINITION OF THE MANAGEMENT MODEL OF APRILIA

The definition of the management model of Aprilia requires three steps of analysis:

- *Analysis of Logistic Process.*
- *Analysis of Product Structure.*
- *Analysis of Production Planning.*

Logistic Process

The structure of distribution network and after-sale service is composed by subjects with different positions and rules through the logistic chain of distribution:

- *Aprilia and Aprilia Consumer Service* work in co-ordination selling vehicles and spare parts to Aprilia dealers and provide them with technical assistance and support for after-sale service.
- *Aprilia dealer*, independent from a corporate point of view, sells Aprilia vehicles and provides after-sales service to consumer;
- *APD (authorized public dealer)*, dependent from dealer but transparent to the corporate, sells motorcycles purchased from dealers and gives after-sale service.
- *Consumer.*

The dealers and APD represent the interface of Aprilia with final consumer; they generate two type of orders to the company:

- orders for stock based on demand forecasting;
- orders on sold against effective orders from a consumer.

The availability of products of dealers depends on the quantity in their stocks, on the quantity in the central stocks and regional stocks of Aprilia, as illustrated in the scheme of logistic process in Figure 1.

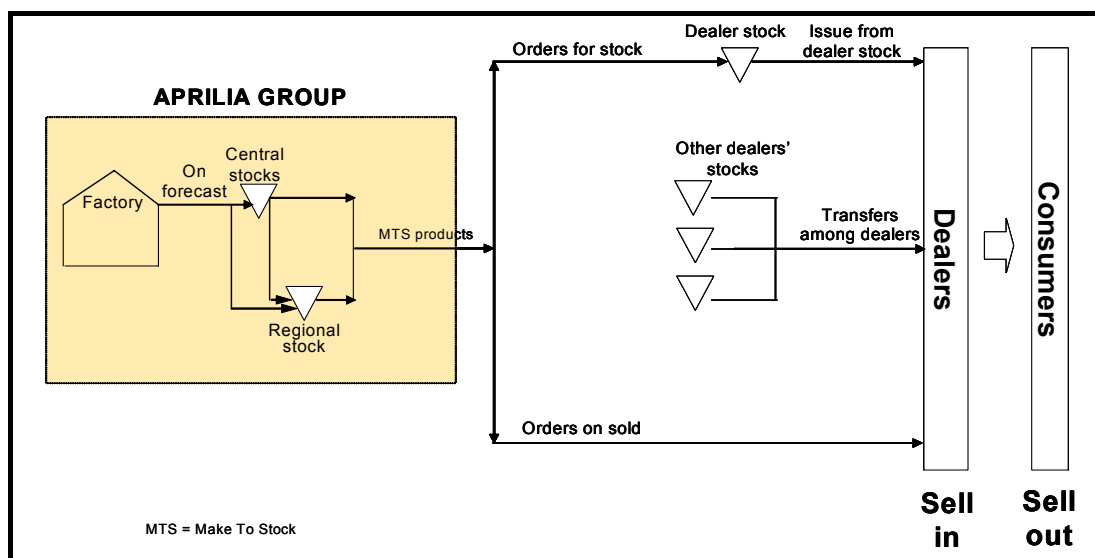


Figure 1 – Original logistic process in Aprilia

The analysis of the logistic process has shown some problems about the level of service and the amount of warehouses' stocks and stock in transit. The actual logistic process results inefficient in order to face the variety and variability of market demand. The causes of this situation are on the one hand in the long lead times and delivery times, on the other hand in the way of answering to market demand, that is, Make To Stock (MTS): in fact demand forecasting, on which production planning is completely based, is inevitably affected by uncertainty and errors, main reasons of over stock or stock out.

A new planned scenario is presented with five different solutions, shaded in Figure 2, which require an increasing integration level in the network of Aprilia Group.

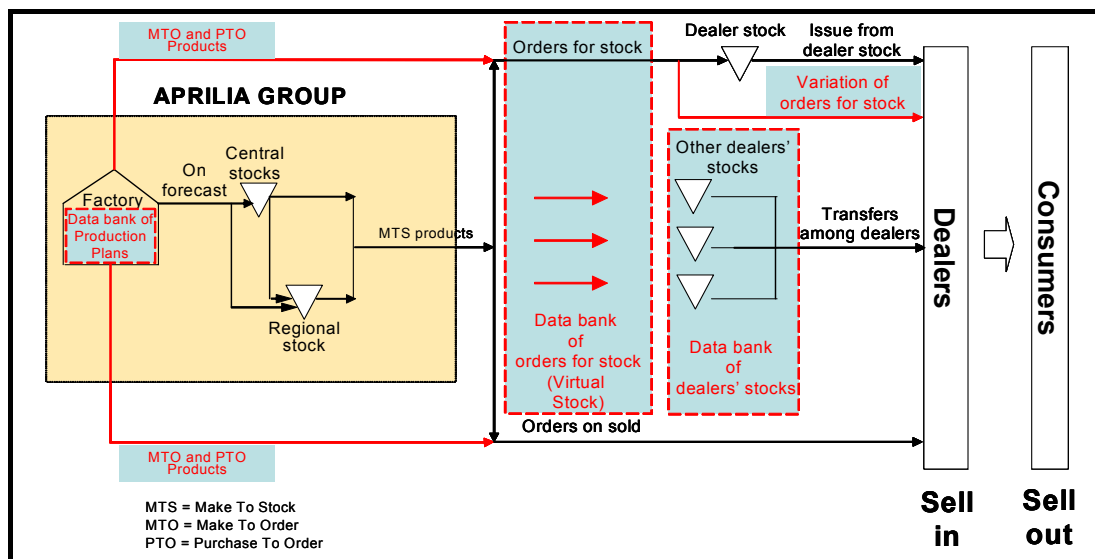


Figure 2 – Planned logistic process in Aprilia

1. Change from an MTS context to a new context where three different logics coexist according to the different predictability of products: MTS, Make To Order (MTO) and PTO (Purchase To Order):
 - High predictability products → MTS
 - Medium predictability products → MTO
 - Low predictability products → PTO
2. Variation of orders for stock by dealers. The dealer can change some characteristics of an order within a limited period of time before the planned date of beginning production. These variations are effected and confirmed by the ICT system which connects dealers to the company. The main benefits are a re-balancing of dealer' portfolio and a reduction of delivery time to final customer with a higher flexibility and efficiency in the matching process between orders and consumers and a considerable reduction of physical stocks.
3. Data bank of dealers' stocks in order to allow exchanges of motorcycles among dealers. The ICT system locates the searched model in order to manage its transfer among dealers: it is probable indeed to find an identical model in another dealer' stock. This system can simplify the research of a product but can not remove the inefficiency of negotiation and transport among dealers.

4. Data bank of orders for stock (*Virtual Stock*) visible to dealers, in order to allow exchange of orders among dealers. Every dealer can gain the access to orders for stock of the other dealers already present in the structure through this ICT system. This system increases the possibility of matching the orders locating an order of a model already in processing along the system and shortening the lead times. Moreover this logic avoids the physical transfer between dealers. This approach evidently requires a perfect integration between the company and the network of dealers.
5. Data bank of master production schedule visible to dealers, who may view the state of progress of their orders and the planned availability of products. This scenario increases the integration level of the previous one.

As pointed out the method of responding to the market based on MTS approach is inefficient; therefore there is the necessity to adapt it to changes in conditions with targeted methods of approaching markets, customers and products. The model of operation that the Aprilia group has to adopt attempts to combine the traditional MTS approach which can be used to manage products with large and established sales volumes and a targeted MTO approach for codes with small and uncertain sales volumes (first solution).

Product Structure

Aprilia has about 30 models among scooters and motorcycles with several final configurations taking into consideration different variants of engines, colours, nationality, accessories, etc.. The analysis of product structure has pointed out the variants of vehicles with small sales volumes: indeed the 20% of variants generates 80% of volumes and consequently 80% of total turnover. The 52% of variants sold has a produced volume, that is lower than 100 units per variant and generates a turnover of only 6.7% of the total. This type of analysis has allowed a distinction between the models which require an MTS approach from models which require an MTO approach.

Production Planning

Aprilia uses a network of about 300 suppliers including both small and large multinational firms, since 15-20 large companies are partners of Aprilia. There is no exclusive arrangement between company and its suppliers, which rely on the company for 20-30% of their production volume. Aprilia has not a clear classification between different categories of suppliers but only a generic distinction:

- The market suppliers, usually small factories, that furnish only minor components. Multi-sourcing policy is adopted only with this kind of suppliers.
- The integrated suppliers, generally considered as partners, are chosen according to their productive capacity and technical and technological skills. There is collaboration and synergy between Aprilia and them during the design of new motorcycles to develop prototypes and to decide the main phases of production on the industrial scale.

Aprilia uses different policies of production planning and order release (Figure 3):

- MRP has an horizon of 3 months with market suppliers while the frequency of recalculation and the detail are 1 month. The orders for minor codes with low value are released more seldom because they cover a long period of consumption and they are sent by traditional ways (e.g. phone, fax).

- MRP has an horizon of 3 months with integrated-supplier while the frequency of recalculation and the detail is 1 week. The orders are released very often because they concern critical components with high value and sometimes also with high storage requirements and they are published through a WEB interface which is accessible to suppliers.

Type of supplier/supply	Communication method	MRP horizon and frequency/detail
Market Suppliers	Fax/phone	M M 1 M 2
Integrated Suppliers	Web	

Figure 3 - The different policies of production planning and information communication

The analysis of the bill of materials and lead time of the suppliers allows the identification of the critical codes of Aprilia. It is possible to define the final configurations of the products at the latest, thanks to a production planning with an increasing detail (Figure 4). Indeed going on the time, during the checking of suppliers' capacity, this type of production planning freezes the orders of components (brakes, wheels, chassis, etc.) in medium term and the orders of finished products in short term.

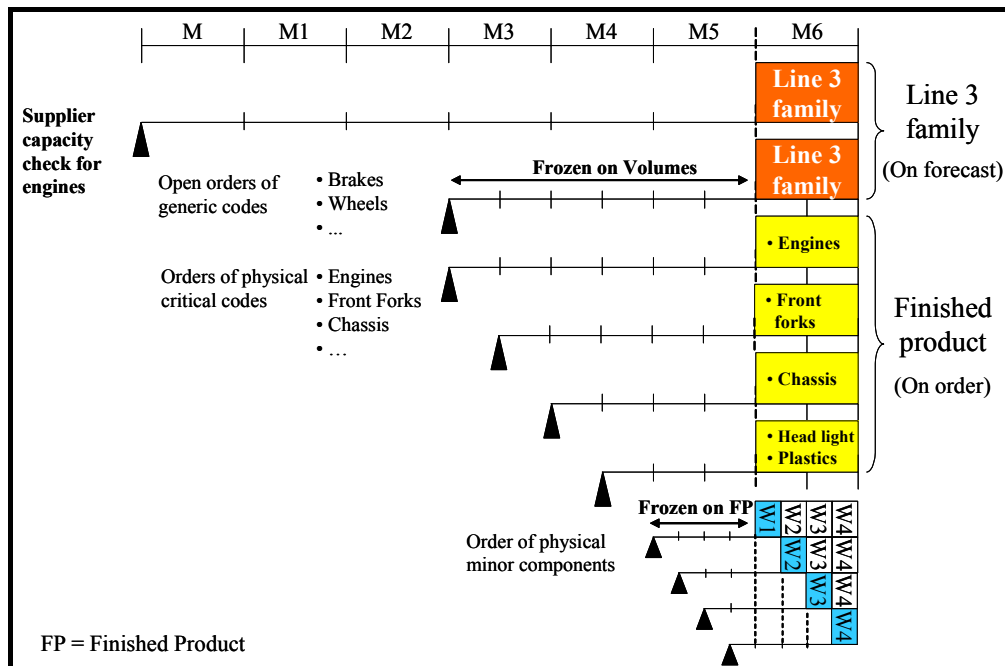


Figure 4 – Production planning with increasing details

The communication system between Aprilia and its suppliers is simple, except for the integrated ones. Orders are communicated and released by phone to smallest suppliers and then confirmed by fax: this kind of methodology is highly inefficient and time-consuming. Furthermore Aprilia doesn't receive updated information about suppliers' capacity and constraints; thus this lack of information causes unforeseen reschedule of MPS and assembly plan, as consequence of continuous supply renegotiations and delays in deliveries.

THE PILOT ICT SOLUTION

The system software developed, named Supplier Visibility System (SVS), is designed to close the loop (Figure 5) between an Enterprise Resource Planning (ERP) system and an Advanced Planning System (APS) of a company and suppliers.

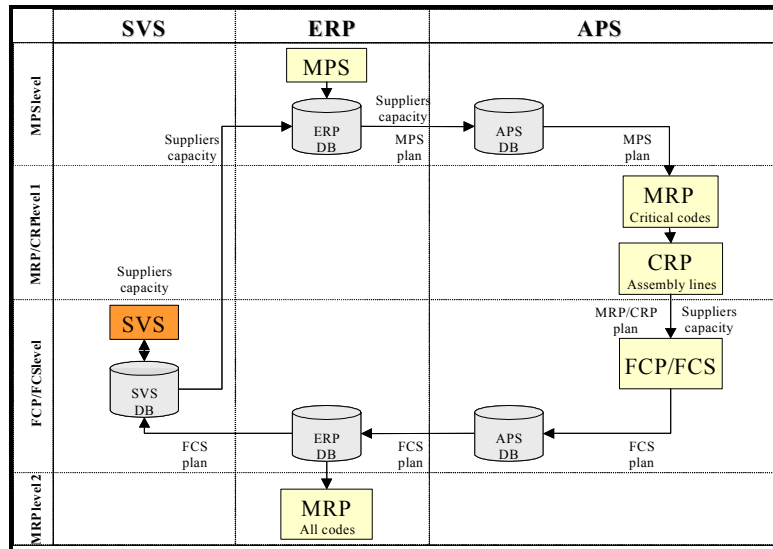


Figure 5 – ICT scheme of the new planning architecture

The SVS carries out the monitoring of the availability of materials and the capacity of suppliers and checks the feasibility of the assembly plans in real-time in order to solve the critical states highlighted above. The collected data allow to define a master production schedule and a final assembly schedule taking into account not only the internal constraints but also the external ones. SVS software architecture (Table 1) is developed with open-source tools and standard languages and with a WEB-based GUI (Graphic User Interface) and the connection between client and server is protected by the SSL protocol at 128 bit in order to ensure a high security level for the data transmitted between the companies.

Table 1- Software architecture of Supplier Visibility System

Software	Description of task
Server side	
MySQL	Standard SQL (Standard Query Language) RDBMS (Relational Data Base Management System) server to store all the data.
JRE (Java Runtime Environment)	Responsible for executing the software that interfaces the WEB with the database through the API (Advanced Programmable Interface) JDBC (Java Data Base Connectivity), which is the engine and generates the dynamic interface.
Apache Tomcat	WEB server necessary to publish the WEB-site, compounded by the static and the dynamic pages which are the interface of the SVS.
Client side	
Internet Explorer or Netscape	WEB browser capable to read the WEB pages written in HTML which are the static and the dynamic interface of the SVS.

The software is compounded by two modules (figure 6): Finite Capacity Planning Visibility (FCPV) and Finite Capacity Scheduling Visibility (FCSV).

1. The FCPV gives visibility of forecasted production volumes in the medium term to suppliers monitoring their productive capacity.
2. The FCSV gives visibility of assembly plans in the short term to suppliers monitoring their materials availability.

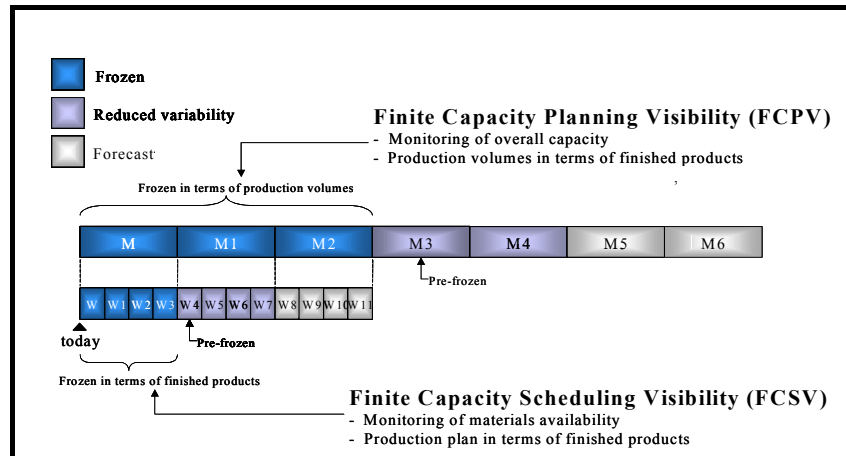


Figure 6 - Monitoring horizons of Supplier Visibility System

The SVS collects from the WEB the data about the capacity of suppliers and availability of materials and stores it into the database. This data can be used to schedule the assembly plans checking the declared capacity of each supplier in order to obtain internally (production capacity) and externally (supplier capacity) feasible assembly plans. The plan is imported into the SVS and the material requirements are evaluated and published on the WEB. The interface allows all the members of the Supply Chain to view the production forecasts and the scheduled plan within the monitoring horizon. The monitoring horizons are fully configurable (number and type of buckets, frozen period). When the production plan is imported, the software evaluates the material requirements using the bills of materials. Data inserted in each period are checked using maximum variations inserted in the set-up phase to respect supply contracts. Afterwards a comparison is performed between the forecasted material requirements based on production forecast and the availability of materials declared by the suppliers in order to find warnings. The automatic generation of supply warnings follows different logics and depends by the monitoring features (FCPV or FCSV module). At the end of each bucket a rolling mechanism is applied to freeze the forecast data of a pre-freezing period (figure 6). The rolling of the plan is executed using the freezing procedure from the planner menu in the interface: if there are some warnings in the pre-freezing period, the software avoids to execute the rolling of the plan, evaluates their criticism, finds a solution to suggest to the planning supervisor and visualizes the warnings. These ones are grouped by period, supplier and component code with different colours according to their critical state. The process works in real-time, because it is continuously repeated after a refresh-time; however there is the possibility to force the system against warnings in order to manage possible exceptions. This type of software architecture and the sensible selection of the programming languages and data base servers reaches important objectives:

- **Adaptability:** the software is fully parametric (products, bills of materials, suppliers, contracts,..) in order to fit different factory model and the adoption of the WEB as interface gets the number of reachable suppliers drastically increased.
- **Easy interfacing:** the software can easily be interfaced with other ICT systems present in the enterprises by the realization of custom data-filters.
- **Freeware status:** the software does not require the payment of licences.
- **Portability:** the software can be run on any software platform present on the market: Windows, Linux, Unix etc..

THE ASTEC PILOT IN ASIA V-CHAIN PROJECT

Asia V-Chain project¹ is carried out within the Asi@ITC Programme with the general aim to promote the access of Asian enterprises, in particular in Hong Kong and China, to European advanced and innovative organisational methodologies and ICT solutions. The management model and Supplier Visibility System are discussed for the use in a pilot Chinese enterprise: Astec Power. In China and in particular in the southern region of Guangdong and Hong Kong there are two major categories of firms: foreign invested enterprises, usually multinational corporations, and local firms. Large firms, like Astec, are often a Foreign Multinational Corporations (FMNC) which gain considerable resources in developing markets and high-tech products; FMNCs are generally much larger than local firms in terms of employees or in terms of real production and tend to have relatively high average labour productivity, average capital productivity, capital intensity, skilled-labour intensity, R&D intensity, profit rates and trade propensities.

Astec Power: logistic process, product structure and production planning

Astec Power (Astec) is a worldwide leading supplier of standard, modified standard, and custom AC-DC and DC-DC power supplies from 1 watt to 6 kilowatts with 14.7% of market share. In 1998, Astec became wholly owned subsidiary of Emerson Electric, headquartered in Carlsbad, California. Astec has three manufacturing plants with a total of 15000 employees: in Bao'an (5500 employees) and Louding (5000 employees) in China and Cavite in Philippines (4500 employees).

The overseas markets in the United States and Europe amount to 80-90% of Astec's annual sales turnover. The customers are categorized into 'ship-direct' and 'ship-to-hub' customers. Astec adopts an MTO approach for the 'ship-direct' customers: it receives indeed concrete sales orders, produces and then directly ships to them; the frozen time of Master Production Schedule is four weeks. For the 'ship-to-hub' customers, Astec adopts an MTS approach and production planning is based on forecast requirements with three weeks of frozen time. The company ships the products to the customer hub managed by a third party logistics providers.

Astec owns a Business Planning and Control System (Oracle) which gives great advantages to the company; the processing time is improved by another advanced planning system (Manugistics) perfectly integrated with the ERP system.

Materials cost contribute to 70-80% of the overall manufacture cost. On average Astec purchases the 70% of raw materials from overseas suppliers, while the remaining from local mainland China suppliers. The corporate procurement group for overseas suppliers is located in Hong Kong; these ones furnish above all electronic parts, while mechanical and plastics parts are purchased from about 250 local suppliers. Many local suppliers, named JIT suppliers, have their plants really close to Astec and require one-day notice for raw materials delivery. The 60% of locally purchased items are under 'sole-source' category with strategic and very close relationship with this type of suppliers. Other vendors are grouped in 'multi vendor' category.

¹ This work has been developed in the Asia IT&C project *Asia V-Chain* (Advanced Strategies and tools for Virtual Supply Chain Management in Asia environment) Contract: ASI/B7-301/97/0126-49 funded by the European Commission. The partners of the project are University of Udine, Universidad Politecnica Valencia and Chinese University of Hong Kong.

In the actual process (Figure 7) a number of key suppliers have signed up service level agreements with Astec promising to stock up certain level of rolling forecast requirements in the central warehouse, which is located in Hong Kong. DHL-Danza, the logistics partner, follows the approach of Vendor Managed Inventory (VMI) and performs the warehousing and stocking service on behalf of the suppliers.

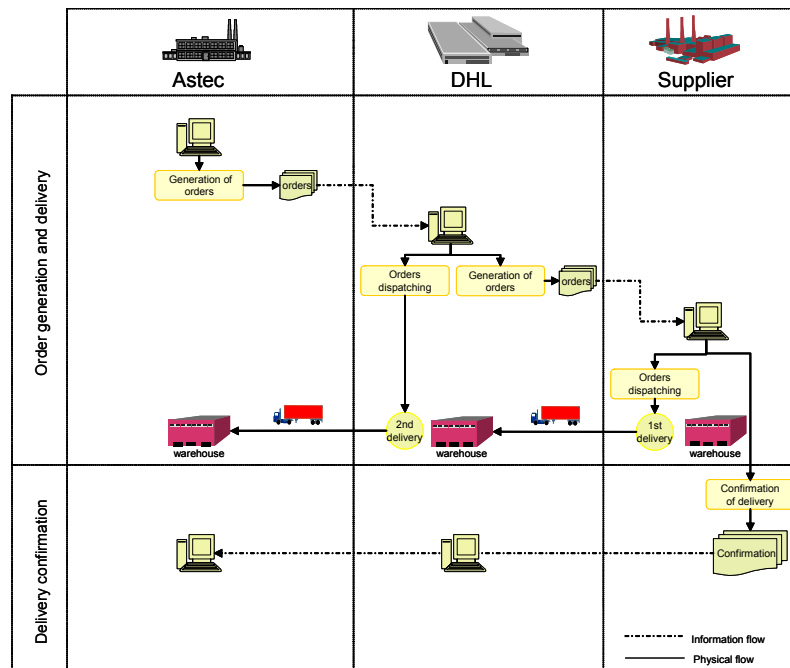


Figure 7 – Actual Process

On a daily basis, Astec provides a pull-list to DHL for picking and shipping to the plants on the next working day. Based upon the pull list, the supplier will send dispatch notes (XML type of inventory data) to Astec on the pull quantities delivered to DHL warehouse. This data can be linked up to Astec's planning system. However many incidents in the past have showed that the XML inventory data had discrepancies with the inventory physically resided in DHL warehouse. Therefore Astec planners have very low 'trust' level in data accuracy and refuse to have the data directly interfaced in the system. Without knowing the exact stock level and basing on the upcoming three weeks production requirements, company planner sends DHL inventory pull list; anyway occasionally DHL has not the sufficient stock level and alerts Astec planners on the exceptions but too late for taking action in avoiding downtime in production due to the shortages.

The application of Supplier Visibility System

This critical state can be solved by considering a previous additional process (Figure 8) with Supplier Visibility System. In fact SVS can by-pass the problem of deficiency of data accuracy between suppliers and Astec caused by a lacking visibility of the effective production capacity and availability of products before the shipment to DHL warehouse. This type of ICT allows a passage from an MRP (Material Requirement Planning) and CRP (Capacity Requirement Planning) of plant to an MRP and CRP of Supply Chain. The data about capacity and availability of codes from suppliers are evaluated during the manufacturing planning allowing a confirmation of MPS and MRP. Furthermore thanks to its simple architecture and its portability, SVS can be used also by less ICT structured

suppliers ('multi-vendor' category) that otherwise could not dialogue with the ERP system of Astec.

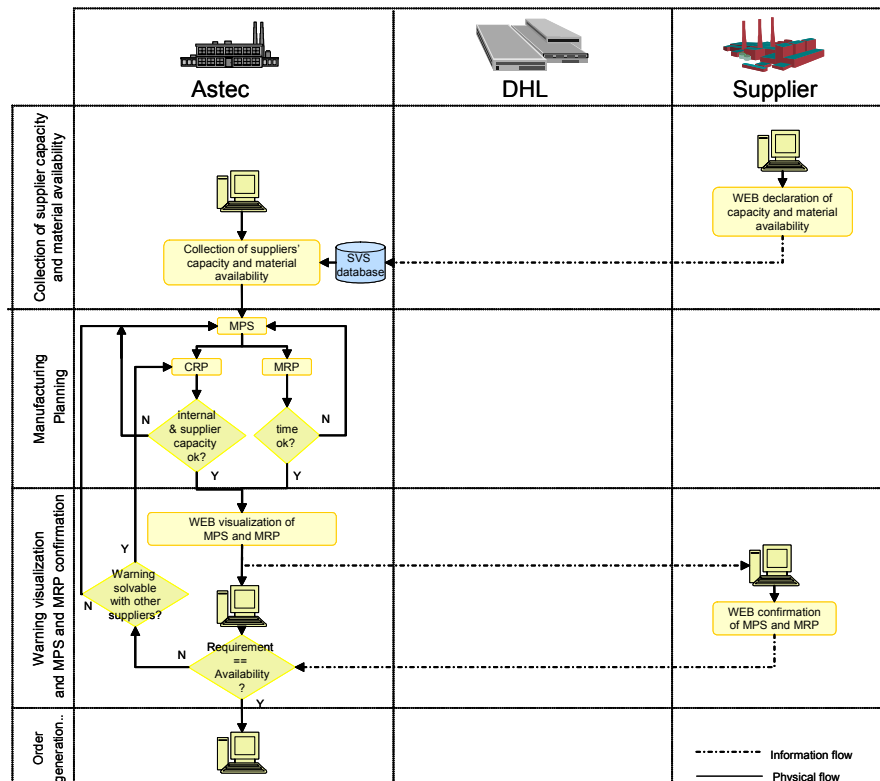


Figure 8 – Previous additional process

CONCLUSIONS

The SVS has been conceived, designed and implemented for a particular model of network enterprise, that is, the Aprilia group. The necessity of this type of software was born in order to solve the problem of communication with the suppliers which implied a great inefficiency in the manufacturing planning. The ICT system, presented in this paper, has demonstrated to be a software sufficiently generalized for the application in different situations. The critical state of Astec pilot is clearly different from that of Aprilia pilot but the wide applicability of the SVS allows its utilisation for different problems with the same lowest common denominator, that is, the relationship supplier-manufacturer. The problem of the transparency of information about capacity and constraints of the suppliers has an effect on the whole Supply Chain and it's common in every environment. The overturning of the advantages of the application of the SVS at level of manufacturing planning is quite evident but there are also advantages in the flexibility in answering to the market.

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